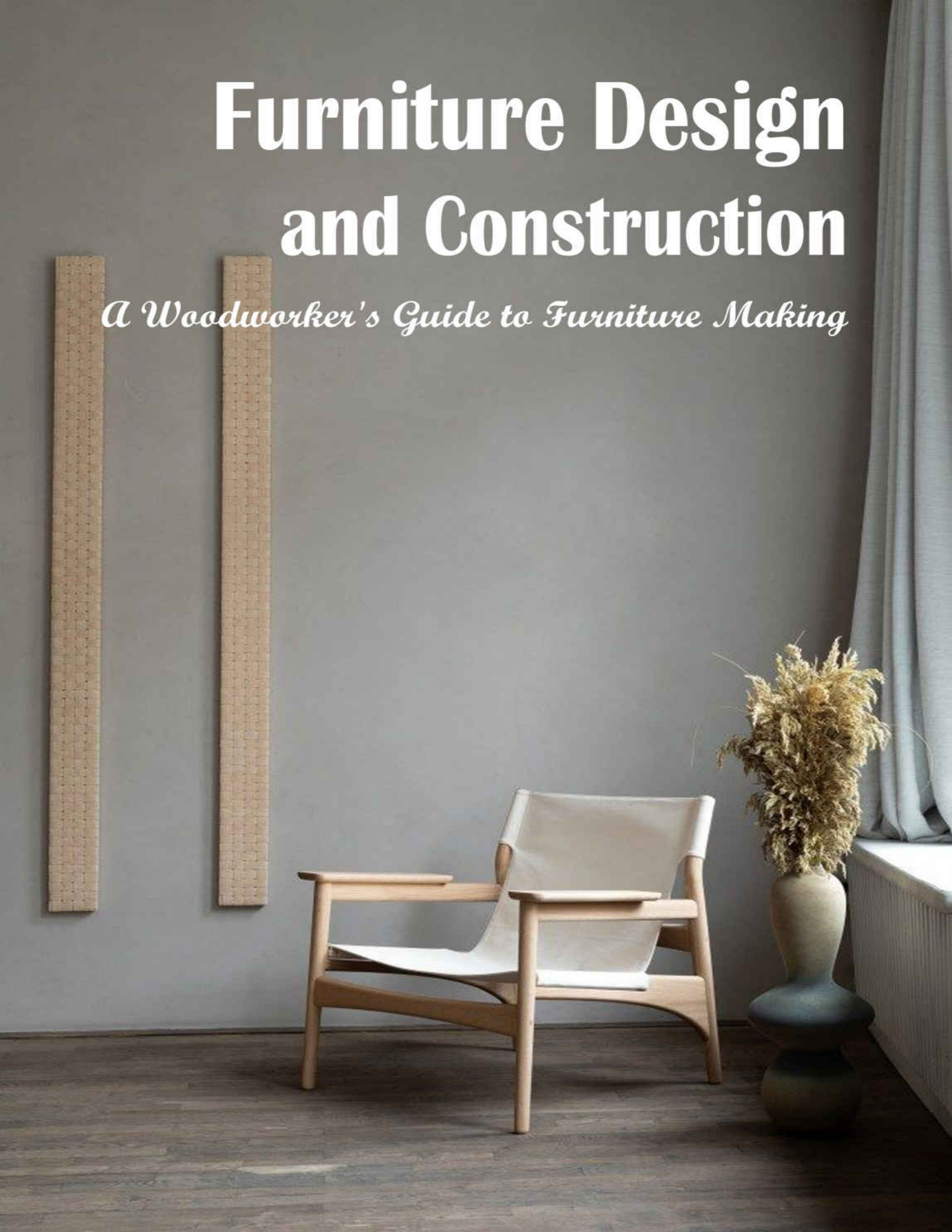
Furniture Design and Construction

A Woodworker's Guide to Furniture Making



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DEDICATION

Contents

A Woodworker's Guide to Custom Cabinets

I am often tempted to say that there are as many ways to build cabinets as there are cabinetmakers. It's an exaggeration, I know, but it gets at a basic truth about the world of cabinetry and built-ins: There is no single "right" way to build them.

At the first shop where I worked, a custom cabinetmaking business in rural England, we built casework out of melamine-coated particleboard. We joined the sides, tops and bottoms using thin plywood splines, then applied solid wood face frames made with a shaper-cut bridle joint. The face frames were glued onto the cases with more plywood splines. Our doors and drawer fronts were inset, and we hung the doors on solid-drawn brass butt hinges mortised only into the door, then simply screwed onto the inside edge of the face frame.

Just like the originals. For a recent job, Hiller built new cabinets, such as the sink base visible here, on details drawn from the surviving original built-in at right.

