Essential Techniques for Bending Wood

Plus a Bent Wood Shelf Plan

Photo by Al Parrish

Bent Laminations

Make curved forms without getting steamed.

by Robert W. Lang

Comments or questions? Contact Bob at 513-531-2690 ext. 1327 or robert.lang@fwpubs.com

Most of the time when a piece of wood has a bend or a curve, it means trouble: Your stock is warped or bowed. But sometimes a bent part can add an interesting design element. The curved supports in these shelves transform what might be plain and ordinary into an interesting and contemporary design.

I usually like to keep things simple, which to me means using as few parts as possible. But when it comes to curved parts, such as the supports for these shelves, I form the curves by gluing together several thin strips rather than steam bending one piece of wood. This technique of bent lamination is faster and the results are more predictable than steam bending.

With steam bending, you need a boiler, a steam box and a way to quickly clamp a scalding-hot piece of wood to a form. Then you need to wait several days for the part to dry. With bent lamination you need only a form and a way to clamp the thin strips of wood to it. You don't need to wait an hour or more for the wood to get ready to bend and you don't need to race like a madman to get a hot piece of wood clamped in place. Once the glue is thoroughly dry, the parts are ready to use.

The techniques I used to build these shelves can be employed many different ways. Table aprons and chair backs are common uses for curved parts. Once the shape and size of the curve is determined, you build a form for gluing, and decide what thickness of strips to use to make the curved parts.

Instead of making a giant compass, I draw the curve by bending a thin strip of wood across the layout marks. Finish nails hold the shape while I mark the curve with a pencil.

After smoothing the first piece, rough-cut parts are then added to the form. A flush-trimming bit is used in the router to make identical curves for the bending form.

Make an Educated Guess

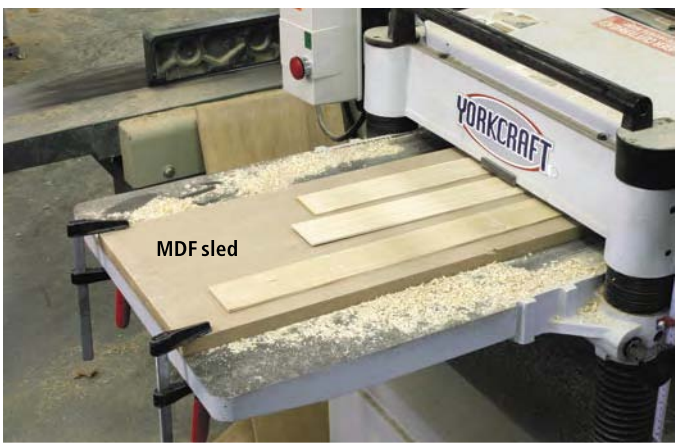
I like to use the thickest strips possible to minimize the number of parts and glue lines. The more strips in the lamination however, the stronger it will be, and the likelihood of the curve springing back away from the form will be minimized.

To get the finished thickness of $^3/_4$", I could use four strips $^3/_{16}$" thick, six strips $^1/_8$" thick, eight strips $^3/_{32}$" thick or a dozen pieces $^1/_{16}$" thick. It all depends on what wood is used and how tight the radius of the curve is.

I make a good guess at a thickness, and resaw a piece of the material to that size. I then bend the piece to roughly the curve I want. If it's difficult to bend, or I hear any popping or cracking noises as I make the bend, I try again with a slightly thinner piece. For this project, which uses ash, I started at $^3/_{16}$" thickness but ultimately decided to use $^1/_8$" for the strips to make the shelf supports.

The next step is to build the form used for bending the curved parts. The shelf supports finish at 2" wide, but the laminations are glued together at $2^1/_2$". The extra width means I don't have to worry about keeping all of the edges perfectly lined up during gluing. After the glue has dried overnight, I can get a clean edge on the jointer, and achieve the final width by ripping the part on the table saw. One more light cut on the jointer will remove any saw

Resawing strips on the band saw is safer and less wasteful than using the table saw. I cut them a little thicker than necessary, clean up the saw marks, and bring them to final thickness with the planer.



Thin pieces can be sent through the planer on a sled, a piece of 3/4"-thick MDF that extends past the feed rollers and is clamped to the planer bed.

Polyurethane glue can be messy as it cures. I use a thin bead of glue and spread it out with a putty knife to avoid this.

marks. A few quick swipes with a card scraper leave the edges ready for finishing.

To get the 2 1/4" thickness for the form, I used three layers of 3/4"-thick birch plywood cut to the inside radius of the curve, and a fourth piece as a base plate. It doesn't matter what the form is made from; I used material that was left over from another project. I would have used particleboard or medium-density fiberboard (MDF) if I had found a piece of that first.

The radius is 56 11/16", which would require a long trammel to draw and cut the curve. Instead, I simply marked the end points and centerline of the curve, and marked off the 4" rise at the center. I then drove a 4d finish nail at each of these points, and bent a thin strip of wood across them.

