

LAMINATED COAT RACK



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Start with a shop-made form and thin strips. Then add glue and clamps. The result is a simple project that's a great place to hang your things.



Hesitant about bending wood? Then the simplicity of this project is perfect to start with. You'll find that the form is easy to build, the hooks are small and quite manageable, and you don't need a wall full of clamps — six is all it takes.

FORM FOR BENDING HOOKS. Before beginning work on the hooks, you need to build the form for bending the hooks. In a way, the form is like a jig — it's not part of the project itself, but it's still essential to getting the project built. (I've described how to build it on page 4.)

THIN STRIPS. After I had completed the form, I began work on making the thin strips that are bent around the form. The safest way to rip thin

strips is to set the fence so the strips fall to the waste side of the blade. But the problem is, you have to reset the fence with each pass, and besides being a hassle, the strips don't end up a consistent thickness either.

Instead, I ripped the piece with the thin strip between the blade and the fence. By doing this, I could leave the fence in one position. But I did have to take some precautions to prevent kickback. First, in order to keep my hands away from the blade, I used a push block that rode on top of an auxiliary fence (Figure 1). In addition to this, I used a zero-clearance insert that had a built-in splitter in the back. This splitter reduces the chance of kickback by preventing the wood from pinching the blade.

When ripping the strips, I started with 24"-long pieces that had relatively straight grain, as shown in Figure 1. (Note: I used 4/4 ash $-\frac{13}{16}$ " actual thickness, as in Figure 1b. I planed and sanded it to $\frac{3}{4}$ " after gluing the strips together.)

Technically, to create each $\frac{1}{2}$ "-thick hook, you'll need eight $\frac{1}{16}$ "-thick strips (Figure 1b). But the actual number of strips you'll use depends on whether your strips are exactly $\frac{1}{16}$ " or a little thicker or thinner. Just get as close to $\frac{1}{2}$ " as you can so the forms fit as tight as possible and you don't end up with any gaps.

PRE-BEND & GLUE STRIPS. While I was determining the thickness of the strips (refer to the article on page 5), even at $\frac{1}{16}$ "-thick my test piece still split as it was bent around the form. So to make the strips more pliable, I soaked them in water for an hour or so. Then, I clamped them around the bending form (without glue), as in Figure 2. To do this, start with the short end of the hook, positioning the pieces flush with the end of the outer form. (This gives you at least 3" of waste on each end just to be safe.) Then when the short end is sandwiched between the outer and inner forms, add the other outer form.

I let the strips dry overnight. Then, I ran a small bead of polyurethane glue on each and clamped them into the form. If you plan on using yellow or white glue, it's best to let the hooks dry out longer, since the moisture in the wood slows down the curing process. Let the glue dry overnight before removing the assembly — the longer the better since the pieces are exposed on only one edge. Once it's dry, remove it from the form and set it aside until you've glued up the other hooks. (You'll need five in all.) Wax the form after gluing up each hook so the next one won't get glued permanently into the form.

CLEANING THE HOOKS. By now, you know that laminating wood is messy business. And at this point, it's time to clean up all the hooks. The first thing I did was to mark the ends of the hooks from the form and cut them to final length with a hand saw.

Next, put the hook back in the form and screw the outer form to the base to hold it tight. This keeps the piece steady as you work on its edge. (If the edge of the hook isn't above the surface of the form, shim it with small blocks until it is.)

I started by scraping away most of the glue with a paint scraper. Then because the laminations weren't flush, I planed the edges with a block plane.

I cleaned up one edge of each hook. Then, I flipped the hooks over to work on the opposite edge. Since the hooks aren't symmetrical, I had to flip the inner and outer forms, as well. This is why the inner form is simply screwed to the base (page 4).

Keep in mind that at this point the assemblies are flat, but they may not all be an identical thickness. To avoid having to cut each dado in the back strip a different size, I made all the hooks the same thickness.

To do this, I measured each hook to find the one that was the thinnest. Then, I cut a dado in a scrap piece to hold this hook. Getting the others to fit was just a matter of sanding or planing them until they fit the dado.

SHAPE ENDS. At this point, the hooks are almost complete. All that's left is to add the tear-shaped curves at the ends. (These don't serve any practical purpose — they're decorative.)

To add the curves, start with square blocks. Glue small ¼"-thick blocks to the outside faces (Figure 3), and draw an arc at each end (Figures 3a and 3b). Most of the waste can be trimmed off with a band saw or hand saw. Then, sand to the line with a sanding drum (photo below).