At the next shop, also a rural English operation, we made casework out of solid pine floorboards. The first step was to glue and clamp the tongue-and- groove material in long lengths, then flatten them on a stroke sander and saw the parts to size. We housed the cabinet floors in dados. Although I can't recall which type of joinery we used for the tops, I know we weren't using biscuits; I didn't encounter a biscuit joiner until I moved back to the United States. We applied face frames with a simple butt joint and glue. All of our doors were inset, hung on solid- drawn brass butts; our drawers ran on traditional wooden

runners, and we dovetailed our drawers by hand.

Much of my current carcase-building technique comes from what I learned at a contemporary furniture business in Vermont. There, we built casework from beautifully veneered MDF, joining the parts with biscuits and Twinthread screws. It was amazingly quick and simple. Doors were full overlay, hung on European hinges; a novelty for me. Drawers, too, were full overlay and ran on Accuride ball bearing slides.

In the 23 years since I started my own business, I have selectively adopted new materials and methods. The method I use most often for built-in cabinetry combines simplicity and strength for the basic casework with materials and techniques that owe more to the world of furniture than that of contemporary commercial cabinetmaking. The technique I will describe here is a hybrid that draws on what I learned at the different shops where I have worked. I have chosen materials and methods that make sense for my business, given my clientele and the styles in which I specialize.

Preliminaries

When designing built-in cabinets, you need to think about installation – and take into account certain features of the cabinets' future context. I'm not referring to aesthetic features alone – timber species, hardware,

how the various cabinet components will interrelate (will the doors be inset or overlay?), or style (slab doors or frame-and-panel?). I'm also referring to how the cabinets will literally intersect with the walls, floors, and ceilings, which are rarely square, level, or plumb. There are many ways of handling these points of intersection, and each has distinct period and other cultural connotations.

For example, many built-ins from the early 20th century were made with flush kicks – the bottom rail of their face frames extended all the way down to the floor. By the 1930s the recessed kick had become nearly ubiquitous – no surprise, considering how much easier it is to install than a flush kick that has to sit on an uneven floor.

The cabinet I'm building in this article was designed for the kitchen of a 1912 house. I planned to scribe (saw and plane) it to the floor and to the wall at its left; that's why the face frame protrudes beyond the cabinet's left side. Unless you're running a production facility where you build things in multiples to standard sizes, you should take the building work in stages. That way you'll have a chance to adjust the different parts to fit what you've made so far, instead of finding that your face frame is 1/16" too narrow or you cut the recess for your kick 1/4" too high. Some people start with face frames then build their carcases to fit. I work the other way around. Once the basic cases have been assembled, I move on to faces.

Let's Get Going

So you have your scale elevations at hand and have made a cutting list based on them. My typical material for kitchen casework is 3⁄4" maple-faced veneer-core plywood, pre-finished on one side. The pre-finished side goes to the cabinet interior; it saves a lot of time, which helps make my work affordable. That said, some jobs call for painted interiors or other finish treatments, so I always choose the sheet material to suit the job. The next step is to cut your basic parts (sides, tops and cabinet floors) to size. Because I'm building each job to genuinely custom dimensions, some base cabinets may not be designed to end up 24" deep or 36" high. (For example, I love a 38"- high counter. It should go without saying that the carcase height must be adjusted to allow for the thickness of whichever counter material you'll be using.) And even if most of the uppers in a kitchen job will be 12" deep, one may be a 5"- deep spice cabinet, while another may be 16" deep.

Rip all of the sides and floors to width. The edges and corners of sheet goods may not be square, and they often have minor damage. It's ideal to make the first rip slightly over-width, then turn it around and rip the other edge to the size you require. That way you'll have two square, clean edges for joinery.

After ripping, cut the parts to length. There are various ways to do this. Aside from cutting each part accurately to length, it's important to cut the ends square. You can do this with a track saw if you have one. Alternatively you can use a straightedge and a pattern- cutting bit to rout one end square, then crosscut on a table saw, running that end along the fence. (The same technique will work with a radial arm saw for the second cut, which trims the piece to length.) My current method is to crosscut one end of each piece using a slider on my table saw, then crosscut it to length using the rip fence. Be sure you add an identifying mark (for example: upper 1, left side) to each part as you cut it.

My method for joining cabinet floors to sides may not be refined, but it's quick, simple and strong. I use a spacer made from scrap 3⁄4" plywood to position the floor and support it. Twinthread screws run in through the cabinet sides will fasten the whole thing together.

Rip first. I store my plywood on sturdy sawhorses near the table saw so that I can pull one end of a sheet over to the edge of the saw, adjust it against the fence and rip.

Be there and be square. A sliding table set at 90° makes it easy to cut the first end of each casework part square. You can then cut multiple parts to the same length by crosscutting with the rip fence.

But First…

Your elevations will determine how high the kick needs to be and whether it will be flush or recessed. Calculate the height of the space that will be beneath the cabinet floor and rip spacers from scrap plywood to this width, then cut them to length. If your kick will be flush, the spacer should be a hair under the width of the cabinet sides in length; if the kick will be recessed, the spacer should be a hair under the width of the cutout portion at the bottom of each cabinet side. Next, predrill for the screws that will tie the sides together with the floor.