It takes three hands to bend and mark the curve. If you don't have someone to help you, drive finishing nails at an angle close to the points used to define the curve. With the midpoint inside the nail, and the ends outside, the thin piece will hold its shape. You can bend the nails to position it exactly where you want it. I cut the curve on the band saw, being careful to saw just outside the pencil line. Then I used #80-grit sandpaper wrapped on a block of wood to get the curved edge smooth.

The First Part is the Pattern

The first layer of the pattern is the only one that requires this much work. The remaining pattern pieces can be marked by tracing the first one. After cutting them slightly oversize, they are attached to the first piece with half-a-dozen #8 x 1 1/4" screws, and the edges are trimmed with a flush-cutting bit in the router.

After attaching the base plate, the surfaces of the form were given a couple coats of paste wax to keep glue from sticking to them.

Now make the strips for the laminations. They can be ripped on the table saw, but it can be dangerous to work with parts that thin, and nearly half of the material will be lost to the saw kerf. By using the band saw, the operation is much safer and less material is wasted. I cut the strips to 3/16" and took them down to the finished thickness of 1/8" by sending them through the thickness planer. I clamped a piece of scrap MDF to the planer bed to carry the thin pieces. Because the ash I used was straight grained, I didn't worry about the edge grain matching, and cut all the strips I needed from 4/4 stock.

In addition to cutting the strips wider than they need to be, I also cut the strips about 6" longer. When you glue six pieces together at a time, they can slide around some, and each layer is slightly shorter than the layer next to it. It's easier to leave them long and trim them when you're done.

Get Ready to Glue

Before attempting a glue-up, I made a dry run to make sure my clamping method would work, and that everything I needed was at hand. To form a fair curve, pressure must be evenly applied. This means a lot of clamps placed closely together. During the dry run I determined that 4" or 5" apart was a good spacing.

Typically I use yellow glue for most of my woodworking but bent lamination isn't a standard process. The wood wants to straighten back out, and yellow glue is somewhat flexible after it's dry. A glue that dries more rigidly should be used. Epoxy, plastic resin and reactive polyurethane all dry to a rigid line. I chose to use polyurethane (Gorilla Glue) because it doesn't need to be mixed before using.

I laid the strips out in order, and put a thin bead of glue down

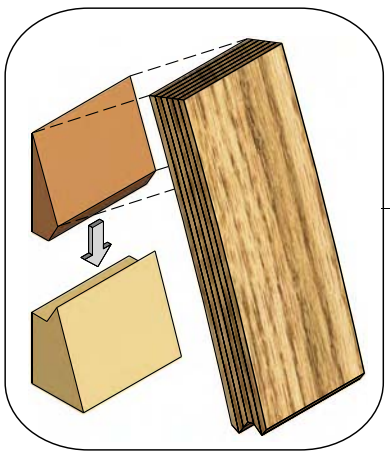
the middle of each strip. I then used a putty knife to spread out the bead evenly across each strip. I stacked the strips back up, and placed them in the form. I started clamping in the center, and worked out to the ends, alternating right and left.

Each lamination was left in the clamps for four hours to dry. After removing the bent part from the form, I scraped off the excess glue. After the last part was removed from the form, I waited another 24 hours to be sure that the glue was fully cured before moving on to the next step.

I cleaned up one edge of each curved piece on the jointer. I then carefully ripped each part to 1/32" over the finished width on the table saw. This can be done safely by keeping the part flat against

Starting at the center and working out to each end, clamps are placed every 4" to 5" around the form.

After scraping off the excess glue, one edge is evened up on the jointer. Make sure to keep the curve in contact with the fence on the outfeed side of the cutterhead.