To create the tear-drop ends on the hooks, I added small blocks and laid out the curves. Then, they're cut and sanded smooth.

Rack Assembly

With all five hooks complete, the hard work's done. Now you just "tie" them together. I did this with two simple backing strips (drawing at right).

OVERSIZED BLANK. I started by cutting a single 3/4"-thick oversized blank. This blank can be cut to final length (30"), but I left it wide enough so both 7/8"-wide back strips could be ripped from it. (I left my blank 21/2" wide.)

CUT DADOES. The first thing to do to the blank is cut the ¹/₄"-deep dadoes that hold the hooks, as shown in Figure 4. The width of the dadoes is determined by the thickness of the hooks. To keep the spacing consistent, I added an auxiliary fence to the miter gauge and used a stop block to position the blank, flipping the piece between passes, as in Figure 4.

ROUND OVER EDGES. Once you've cut and completed the dadoes, the next thing to do is rout a roundover on the ends of the strips. I used a $\frac{1}{4}$ " roundover bit to do this (Figure 5a). And to prevent chipout, I backed up the cut with a push block.

Now, the two back strips can be ripped to final width ($\frac{7}{3}$) from the blank, as in Figures 5 and 5b.

ATTACH HOOKS. Here's where things really come together. Each of the five hooks is glued and screwed to the strips. Of course, it took me a while to figure out how to get the hooks to line up evenly. But the solution turned out to be right under my nose.

First, I stood each of the hooks against the rip fence on my table saw,



During assembly, I aligned the hooks by butting them against the rip fence on my table saw. The back strips are held parallel with spacers clamped between them.

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using one of the back strips to space them apart so they lined up with the dadoes (photo below). Next, I clamped the two back strips together with a few $\frac{1}{4}$ " spacers between them. Each of the dadoes on the back strips got a small drop of glue. Then, I set the back strips on the hooks and screwed them together.

FINISH. To finish the hooks, I stained them a golden oak color. Then I applied a few coats of an oil finish.

HANGING THE RACK. When hanging the rack, the ideal situation would be to screw into two wall studs. However, it's likely that you won't be able to do this. Screwing into at least one wall stud would be acceptable, but wall anchors would work too.

If you'd like, you can easily cover the screw holes with button plugs. Just drill ³/₈" counterbores in the back strips. But leave the plugs unglued, so you can move the coat rack later.



COAT RACK FORMS

Like pouring concrete, the first thing you need to do when bending wood is build the forms. There are two forms here — an inner form that the pieces are bent around and an outer form that sandwiches the pieces.

MDF FORMS. To make the form, all you need is some scrap 3/4"-thick MDF (or plywood) and a jig saw or band saw. Usually, I make the forms at least as thick as the strips that are being bent. But the coat rack hooks here are an exception.

I used 34'' MDF even though the strips start off 13/16''. (I used 4/4 stock, which typically comes 13/16'' thick.) This extra 1/16'' did not create a problem (the laminations still ended up tight), and it saved me from having to laminate two pieces of MDF together to build up the forms.

To build the form, I started with a single piece of MDF, as you see in Figure 1. Then I laid out the curves for both the inner and outer forms. Because the final thickness of the strips will be $\frac{1}{2}$ ", there's a $\frac{1}{2}$ " gap between these two layout lines that will be cut away as waste.

SHAPE FORMS. When cutting out the inner and outer forms, it's important to stay on the waste side of the line. Then, use a sanding drum and sand them up to the lines. Be as careful as you can here. The better the two forms sandwich the strips, the less chance there will be for any gaps between the laminations.

Though you've cut the two forms and sanded them smooth, they still need a little work. On the inner form, drill $1\frac{1}{4}$ "-diameter holes $\frac{1}{2}$ " from the edge for clamps (Figure 2).

On the outer form, first trim two of the outside corners (Figure 2). These angled edges allow the clamps to apply pressure directly across the strips. Then, with the corners cut, the outer form can be cut into two pieces — a short one for the short end of the hook and a longer one for the long end. This lets you work on one bend at a time.

BASE. All that's left is to make the base, as shown in the drawing above. It's cut to final size and shape, and its corners are angled like the outer forms — but for a different reason. If the base sticks past the outer form too much, you'll skin your knuckles when tightening the clamps.

Instead of gluing the inner form to the base, I screwed it in place. This allowed me to flip it over when cleaning up the edges of the laminations.

WAX FORMS. Now before you begin bending with the forms, you need to mark the location of the ends of the hooks on the forms (Figure 2). And finally, apply a heavy coat of wax. This way, your laminations won't be permanently glued to the forms.