Predrill. Even though the screws will be run in from the outside of the cabinet, I predrill from the inside, because that way I don't need to measure for the holes' positions. The spacer tells me where the holes should be: 3⁄8" on center above its top edge. Then I ip the side over and countersink. Five or six screws are usually ample for a 24"-deep base cabinet.

Simple and strong. Clamp the spacer in place at the bottom of the cabinet side and attach with 11⁄4" Twinthread screws. Four or five are plenty for each side of a typical base cabinet. You can predrill and countersink or use an impact driver, as I did here.

Move on Up

Most base cabinets do not need a solid plywood top. A strip several inches wide at the front and back offers plenty of material to tie the sides together and support a counter. Using less material lightens the weight of these substantial cabinets while minimizing waste. Sink bases, in particular, do not need a solid top; the vast majority of a sink base's top will be cut out to accommodate the sink. For narrow

cabinets (those 18" or less wide) it's usually quicker to go ahead and make a solid plywood top, following the same directions as those for a strip top.

The strips for a particular cabinet will be the same length as the floor for that cabinet, so cut them to length at the same time. The sides of the cabinet will be joined to these strips with Twinthread screws, but I also use biscuits, for increased strength as well as a positive means of locating the parts during assembly. Mark each strip with the cabinet name or number and "front" or "back," so you'll be able to identify quickly which end is right and left, and which long edge faces forward. It is a good idea to have at least two biscuits in each strip to help prevent the strips from twisting during assembly.

Top joint. In most cases you can simply hold the strip in place and mark the center line for each biscuit from the strip to the cabinet side.

Steady on. For safety and accuracy, clamp the cabinet side in your vise and hold the biscuit jointer firmly against the fence to make a square cut.

Flat and firm. Clamp the top (whether it's solid or strips) to your bench and hold the biscuit joiner firmly in place, then make the cut.

If you have ever found yourself on hands and knees, searching for that custard pan in the very back of a base cabinet, you'll understand why most base cabinets today are made with drawers or pullout trays on full-extension mechanical slides instead of with shelves concealed by doors. I rarely put shelves in base cabinets, but I do use them in upper cabinets and in shallow base units such as bookshelves.

When a cabinet will have adjustable shelves, I usually use 1⁄4" pin-style

supports, which are unobtrusive, extremely strong (I have used them to store large shelves of LPs) and fast. Now is the time to drill shelf support holes, because you can clamp the cabinet sides together and mark them at the same time. Lay out the positions with a long square.

Assembly Time

With the basic carcase joints cut and shelf support holes drilled, you're ready to glue up the cabinets. Run a bead of glue along the top edge of each floor spacer then stand the sides on the floor, front edge facing up. (You can lean each side against a workbench, stationary machine or sturdy trash can to hold it temporarily.)

Set the cabinet floor in place between the sides and clamp loosely. Depending on the size of the assembly and whether you have a helper, it may be more practical to hold the floor and sides together by clamping the floor to the bottom spacers instead of clamping across the cabinet's width. At this point the clamp is just to hold the parts together while you insert the top (or top strips); there will be time to adjust the fit and get things square.

Maximize the efficacy of glue. Make sure the bottom face of the cabinet floor is tight against the top edge of the spacers; the bead of glue along the spacers' top edge will contribute to the cabinet's

strength, especially if you are using plywood that's prefinished only on the interior face and so offers limited opportunities for gluing. Now apply glue to the biscuit slots for the top (or top strips), insert the biscuits and set the top in place. Apply a couple of clamps to hold the assembly together while you adjust the fit.

After squaring the cabinet, sight across the top edges to check for winding. Shim at the bottom as necessary to remove twist, then drill and screw. Let the cabinet sit until the glue has set, per the glue manufacturer's instructions.

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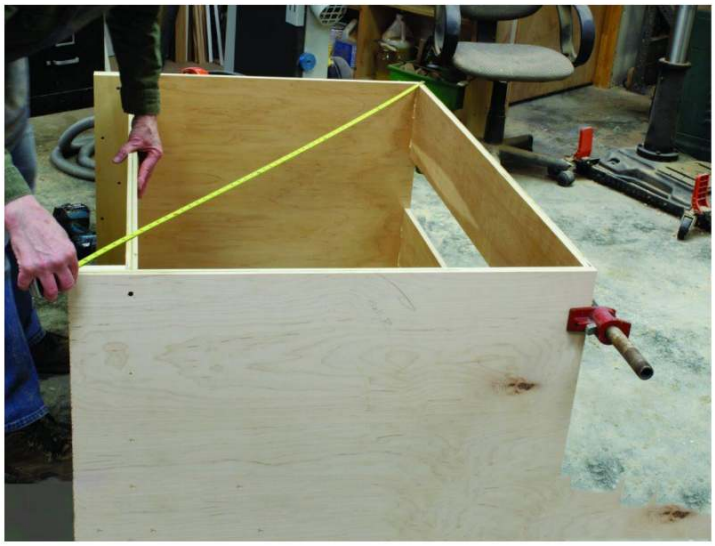
the interior face and so offers few opportunities for gluing.