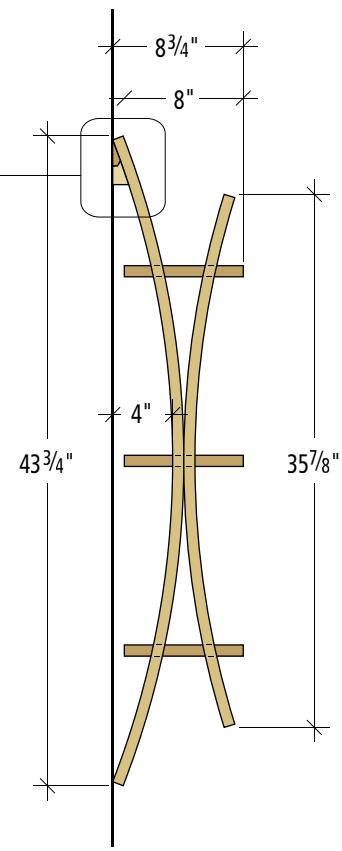


Hanging blocks

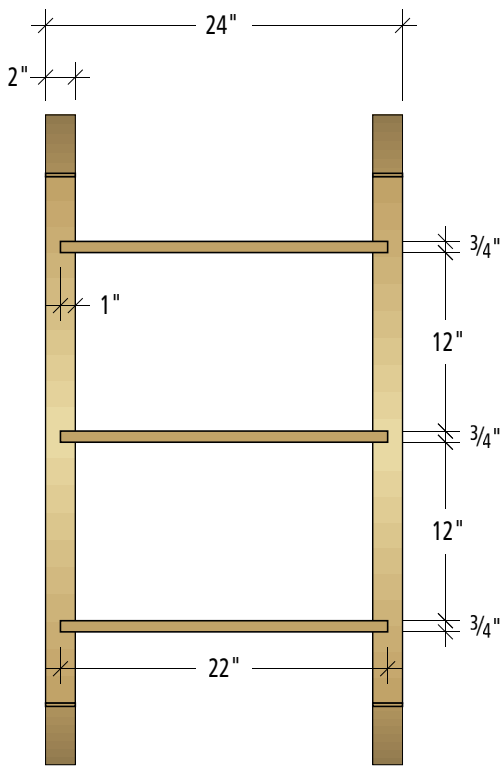
BENT-LAMINATION WALL SHELF

	NO.	ITEM	DIMENSIONS (INCHES) T	W	L	MATERIAL	COMMENTS
❑	2	Rear supports	3/4	2 1/2*	54*	Ash	From 12 1/8" pieces
❑	2	Front supports	3/4	2 1/2*	54*	Ash	From 12 1/8" pieces
❑	3	Shelves	3/4	8	22	Ash	
❑	4	Hanging blocks	1	1 1/2	1 3/4	Ash	Cut from larger block

*Sizes reflect overage for trimming



Profile



Elevation

the table and tight against the fence at the infeed edge of the saw blade. After this cut, I returned to the jointer and removed the saw marks with one pass over the machine's cutterhead.

Form Does Double Duty

To make the 3/4"-wide x 1"-deep notches in the supports, I put them back in the gluing jig. I added spacers below them to keep the top of each piece flush with the top of the jig. I added guide strips to the form to guide my router when cutting the notches. To prevent making two lefts and no rights, I didn't trim the ends to their final lengths until all the 3/4" notches were cut and the pairs of curves were glued together.

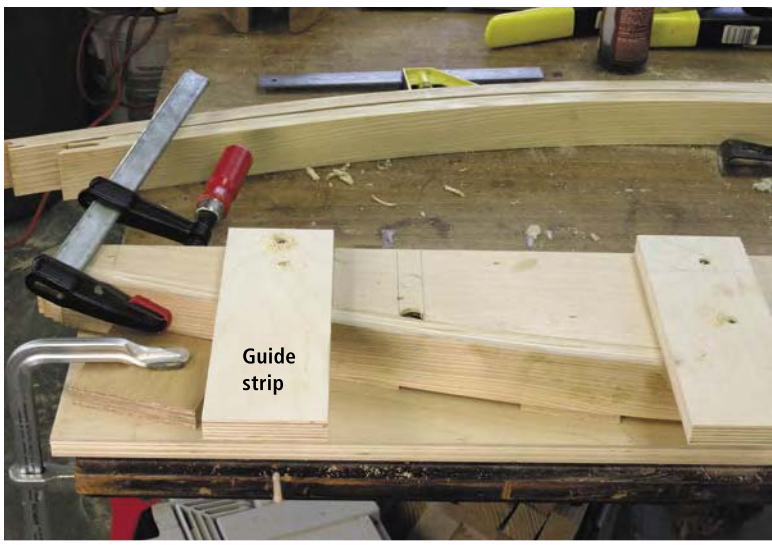
I marked the center 2" of each piece and planed a flat in this area with my block plane. I clamped pairs of curves together, using scraps of wood to keep the notches aligned and in the same plane. After the glue had dried overnight, I marked the ends of the uprights from locations marked on the bending form and trimmed the ends with a handsaw.

I used my smoothing plane to fine-tune the fit of the shelves to the notches. I scraped all of the parts and then hand-sanded them with #220 grit before assembly. The ends of the shelves slide into the notches and are simply glued and clamped.

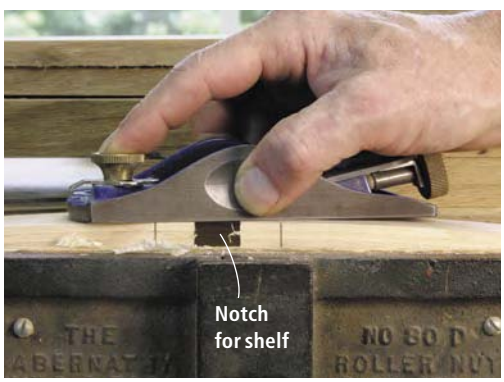
It's a bit of a challenge to keep everything lined up during assembly. I started the shelves in the notches before brushing in glue.