▲ To glue up each of the hooks for this coat rack, all you need are eight ¹/₁₆"-thick strips, a simple shop-made form, six clamps, and plenty of glue.







BENT LAMINATION

Bending wood with thin strips creates graceful curves that are surprisingly strong. And the process takes less time than you might expect.

Whenever I show someone a project that involves bending wood, I usually get the same response: "It looks great, but I don't think I'd have the time to tackle it." Somehow, bending wood looks time-consuming and a bit difficult. But looks here are deceiving — especially with the bent lamination used to build this coat rack. In fact, this projects would be considered a "weekend project" except that you have to give the glue a chance to dry.

The process I used to build the laminated coat rack is one of the easiest ways to bend wood. To put it simply, a piece is ripped into thin strips and then glued back together as the strips are bent around a curved form. Thin strips are very flexible so you can bend tight curves with them, and the glue "locks" the bend in the laminations.

Why go to all this work? Why not simply cut out each curved coat rack hook from a single blank? The problem is that somewhere along the curve the grain will run across the hook, and this point will be weak (photo below). By laminating each hook from several pieces, the grain essentially "wraps" around the curve, creating a much stronger piece.

Besides being much stronger, I also like bent lamination because it doesn't require any special tools. The thin strips can be ripped on the table saw. And the bending forms can be built quickly, using either plywood or MDF. All you need are a dozen or so clamps and some glue. (Quite a bit of glue, actually.)

MAKING THE FORMS

The first thing to do with any bending project is to build the forms. They distribute the clamping pressure along the strips so you don't end up with any gaps. Basically, a bending form is made up of three pieces: a base, an inner form, and one or more outer forms.

You'll notice that the photos and illustrations on the following pages show a form I made for a different project, but the same concepts can be applied to the coat rack. The inner form is attached to the base. Then the outer forms are used to clamp the wood strips around the inner form.

SHEET GOODS. All three pieces can be made from either plywood or MDF. For the coat rack, each form was built with less than a quarter sheet of ³/4"-thick MDF (refer to page 4). I used MDF because it was a little less expensive than plywood. Note: If you choose a low-grade plywood, watch out for large voids. They can weaken the form or create rough edges.



The hook on the left was cut out of a single board. It broke where the grain ran across the hook. The right hook, made with a number of thin strips, is much stronger — the grain "bends" around the curves.

You want the forms to be approximately as thick as the wood strips you're going to bend. This way, the clamping pressure is distributed evenly across the thickness of the stock, and you're less likely to end up with gaps on the outside edges.

But for the laminated coat rack, my forms were slightly shorter $(^{1}/_{16}")$ than the thickness of the strips. This wasn't a problem, but if you're using thicker stock, you can build up the forms by gluing two pieces of MDF together before cutting them to shape.

LAYING OUT THE FORMS. When creating the inner and outer forms, the goal is to get a fit that's tight and consistent along the entire length of the strips. If the forms don't fit well, there's a good chance you'll end up with small gaps in your laminations.

So to make sure the inner and outer forms match, I lay out both of them on the same blank. And when doing this, you'll need to allow for the thin strips that will be sandwiched between the forms, as in Figure 1. (For the laminated coat rack, there was $\frac{1}{2}$ " between the inner and outer forms.)

ALLOWING FOR CLAMPS. With the inside curves laid out, you also have to figure out how to clamp the inner and outer forms together.

For the heads of the clamps (usually on the inner forms), I drill a series of holes parallel to the curved edge after the forms are cut out (Figure 2). Size the holes large enough to hold the head of your clamps.

Then on both forms, you'll probably have to do some work on the outside edges too. The clamps should apply pressure straight across the strips as much as possible, as you can see in Figure 2. This means laying out angles and creating shoulders on the forms near the areas where the strips bend.

With the layout of the forms complete, they can be cut out with a jig saw (or band saw), as in Figure 1. Stay on the waste side of the layout line. Then sand the edges smooth with a drum sander in the drill press. I also cut the outer form into separate pieces so it's easier to work with.

Finally, I drill the holes for the clamp heads. (My clamps required $1\frac{1}{4}$ "-dia. holes.) I don't bother to lay them out. Instead I drill them about a $\frac{1}{2}$ " from the curved edge. Don't space them too close together because it could weaken the form.

ATTACHING FORMS TO BASE. With the forms cut to shape and the holes for the clamps drilled, I attach the inner form to the base. The base is sized to support both the inner and outer forms when the strips are clamped in place. It should be a little oversized — but not too much. Otherwise, you'll find yourself scraping your knuckles as the clamps are being tightened.