Glue guide. Apply a bead of glue to the top edge of the spacer and where the biscuits will go. Don't waste your time or glue on the pre-finished surfaces; it won't bond to them.



A screw can help. If you are working alone on a relatively large assembly, it's sometimes helpful to insert one screw at each side before the carcase is fully squared up to keep the parts joined together. You can remove that screw if necessary, then redrill and replace it once the cabinet is squared. The carcase is square when the diagonals are equal.

Drill, then screw. Predrill for the screws using a bit just smaller than the shank of your screws. Countersink to prevent breakout. Insert screws with a driver.

Adjust clamps and square up. I nd light clamps useful in holding the oor against the spacers while getting things adjusted. Here I am tightening the clamps at the top, having flushed up the front and back edges. Next I will move to the cabinet floor, tapping the back down firmly onto the bottom spacer before I insert a clamp under the back edge to tighten everything up.

Vertical Dividers

Plywood that is prefinished on both sides comes into its own for vertical dividers. I measure for dividers at this point and fasten them in place with screws.

Instead of using a tape measure, I cut a couple of pieces of scrap plywood (one for the bottom, the other for the top) to the distance between the divider and the nearest cabinet side. Clamp the scrap in place and you have an instant way to predrill the screw holes, 3⁄8" on center from the edge of the scrap. This method also makes locating the divider a snap when you're ready to screw it in place.

Of course, you cannot insert that divider until you've cut it. Don't precut dividers to size; cut them to fit. Otherwise you may find that your divider is too small. The most accurate way to determine a divider's length is by setting one end in place and marking the other.

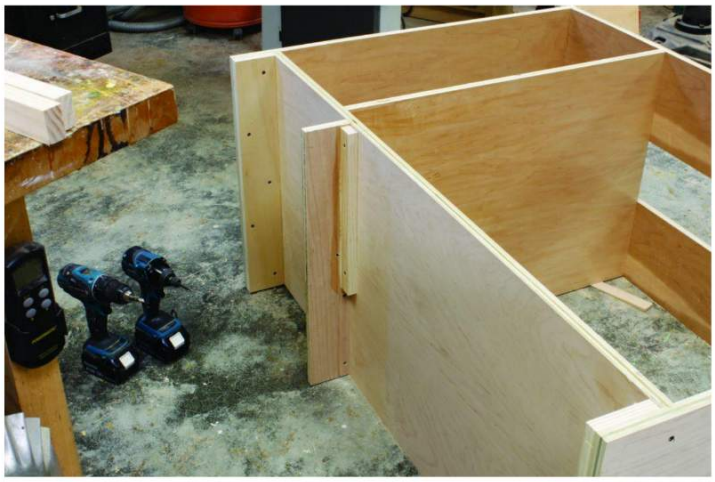
Wide cabinets should have support feet below or near vertical dividers to prevent sag. Make these from strips of 3⁄4" plywood cut to the same height as the spacers supporting the cabinet sides. Screw a batten on each side of the foot through which you can fasten to the underside of the cabinet floor.

Direct measure. Determine the length of dividers by holding one end against the cabinet floor, then marking the other. Because it's typical for floors and tops of wide cabinets to sag or bow, measure for dividers at the nearest end. That way your divider will even up the height of the cabinet near the center.

Spacers for the win. Use a piece of scrap plywood to lay out holes for vertical dividers and locate them for fastening. Then rely on the scrap to locate the divider while you drill pilot holes with a countersink/drill bit and screw it in place.

Intermediate support. A batten screwed to each side of the foot allows you to attach it to the cabinet's underside. I stagger the battens, putting one toward the front, the other toward the back, so that I can screw

into them from the opposite side of the support foot.



Direct measure again. For vertical dividers, wait until you have the main part of the face frame screwed together. Clamp (without glue) to the carcase. Hold one squared end of the divider stile in place and mark the other, then cut.

Face Frames

After using several kinds of joinery for kitchen-cabinet face frames, I now regard a pocket screw jig as my go-to. Pocket screws are quick, simple and strong. If you make a mistake, you can often remove the screws and replace a part.

Mill the stock for your face frames to thickness and width but do not cut anything to length until the cabinets are assembled. Direct measurement is the quickest, most accurate way to go: Start with stiles, setting a squared end on your shop floor for face frames with stiles that go to the floor; for cabinets with fully recessed kicks, start at the top and mark the location of the cabinet floor's under- side, then add 1⁄2" (or however much you want the face frame to hang down, which will hide the joint between the cabinet and an applied kick). Clamp the

stiles in place, then hold one end of the top rail against one stile and mark the position of the other. Repeat with the bottom rail.