To keep the shelves aligned while clamping, I placed 3/4"-thick sticks on my bench to support the back edges. This is the distance from the wall in the finished shelf. I also made sure that the ends of

The other edge is ripped on the table saw, maintaining contact with the table on the infeed side of the saw blade.



Use layout lines on the top of the bending form to attach guide strips for the router. Working from the center, I also established lines for the ends of the supports. Then I notched the curved parts for the shelves with the router.



With the finished part back in the jig, I lay out a 2"-long flat at the center of each curved piece and then plane it by hand. Check the fit by measuring the space between the two parts at the shelf locations.

The ends of the shelves fit in the notches. Adjust the fit with a few swipes with a smoothing plane. Mark the support locations on the bottom of the shelves to keep the parts in line during assembly.

the back uprights were flat on the surface of the bench.

After a final hand sanding with #280 grit, I finished the shelves with three coats of lacquer sprayed from an aerosol can.

Curved parts aren't hard to make, and can be both structural and visually interesting. The ability to make them adds to the skills that make a well-rounded woodworker. **PW**

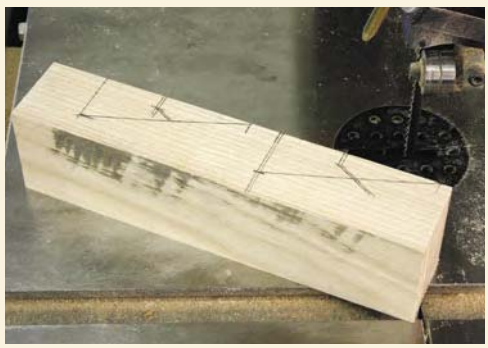
Line up the shelves in the notches, then brush glue on all surfaces of the joint.

Assemble the shelves on a flat surface, making sure the ends are flat on the table. Square sticks keep the backs of the shelves in position.

HANGING THE SHELVES

To hang the shelves, I made two small blocks to fit behind the top of the back uprights.The dimensions of the blocks aren't critical, but they need to fit neatly together, and be tight against the inside of the curved support. I started with blocks larger than I needed so that I could cut them to shape while keeping my fingers a safe distance from the band saw blade. After cutting the blocks to shape I fit the curved edge to the back of the shelf support.

These can be fastened to a wall with Zip-it anchors (available from your local home center) after drawing a level line on the wall. The matching half of the hanger is glued to the back of each of the curved uprights. To hang the shelf on the wall, it is simply dropped in place on the hangers. *– RL*



Lay out the hanging blocks on a piece of wood big enough to let you cut them safely on the band saw.

Cut the curve first, then make two short cuts to form the interlocking joint. The last cut frees the hanger from the block.

The bottom half of the hanging cleat is attached to the wall forming a hook.

The other half of the hanger is glued to the back of the shelf support, letting the shelves hang nearly invisibly.

Bending Wood the Wright Way

Cold bending is a whole lot easier with this flexible clamping fixture.

In my mind, there are three classifications of woodworking techniques. There are many that I classify as "useful," a smaller number that I think of as "indispensable," and then a very few that represent a true breakthrough in woodworking technology. Bending wood is one of the latter.

The ability to alter the grain direction as our imagination dictates while preserving the strength inherent in a straight piece of wood allows us to create the elegant beauty of a continuous-arm Windsor chair and the inspiring sweep of a vaulted ceiling. We first explored our world in sailing ships with bent wood hulls, then left it in airplanes with bent wood wings. Our world would be much less beautiful and much less exciting without this simple woodworking technique.

I'm currently engaged in a woodworking project designed to create a little excitement, and bending wood is at the very heart of it. I'm part of a group of historians and aviators who are recreating the six experimental airplanes of the Wright brothers, beginning with their model glider of 1899 and ending with the 1905 Wright Flyer 3, the first practical airplane. The frames of these primitive aircraft are a collection of bent wood parts — ribs, wing ends, braces and skids — ingeniously arranged to catch the wind and lift a man into the air.

Photos by Chris Schwarz

True Geniuses Prefer Cold Bending

When most of us hear the words "bending wood," we think of steam bending. The wood is heated briefly in low-pressure steam to soften the lignin (a glue-like protein that holds the cellulose fibers together). While the wood is still hot, it's clamped into a bending form. The cellulose fibers telescope to conform to the curve, and the lignin cools to hold them in place. Or almost. In actual practice, the fibers never quite conform, and when you remove the wood from the bending form, there is a great deal of springback — the wood loses some of its curve. If the wood is not attached to the other parts in the project so as to hold the curve, it may continue to relax and it will spring back even more. This problem plagued the Wright brothers while they were doing their glider experiments — they calculated precise curves for the ribs to fly as efficiently as possible, only to have the ribs relax and lose a good deal of curvature before they could get their gliders in the air.