After the base is cut to size, the inner form can be glued to it. Note: The coat rack form is screwed to the base — not glued, see page 4.

GLUE BARRIER. The forms aren't complete quite yet. You're going to need a barrier between the forms and the



To prevent gluing the strips to the form, I brushed on a heavy coat of wax. (It was softened with turpentine. Note: Don't heat the wax — it's flammable.)

strips so they're not glued together permanently. To do this, I used wax to "finish" my forms (photo above). Then when the strips were glued together, I was able to carefully pry them out of the form. Note: For a more effective barrier and a longerlasting form, you can apply a coat or two of polyurethane or varnish and then a coat of wax.

Keep the wax handy. After each use, you'll need to scrape away the excess glue and apply another coat of wax to the forms.



Making the Laminations

Though you haven't technically started working on the project yet, don't worry. From here on out, things progress pretty quickly, and you'll be wrapping glued-up strips around the bending form in no time.

RIPPING THE STRIPS

With the forms built, you're ready to rip the thin strips (Step 1). Just about any hardwood can be used — as long as the grain is reasonably straight and there are no knots.

What's more important is the thickness of the strips. I like to work with as few strips as possible. So I try to keep them as thick as I can. But with tighter curves, you'll need thinner strips (and more of them).

TEST STRIP. I start by cutting a test strip. If it breaks when bent around the form, I cut a thinner strip and try again. Remember, $\frac{1}{22}$ " can make a *big* difference. Note: I don't rip strips thinner than $\frac{1}{16}$ ". If $\frac{1}{16}$ " strips break, I "pre-bend" them, see below.

RIPPING THIN STRIPS SAFELY. When ripping thin strips, having the rip fence close to the blade is an opportunity for kickback. So to avoid this, I use a shop-made auxiliary fence and push block. As an added prevention, I use a table insert with a splitter in back. (Refer to page 9 for more on this.)

PRE-BENDING & GLUING

With the tight curves on the coat hooks, even ¹/₁₆"-thick strips would crack as I pulled them around the form — the bend was just too tight.



With the forms built, the thin strips for bending can be ripped. Their thickness will depend on the curve — the tighter the curve, the thinner the strips. To do this safely, I used an auxiliary fence and a stop block, as you see on page 9.

So I "pre-bent" the wood first, as shown in Step 2. This is a lot like dry assembling a project — only the wood is wet, which allows its fibers to stretch. To do this, I soaked the strips in the bathtub for an hour or two. Then I clamped the strips around the form and let them dry overnight.

Shop Tip: Before taking the prebent strips out of the form, I marked the centerline of the form across the strips. Then when gluing them together, you'll be able to get them aligned quickly in the jig.

POLYURETHANE GLUE. While pre-bending allows for tighter curves, you do end up with wet wood. This can be a problem with water-based glues like yellow and white glue unless you let the wood dry completely. However, if you use a polyurethane glue, the extra moisture isn't a problem — it's a benefit. That's because polyurethane glue reacts *with* the moisture in the wood. In fact, the instructions tell you to wet the wood before applying the glue. So I didn't have to let the wood dry before gluing it up.

Note: Regardless of what type of glue you choose, be sure to have plenty on hand. You don't want to run out in the middle of an assembly.

GLUING THE STRIPS. Gluing up the strips is a rather messy affair — all those strips require a lot of glue that squeezes out all over. I started by laying one piece down and then running a bead of glue on it, as you see in Step 3. Then set the next piece on top and run another bead. Continue until the last strip is set on top (but don't glue this one). Now you can set the assembly into the form and apply the clamps.

When applying the clamps, the goal is to remove gaps between the strips (Figures 4 and 5). For the coat hooks, I worked from one end to the other.



2 Next, I soaked a set of the strips in water to make them pliable. Then to "pre-bend" the strips, I clamped them in the form. After setting overnight, mark a centerline across the strips and remove them from the form.



3 To glue the strips together, start by running a narrow bead along one side of one strip. Set another strip on top and repeat the process. When the last strip is set on top, place the assembly into the form.

You'll soon see that as the strips are being clamped, they tend to slide. So as you're adding clamps, it's a good idea to use a hammer and a scrap block to pound them flush, as shown in the margin drawing. (The closer they are to being flush now, the less clean up work there will be later.)

LET GLUE DRY. When the clamps are all in place, you can step back and take a deep breath. The important thing now is to let the glue dry.