For vertical dividers, wait until you have the main part of the face frame screwed together so that the spacing of all the parts is locked in. Then continue with direct measuring. Hold one squared end of the divider stile in place and mark the other, then cut. Hold the skeleton face frame against the cabinet and transfer the position of the divider onto the edge of the top and bottom rails. Drill pocket screw holes at the ends of the stile and insert the stile.

Pocket the difference. A pocket screw jig makes strong face-frame joints quickly. You can buy a special clamp to hold the rails and stiles in place, but I simply clamp the parts together on my bench, making

sure they're square.

Drawer Rails

Even if your drawers will slide on mechanical runners, you may wish to install drawer rails for a more traditional look (at least for built-ins from the late-19th through the mid-20th century). With the vertical divider in place, repeat the same steps to size and install these rails.

When you have completely assembled your face frame, give a light sand- ing to the inside edges (this is much easier to do before the frame is glued against a prefinished surface that you would not want to mar). Brush glue onto the front edges of the carcase, spreading it over the surface and apply the face frame. Make sure that the top edge of the bottom rail is flush with the floor of the cabinet; do the same with any critical inside or outside edges. Then clamp.

Let's face it. Clamp position is important. Put the clamps where they will do the most good. For joints that will be seen from the inside of the cabinet, such as the one between the cabinet floor and the bottom rail of the face frame, put the clamp inside. Sometimes, such as when the face frame is flush with an outside face that will be a finished end (see the right end of the cabinet), it's preferable to put the clamp on the exterior. Cauls protect the face frame.

Hanging Cleats

Next I usually tackle the hanging cleats, through which the cabinets will be screwed to the wall. Then I cut the backs. After these steps, the structure of the cabinet will be finished and I can turn to the fun parts – doors and drawers, both of which deserve their own articles and have

been covered amply elsewhere.

For safety, the attachment cleat must be firmly fastened to the carcase, otherwise a cabinet could be separated from the cleat and fall off the wall, with potentially fatal results. I make a sturdy cleat from solid wood or 3/4"-thick veneer-core plywood and attach it to the carcase with Twinthread screws run through the top and sides. The cleat becomes part of the cabinet structure, not only supporting the weight of cabinet and contents from beneath the top, but also resisting the kind of leverage (such as that imposed when a child leans on an open cabinet door – please, please teach your children not to do this!) that could pull the cabinet sides away from the cleat if gravity alone were holding the cabinet in place.

It should go without saying that a cabinet designed to store pantry goods, appliances or dishware must be attached to the wall through studs or heavy-duty blocking, not just fastened to a wall with molly bolts or drywall anchors.

Backs

Many people think backs are optional for built-ins, but backs are almost always worth incorporating. A good back will help a carcase resist racking, in addition to giving a more finished interior look.

Generally, for kitchen cabinets I simply apply a back cut from 1⁄4"-thick veneer-core maple plywood, prefinished on one side. The prefinished side goes toward the interior. Measure the width of the carcase and cut the back to that width, then measure the height from the underside of the cabinet floor to the top of the cabinet and cut the back to that dimension. Fasten the back to the cabinet with #6 1" or 11⁄4" Twinthread screws after drilling countersunk pilot holes.

Shelves

In most cases, kitchen cabinets will be far more functional if made with shelves that are adjustable, rather than fixed, allowing you to customize placement so as to utilize the available space efficiently. I generally make shelves from the same 3⁄4"-thick veneer-core plywood as the carcase and add a solid front lipping to finish the edge and increase rigidity.

For shelves, as with vertical dividers, it's nice to use stock that is prefinished on both sides if you have it available. Resist the urge to make your shelves a perfect fit. They need to have a gap of about 1⁄32" to 1⁄16" on each end in order to be easily adjustable.

Shelf-Spacing Considerations

There is no point in putting shelf support holes too close to the cabinet floor or top (or in cases where there will be drawers above the shelf compartment, too close to the drawers) where there would not be enough room to store any- thing on the shelves. Think about what the shelves will need to hold and plan their spacing accordingly. If the bottom of the cabinet will be holding flower vases that are 12" tall, there may not be any point putting shelf support holes lower than about 13" above the cabinet floor.

Holes at the back of the cabinet should be about 1" forward from the back edge to allow enough space for fingers when inserting and removing supports.

Holes near the front of the cabinet should be positioned close enough to the front edge of the shelves that they prevent the shelves from tipping when someone is putting an object away or taking it out. At the same time, take any lipping at the front edge of the shelf into account. In general it's a good idea to center the front shelf support holes about 5⁄8" on center behind the back face of a shelf lipping that hangs below the underside of the shelf.

Consider how much adjustability is really necessary for the shelves in a given cabinet. For cabinets that will store shorter items such as juice glasses and dishware, closer spacing may be warranted; I often lay these out at 1 1⁄4" on center. For cabinets storing large items such as tall jars

of dry goods, 2" on center may be more practical. The point is to allow as much versatility in positioning the shelves as may be needed while avoiding the visual busyness of too many holes.