To solve this problem, they eventually abandoned steam bending for an early form of cold bending. They arranged the parts of the ribs for their Flyers in a bending form, then nailed them together with brads. They could not use glue — the adhesives 100 years ago were not weatherproof. A good rain and the wings would have come apart.

Fortunately, we have a much larger and more reliable selection of adhesives to choose from than the Wrights. We decided to make the bent wood ribs of our replica Wright gliders by laminating the parts with a water-resistant aliphatic resin (yellow) glue. You could also use Resorcinol, epoxy or polyurethane glue for an application like ours. If your project won't be exposed to the weather, you can use almost any good wood glue.

To cold-bend wood, first resaw your

stock into thin strips and plane it so the thickness is even. The thickness of the strips depends to a large extent on the radius of the curve. The tighter the radius, the thinner the strips. I use this chart as a jumping-off point:

- 2" to 4" radius — 3/32" thick
- 4" to 8" radius — 1/8" thick
- 8" to 12" radius — 3/16" thick
- 12" radius or larger — 1/4" thick

There are other factors to consider: the species of wood, the slope of the grain (as it runs between the faces of the strips), the strength you want, and the amount of springback you can tolerate. For maximum strength and minimum springback, we decided to glue up the ribs from 1/8"-thick strips, although the radius of the curve was nowhere near 8".

Stack the strips as you will glue them together. If you use strips that were all resawn from the same board, flip every other strip end for end to reverse the grain slope. Spread a thin layer of glue on the face of one strip, lay the next strip on top of it, spread more glue and repeat. If you're laminating a large number of strips, you may want to choose an adhesive with an extended working time.

Before the glue sets, clamp the laminated strip in the bending form. Let the glue set up for its full clamp time. If you're not sure of the clamp time, wait a full day before you remove the assembly from the bending form. As you release the clamps, there will be a small amount of springback. If the curve is critical (as it was for our glider ribs) make the curves in the bending form slightly tighter to compensate.

Making a Cold Bending Form

Pretty simple, huh? The only real trick to cold bending is in making a form that will apply an even clamping pressure all along the laminated assembly. Traditional bending forms consist of two parts, the form (the positive shape) and the press (the negative shape). Both of these parts are normally cut from the same stock. Begin by drawing the curve you want on the face of the stock. Cut the curve with a band saw, separating the stock into two parts. On the negative part, mark the thickness of the bent wood part. (Tip: Use a compass like a calipers, set it to the desired thickness. Follow the curve with the point of the compass, marking the thickness with the scribe.) Cut away the thickness on the band saw — this will create the press.

The trouble with this traditional bending form is that the press doesn't compensate for small variations in the thickness of the laminated stock or a band saw blade

Help Kids Build a Wright Flyer

The most exciting woodworking project in 100 years.

The year 2003 will mark the 100th anniversary of the first controlled, sustained flight. On Dec. 17, 1903, Wilbur and Orville Wright flew their first powered aircraft, called simply the Flyer, 852 feet across the sands of Kitty Hawk, North Carolina. This coming anniversary presents a unique opportunity to get young people all across America excited about aviation — and woodworking!

A replica of the Wright Brothers' 1900 Glider that Nick Engler built and got airborne at Kitty Hawk, N.C., in late October.

The Wright brothers built the gliders and airplanes in their workshop in Dayton, Ohio. These machines were largely made of wood: spruce for the straight parts, ash for the bent parts and a little boxwood for the pulleys. The end result of these labors was that the Wrights, by virtue of their ingenuity and craftsmanship, achieved the age-old dream of flight. The story of their woodworking projects has become one of the most inspiring stories in American history.

That said, it is becoming harder and harder for young people to acquire the woodworking skills that gave us the airplane and a thousand other useful and beautiful innovations. High school shop programs are becoming a thing of the past. Vocational schools train students for industry, which relies more and more on computer-aided manufacturing. The old manual machine setups — what we use every time we make a cut or drill a hole — are no longer being taught on a wide scale, and our craft will suffer if we don't find other ways to introduce young people to the joys of woodworking.

***Popular Woodworking* has lent its support to a unique program of the Wright Brothers Aeroplane Company (WBAC) of Dayton, Ohio, that addresses these concerns directly. The WBAC is a non-profit educational organization of craftsmen, historians and aviators who are building replicas of Wright aircraft, including the 1903 Wright Flyer. They will build the Flyer with the involvement of young people across America!**

Here's how it works: The WBAC has scripted a learning experience for kids ages 10 to 18 during which they learn a little aviation, a little history and a little woodworking. During this experience, which takes just a few hours of a morning or an afternoon, the kids build 1/4-scale ribs of the Flyer that they can take home. Then the whole class comes together to build a full-scale rib. The kids sign it and send it to the WBAC in Dayton, Ohio. There, more kids under the supervision of accomplished craftsmen, will assemble the ribs in a replica Flyer, that's 40 feet from wingtip to wingtip.