It's hard to say exactly how long you should wait before removing the clamps. But since there's only one edge exposed, it should be quite a bit longer than you usually let glue dry. With the polyurethane glue, I let the assembly stay clamped up at least eight hours (overnight if possible).

After the glue dries, gently pry the assembly out of the form. Then before gluing up the next assembly, scrape off the glue and wax the form again.

Shop Tip: When removing the assembly, the curves will tend to straighten out just slightly. So to help it keep the right shape, I clamped a spacer into the assembly until I was ready to clean up the edges.

CLEANING UP THE LAMINATIONS

At this point, the assembly isn't a pretty sight. There's dried glue caked everywhere, and the edges of the strips aren't even. So the job now is to clean up the assembly.

The trick was figuring out how to hold the assembly secure while I squared the edges. I couldn't hold it by hand very easily, and I couldn't



To bend the pieces of this project, I started adding clamps at the center of the forms. But for the coat rack, I started at one end and worked my way to the other end. As you tighten the clamps, make sure the strips stay as flush as possible (illustration at right).



5 As you work your way around the forms and continue bending the strips, you'll need quite a few more clamps. It's important to distribute the clamping pressure, so add and adjust as many clamps as you need to achieve tight laminations with no gaps.

clamp it to the bench without having to reposition the clamps.

The solution ended up being pretty simple. I set the assembly back in the form. Then I secured it by screwing the outer forms to the base, as you can see in Step 6. This really held the assembly secure and left the entire edge free. (Note: If your assembly is flush with the inner and outer forms, you can set it on thin strips to raise it slightly.) The next step is to scrape off the excess glue. (I used a paint scraper.) Then to even out the edges, I used a sharp block plane, as in Step 7.

When one edge was even, I flipped the assembly over and repeated the procedure on the opposite edge. When that edge was finished, I took a final step to make sure the edges were flat. I placed adhesive-backed sandpaper on my table saw and sanded the assembly.



While the strips are being clamped, they tend to slide, so use a hammer and scrap block to pound them flush.



6 With all the assemblies glued up, the excess glue can be removed and the edges made flush. To hold each assembly while doing this, I placed it in the form and screwed the outer forms to the base.



After the excess glue had been removed with a paint scraper, I evened out the edges of the assembly, using a sharp block plane. When smooth, flip the assembly over and repeat this process.

SHOP NOTES

Ripping Thin Strips

When ripping a single thin strip, I'll set the rip fence so the strip ends up on the waste side of the blade. But when I need a bunch of thin strips, as I did with the coat rack, I cut the strips between the rip fence and the blade. To do this safely, I use an insert with a splitter (shown in the box below) plus a simple auxiliary fence and push block that keeps my hand out of the way, as in Figure 1. The trick is that the push block and fence are cut from the same piece so they're the same width. And to move the piece through the blade, a small "heel" is glued to the edge of the block near the back, as in Figure 2. (The heel started out as ¼"-thick hardboard and is trimmed to final thickness after the fence is set.) Finally, I added a handle to make the block easy to push.



Next, I set the rip fence so there would be $\frac{1}{16}$ " between the blade and the auxiliary fence (Figure 1a). Then, I used double-sided tape to attach the auxiliary fence face down to the table (Figure 1).

To rip the strips, start by feeding the stock by hand. Then when you're near the end of the piece, set the stop block in place and complete the cut. This short, wide auxiliary fence and stop block combination keeps your hands away from the blade while ripping thin strips from both long and short blanks.



ZERO-CLEARANCE INSERT WITH SPLITTER

When I rip thin strips, I like to use a shop-made table saw insert that has a splitter. It helps to keep the wood from binding on the back of the blade. (Mine is a zero-clearance insert.)

To make the new insert, you'll need a blank that matches the thickness of your old insert. (I used ½" MDF. It was a little thin, but later I shimmed it with tape until it was flush with the top of the saw.) Next, trace the outline of the original insert onto the blank and rough cut it to within ½16" of the pencil line (Figure 1).

To trim the blank to the same shape as the original

insert, I attached them with double-sided tape. Then I mounted a flush-trim bit in the router table and, with the bearing riding along the original insert, trimmed the new one to shape (Figure 1a).

To rip the blade slot in the new insert, carefully align the fence with the edge of the original insert (Figure 2). Then rip the slot, turning off the saw when you're 3" from the end.

To make the splitter, rip a piece to the exact thickness of the kerf, 1" high and 3" long (Figure 3). Sand the end closest to the blade to a point and glue the splitter into the kerf.