Kicks

If your cabinets have a flush kick, as does the one in this article, you're home free – at least until it's time to scribe the kick to fit the floor. If your kicks are recessed, mill them to thickness but leave them over-width and over-length until your cabinets are installed. Then cut them to fit.

Finished End Panels and Trim

The basic cabinetmaking method above will work well for cabinets that are trapped by walls at both ends. But it's also designed to allow for finished end panels. I find it more efficient in many cases to build and install the cabinets, whether uppers or bases, then carefully fit and apply finished ends. Regardless of whether the finished ends will be frame-and-panel construction, solid wood sides, or sheet goods custom- veneered to match the cabinets, I cut them roughly to size in the shop, then scribe them to fit on site. The end panels will cover the 1/4" back, which would otherwise be exposed. Likewise, crown moulding and other applied trim goes on after the cabinets have been installed. That way you can cut it to fit the room.

How to Build Your Own Adirondack Rocking Chair

Working Time: 70 hrs

Total Time: 70 hrs

Yield: 1 Adirondack rocking chair

Skill Level: Intermediate

What You'll Need

Equipment / Tools

Table saw

Circular saw or compound miter saw

Band saw

Cordless drill or power drill

Random orbital sander

Pencil

Countersink pilot hole drill bit

Wrenches or socket set

Materials

1 1x6 x 6' wood stock of choice

7 2x4 x 8' wood stock of choice

12 1x4 x 8' wood stock of choice

1 1x4 x 8' hardwood of choice

1 set of 8 glider rocker bearings and hardware

1 1/4" deck screws

2 1/2" deck screws

Woodworking glue

Paint or stain/polyurethane

Instructions

Patio furniture can be expensive. Fortunately, you can put your woodworking skills to good use and build some great pieces of patio furniture for a lot less than it would cost to buy (and you'll have the benefit of knowing just how well you built it!)

In this set of free woodworking plans, learn how to build a Loveseat Glider Rocker based on a very comfortable Adirondack chair design. This glider rocker is very roomy and comfortable for two people, whether you choose to add cushions or sit on the wood directly. The rocking motion is smooth and the wide armrests are a great place to set a cool drink while you're relaxing.

While this project isn't technically difficult to build, it is time-consuming. Plan on 30 to 40 hours before you get to the finishing stage, and probably at least 20 to 30 more for finishing, depending on whether you choose to stain or paint the project. You can build it out of any hardwood or pine. Redwood would be a terrific choice for staining, or poplar if you want to paint the project.

No matter how you choose to finish this glider rocker for two, you'll have a piece of patio furniture that your guests will truly admire!

Build the Glider Rocker Base

To begin building the Adirondack chair-style Loveseat Glider Rocker, we'll start by cutting the feet for the base of the glider rocker out of 2x4 on the band saw. You can cut these feet in any shape that you like as long as it is something similar to the shape in the picture above.

Next, using your circular saw or compound miter saw, cut two 2x4 sections at 16" and round over the four corners with a 1" radius on your band saw. These two pieces will form the tops of the base sides.

Then, cut four 2x4 pieces at 15 1/2" to serve as the vertical pieces on each end of the base. While you're cutting, cut two pieces of 2x4 at 42" in length for the top and bottom spreaders.

With each of these ten pieces cut, set up your table saw with a stacked dado blade set to cut half-lap joints in the foot, top and two vertical pieces of each side of the base.

These half-lap joints should be cut exactly the width of the joining board and at half of the depth. The fit should be snug, but not too tight.

Note: These joints could also be done using mortise and tenon joinery should you so choose.

With the half-lap joints cut in all four pieces of each side of the base, dry fit the four boards together to check the fit. If it looks good, assemble using some woodworking glue and 1 1/4" deck screws in pre-drilled, countersunk holes. Repeat with the opposite end of the base.

Now would be a good time to sand each of the two base side assemblies. Pay special attention to the curved cuts from the band saw.

After both base sides are completed, install the two spreaders between the two bases. These two spreaders should be centered on the top and bottom of the base sides. Attach using 2 1/2" deck screws.

Assemble the Sides of the Chair

With the base completed, we'll turn our attention to the Adirondack chair structure of the loveseat glider rocker.

Using your circular saw or compound miter saw, cut two 2x4 boards at 22 1/8" (for the bottom pieces), three at 20" (for the seat supports) and another two at 28" (for the front). Then, cut two pieces at 29" in length (from long point to short point) at a 15-degree angle miter on each end.