And that's not all. Each of the kids who works on a rib gets to sign it. The WBAC also invites each young person to make a prediction about what the next 100 years of aviation will bring. All the signatures will be preserved on the replica Flyer, and the predictions will be edited and assembled into a large book. The completed kid-built Flyer and the book will be unveiled at the Dayton International Airport on December 17, 2002 (a year before the centennial anniversary), where it will serve as a milepost in both aviation and craftsmanship, pointing 100 years back and looking 100 years forward.

We're looking for woodworkers to serve as teachers and mentors to help conduct these learning experiences and to communicate the thrill of building something wonderful to children. The WBAC will send you information on these experiences if you'll just raise your hand and say "I'll do it." You can contact them through the Internet a www.wright-brothers.org, or write Wright Brothers Aeroplane Company, Kids Build a Flyer!, P.O. Box 204, West Milton, OH 45383.

Meanwhile, we'll continue to report on this exciting woodworking project as it progresses. PW

Spread the glue on the surface of each strip with a 3/8"-32 threaded rod to draw the adhesive out as evenly as possible. Note that I've placed the strip on a long scrap to elevate it above the bench. This allows the extra glue to drip over the edge.

Clamp the laminated strips in the bending form, spacing the clamps every 3" — dead center in the middle of each segment of the press. I drilled 1 1/4"-diameter holes in the form to hold the top face of the clamps and automatically space them.

Before you tighten the clamps, just snug them up to hold the stock against the form. With a scrap of wood and a hammer, tap the top edges of the strips to even them up. Then tighten the clamps until the gaps disappear between the laminations.

that wanders a hair off the line. Consequently when you apply the clamps, the clamping pressure may not be completely even all along the form. This may result in weak laminations or even gaps between the laminations when the glue dries.

To ensure that this didn't happen to our glider ribs, I designed a compensating press. After cutting away the thickness of the bent wood part, use the compass to mark yet another curve on the negative part, this one 1" larger in radius than the curve you just cut. Saw this curve then cut the 1"-thick piece into 3"-long segments. Adhere the segments back to the negative part temporarily with double-face carpet tape. Glue a strip of canvas to the inside curve of the segments and cover the canvas with 6-mil plastic.

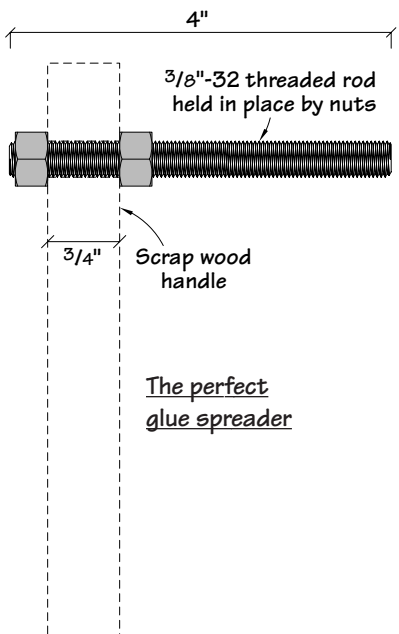
When you separate the segments from the negative part and discard the tape, they should be held together by the canvas like the tambours of a rolltop desk. This is your press. When you squeeze the laminated stock to the form, arrange the clamps in the middle of each segment; this will compensate for any variation in stock thickness or inaccuracies in the bending form and keep the clamping pressure relatively even.

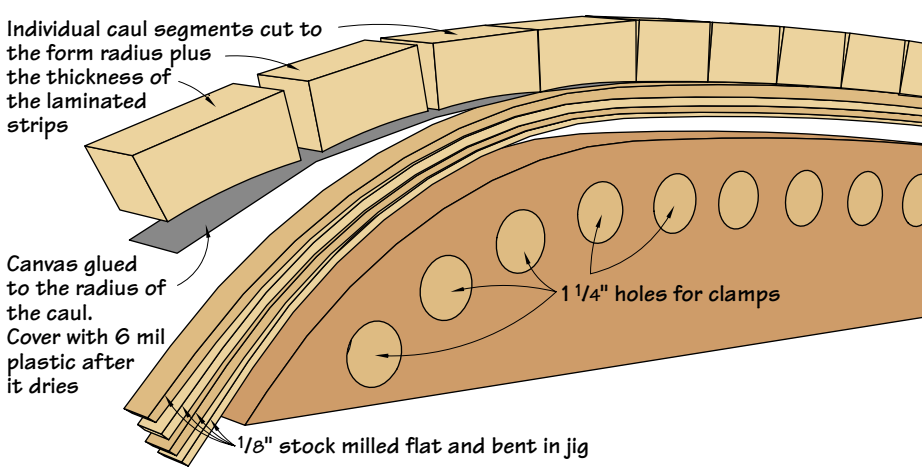
Note: The plastic on the press will keep any glue that squeezes out from between the laminations from sticking to the canvas. To prevent the squeeze-out from sticking to the form, apply paste wax to the form before each glue-up.