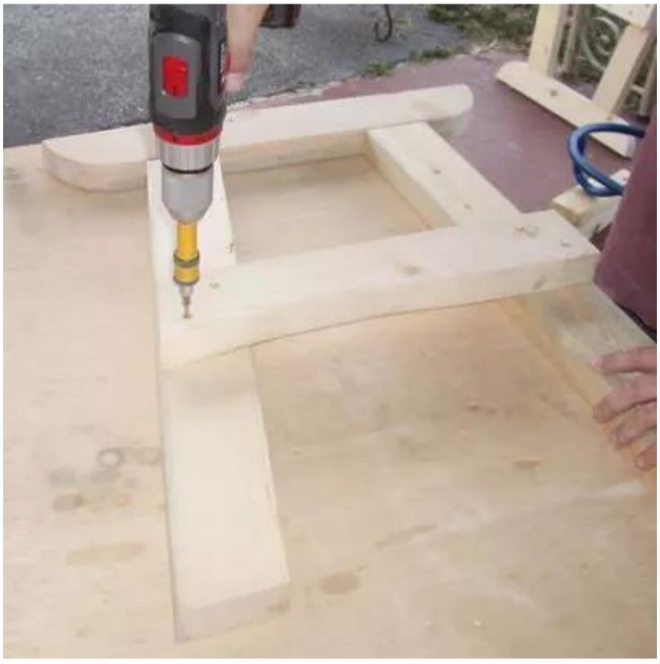
Next, switch to your band saw, and make a 3 1/2" radius cut on each end of the two boards for the bottom pieces. Then lay out and cut the angles on the three seat supports.

Note: Be sure to cut these three as accurately as possible, as all three will work together to hold the seat slats at the proper positions for comfortable sitting.

Now, return to your table saw with a stacked dado blade set to cut half-lap joints in the two bottom pieces, and the bottoms of the front and back pieces. Notice that the half-lap for the back pieces will be cut at a matching 15-degree angle.

To assemble each side section of the chair, connect the pieces at their respective half-lap joints using woodworking glue and some 1 1/4" deck screws. Then, using some 2 1/2" deck screws, attach one of the seat slat support pieces at the appropriate height on the inside of each end.

Note: Keep in mind that on the right side of the chair, this support will be on the left side (or inside) and on the left side of the chair, the support will be on the right side (again, on the inside as the two ends face each other).



Attach Spreaders to the Glider Rocker Ends

With the two structural chair ends of the loveseat glider rocker completed, the next step is to connect these two ends with the spreaders.

Using your circular saw or compound miter saw, square cut two 1x4 pieces at 51" in length.

Using 2 1/2" deck screws in pre-drilled, countersunk holes, attach one

of these to the fronts of the two ends flush with the top of the two-seat slat supports, and the other to the backs of the two ends, again flush with the tops of the seat slat supports. Be very cautious in making sure that the boards are attached square to the sides. See the image above for correct placement.

To complete this step, mark a center point on the two spreaders, and attach the middle seat slat support so that it is perfectly centered between the two ends, with the top of the support flush with the two spreaders.

Attach the Back Spreader

Now that the two-seat spreaders and all of the seat slat supports have been added to the assembly, the next step is to add the back support that will help hold the Adirondack chair back slats.

Using your circular saw or compound miter saw, cut a section of 1x4 to 55" in length. Then, with your band saw, cut a 2" radius on one of the corners on one end of the board. Follow up by cutting the same corner on the opposite end of the board.

After cutting curves and sanding the board completely using your random orbital sander, make a pencil mark perpendicular to the long axis of the board two inches in from each end of the board. Then, attach this board to the angled backboards of the two chair side assemblies. This back spreader should be flush with the top of the angled backboards, and the 2" mark should match up with the outside edges of the angled backboards of the two chair side assemblies. Pre-drill, countersink and attach with 2 1/2" deck screws. See the image below for clarification.

Attach the Back Slats

Time to work on the curved back slats. These slats will be installed, then the curves will be marked so they will have the proper continuity. After marking the curves, each board will be removed, the curve cut on the band saw, then returned and permanently installed.

To begin, use your circular saw or compound miter saw to cut eight 1x4 boards at 38" in length, and another eight at 32" long. Also, cut a couple of pieces of 1x4 at 1/2" in width for spacers.

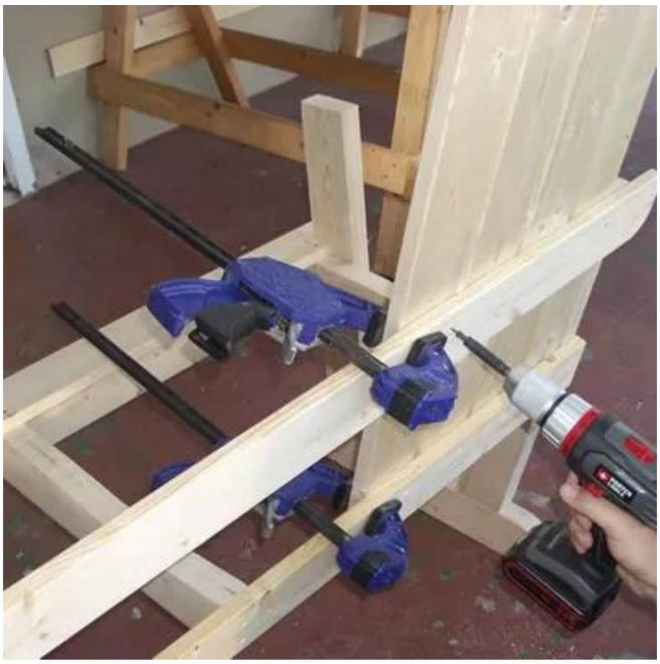
To install the backboards, we'll start in the middle and work outwards to ensure that the boards will be evenly spaced. Find the center point on the back spreader and make a pencil mark on the inside face (the face onto which the backboards will attach. Then, make another mark 1/4" on each side of this center mark. Do the same on the lower spreader.