Spreading the Glue

Just as uneven clamping pressure will reduce the strength of the lamination, so will an uneven application of glue. You must spread it as evenly as possible, and I've got just the ticket. This little trick was shown to me by the good folks at Franklin International (makers of Titebond glue). Get rid of your glue brushes and spread the glue with the teeth of a 3/8" x 32 threaded rod. The threads spread the glue to just the right thickness (about 0.005") for a strong joint with a minimum of squeeze-out. For this particular project, I mounted a short length of threaded rod in a wooden handle. Between glue-ups, I keep the rod submersed in water to prevent the glue from drying on the threads. **PW**

Nick Engler is a craftsman, pilot and the author of 52 books on woodworking. He's also the director of the Wright Brothers Aeroplane Co. — you can find out more about the Wright aircraft he's helping to build at www.wright-brothers.org.





Bend the Laws of Lignum

BY CHRISTOPHER SCHWARZ

A recent innovation lets you bend wood without steam or adhesives.

I can bend that. *With Compwood, you can bend wood in ways that are surprising. When the wood dries, it holds its shape and can be worked with standard woodworking tools.*

The package of wood looked everything like a mummy when it arrived in our shop. The wood was wrapped in clear plastic, bound by plastic straps and wrapped by more plastic and cardboard.

We peeled away each layer to reveal a stick of unassuming 8/4 ash that was about 6" wide and 54" long. Aside from the fact that the wood was cool to the touch, it looked like regular ash.

I took it to the jointer and planer and machined it flat. I ripped off a 1"-wide slice and machined that to 1 3/8" thick, just like any other piece of wood.

But then I put that stick into a bending form, and the wood gave up its secret identity. Working alone, I bent the piece of ash along its 1 3/8" dimension and pulled it around a C-shaped bending form with a 9" radius. In 10 minutes, the wood was bent and clamped up. No steam or heat. No adhesives.

This is Compwood, a 1988 European invention that allows you to bend room-temperature wood around a form in multiple dimensions. The lumber comes to your shop wrapped in plastic because it is fairly wet – my piece of ash measured 20 percent moisture content.

"The New Age? It's just the old age stuck in a microwave oven for 15 seconds."

— James Randi (1928-)
magician, skeptic

While it's wet, you can bend the wood in almost any direction. When it's dry, it holds its shape and can be worked just like any other piece of wood.

Why Try It?

I became interested in Compwood when I saw it in use at Jeffrey Miller's woodworking shop in Chicago. He's been experimenting with the material to use in some of his chair designs and he showed me how it works. Intrigued, I purchased some for my own chairs, and I first cut into this batch to make some arm bows for some Welsh stick chairs.

The Compwood appealed to me for several reasons. While expensive, the Compwood allows me to make my arm bows without investing in a steam box, which I don't have room for. Also, the material allows me to bend wood to a tight radius without a bending strap and without the risk of compression ruptures on the inside curves or delaminations on the outside curves.

How tight? There's a formula for each species. For ash, the smallest bending radius without a strap is six times the thickness of the work being bent. So my 1 3/8" arm bow could be bent to an 8 1/4" radius or larger. So a 9" radius could be bent without a strap.

The Compwood is also less labor- and machine-intensive than a typical cold-lamination job. When I make cold laminations, I typically have to sand all the pieces down to 1/8" thick or less for tight bends – that's a lot of machine work. And I prefer to use plastic resin

Flexible terms. *Compwood can be bent without steam or – in many cases – a bending strap. It also can be bent in three dimensions.*

LEAD PHOTO BY AL PARRISH; STEP PHOTOS BY THE AUTHOR

glue for these parts, and it is nasty and messy stuff.

While I probably wouldn't consider the Compwood if I made hundreds of chairs for a living (I'd probably invest in a steam box), it did make sense for me for a short run of chairs.

How to Dry it

So how did the material fare? I found that it worked as advertised. After clamping up my arm bows, I let the wood air-dry in the form for a day, and its moisture content dropped to about 12 percent. Then I placed the form in a box that was heated with a lightbulb to 85° F and the work quickly dropped to 7 percent, according to our pinless moisture meter. That's when I first removed it from the form.

The piece sprang out a little at the ends (though it was nothing unacceptable). The reason for the springback was that the wood likely wasn't completely dry.

My makeshift "kiln" wasn't ideal. Miller makes his kilns out of 2"-thick pink foam insulation boards then heats the kiln with a ceramic heater with a fan. His kilns are leaky, which is good because it allows the moisture to escape. He leaves parts in his kiln for about a week. The results were impressive.

"It was pretty much flawless from a springback perspective," Miller says. "It didn't move a bit."

Relax(ed). *One of my arm bows sprung out a little after being released from the form before the arm bow was completely dry. Back onto the form for you.*

Chris Mroz, who makes and sells Compwood to woodworkers and industry through his company, Fluted Beams, says that I probably removed the wood from the form too soon. For a piece like mine, he would dry it at 110° F for about six days. If he were to air-dry it, he would leave the piece in the form for two or three weeks. So I clamped my arm bows back into the form and let them sit.

How the Stuff is Made

The way Compwood is made is just as interesting as using it. Compwood is made by first steaming the wood at 212° F until it becomes plasticized. Then it is placed in a press that compresses the wood in length. A 3-meter-long piece of wood will end up about 2.4 meters long when in the press. When the press is released the board will expand again, but it will have lost about 5 percent of its length.

This time in the press bends the cells of the wood like an accordion. The structural change in the cells is what allows the Compwood to bend when it is in a cold but wet state.

Not all species work with this process, but the range is expanding all the time. Fluted Beams, which has the only Compwood press in the Americas, sells 14 different species, from beech, white oak and walnut to cherry, elm and even osage orange.

Softwood species and exotics don't seem to respond well to the Compwood process, though experiments with exotics are ongoing.

As far as pricing goes, expect to spend $30 to $40 a linear foot for 8/4 material that is about 6" wide. Thinner stock is considerably less ($18.75 a linear foot). And Fluted Beams (fluted beams.com or 253-988-2046) also offers small bundles of Compwood for as little as $20 that will allow you to experiment with the wood without buying large planks.

Mroz quickly acknowledges that because Compwood is expensive it's not for every job. If the project can be done with steam-bending, that definitely is a cheaper way to go.

"I tend to focus on using this product for things that haven't been done before – when the wood needs to bend in multiple dimensions," he says. "It's whenever the shape gets more sculptural that this product becomes useful."

The golden arches. *I was well pleased with the way the Compwood behaved for these arm bows. Now I just have to get on with saddling the seats of the chairs.*

And while I can see that side of the equation, I also am a fan of it for my simple bends because it's easy to use in a small shop with limited equipment. Plus it doesn't fail spectacularly like some of my steam-bending adventures. **PWM**

Christopher is the editor of this magazine and secretly wishes at times to be a starving chairmaker, instead of a starving writer.

Go Online FOR MORE ...

For links to all these online extras, go to:
▶ **popularwoodworking.com/apr11**

VIDEO: *See Chris bend an arm bow around a form using Compwood.*

ARTICLE: *Read about the drying process and see our makeshift kiln.*

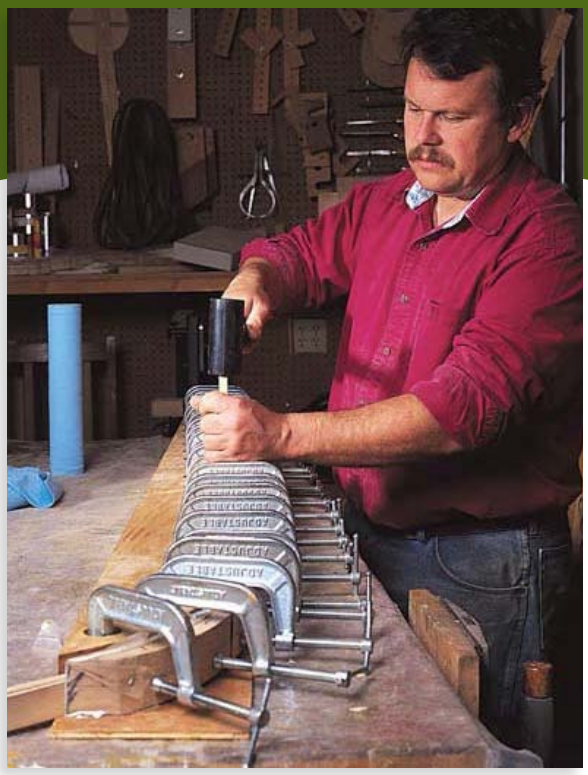
WEB SITE: *Visit the Fluted Beams web site to order Compwood.*

WEB SITE: *Read details of how Compwood is made at the factory.*

IN OUR STORE: *"Woodworker's Guide to Bending Wood."*

Our products are available online at:
▶ **ShopWoodworking.com**

Enter Our New Contest!



Popular Woodworking is giving away a Shopclass Subscription* to the best, or worst, wood bending project photo. Submit your photos (prior to, during or post project) to PopularWoodworkingPhotoContest@gmail.com!

We'll post the submissions on www.popularwoodworking.com/how-to-bend-wood-photo-contest for the public to vote on, so be sure to share, tweet, post and vote for your favorite picture!

On October 31, 2013 we'll declare a winner!

*The Winner will receive a one-year subscription; the Runner Up a 6-month subscription; Third Place a one-month subscription.

Submit Your Photos Today!