Next, take two of the 32" backboards and, with the band saw, cut a notch 1/2" wide by 3-1/2" long. These notches are to go around the center spreader. Attach these two boards with countersunk 1 1/4" screws from the back side (through the spreader), aligning the notched side of each on the appropriate pencil marks you made earlier in this step. Check to make sure that the boards are square to the spreaders. The bottom of the boards should be flush with the bottom of the lower spreader.

Then, attach four 38" boards to each side of the first two, flush with the bottom spreader and using the spacers to ensure proper separation. Finally, attach the last two 32" boards to the back, notching around the two seat supports.

Next, use a scrap of stock or a length of string along with your pencil to mark the semi-circular arcs for the curved backs. Remove each

board, cut the arcs on the band saw, and re-install.



Tip

Use the arc you cut on the first longboard in the series to trace the arcs to the short boards.

Attach the Seat Slats

After the back slats have been cut and attached, be sure to give them a good sanding using your random orbital sander. Then, we'll turn our attention to the seat slats.

Using your circular saw or compound miter saw, cut four sections of 1x4 to 48" in length, and another at 51" long. Then, using your band saw, cut a notch in the same side of each end of the longboard 1 1/2" in from each end, and 1 3/4" in from the same long edge of the board. These notches will allow the front board to be installed around the two vertical posts of the sides of the seat.

Position this notched board on the seat supports so that the notches are flush with the vertical posts, and attach using 1 1/4" deck screws (be certain to countersink and pre-drill before attaching). Then, using your 1/2" spreaders from the previous step, position one of the 48" seat slats directly behind the first slat. Align the edges of the board with the outer edges of the seat supports and attach with deck screws. Continue with the other three seat slats.

Attach the Rocker Arms

The next step of these free plans is to cut and install the rocker arms and bearings. No matter what type of stock you used for the base and the chair, the rocker arms should be cut from hardwood, since the entire weight of the chair and the occupants will be on these four pieces of stock.

With your circular saw or compound miter saw, cut four 1x4 sections of hardwood to 14" in length. Round over the corners with a 1" radius using the band saw. Then, make a pencil mark 1 1/2" in from each end on center (1 3/4" from the edge) of each board. These marks will be the locations for the bearings and bolts.

On the outside edges of the chair base, make four pencil marks for bearings as well. Each mark should be 1 3/4" in from the ends of the rounded top board on each end of the base, and 1 3/4" down from the top.

Finally, on the insides of the curved base boards on the bottom of the chair assembly, we'll need four marks for the bearings as well. These should be 1 1/2" up from the bottom. Measure 8 1/2" back from the front end of the curved chair base board, and 6" forward from the back end of the chair base for the marks.

Now, depending on the bearing assemblies that you chose for the glider rocker (that should include eight bearings, the bolts, washers, and nuts, plus some 1/2" pan head screws to hold the bearings in place), drill the appropriate diameter holes for the bearings at the marked locations. The holes in the chair and the base should also have a countersink to accommodate the bolt head, whereas the rocker arms should have through holes, with countersinks the width of the washers on the opposite sides of the board deep enough to accommodate the nuts.

Sand the rocker arms and assemble the base, rocker arms and chair

using a socket set to tighten the nuts as shown in the image above.

Note: Although the placement of the bearings worked well when the prototype was built, the chair tended to tip over backward when the rear bearings are placed at 1 1/2" in from the rear. Moving the bearing in 2 1/4" solved the problem.

Attach Additional Back Support

The second to last step of these free woodworking plans for an Adirondack Loveseat Glider Rocker is to attach additional back support to the seat slats. This board will only be attached to the seat backs, and not the frame of the chair, but it will provide lateral support

for the seat back slats.

With your circular saw or compound miter saw, cut one length of 1x4 to 44" in length. Sand it completely using your random orbital sander before installing.

To install, measure 13" down the back side of the tallest back slats and make a mark. Then, position this support board so that the top edge of the board is on these marks, and so that it is equally centered side to side (approximately 1 3/4" in from the outer edges of the outermost back slats). Attach with two pre-drilled, countersunk 1 1/4" deck screws to each back slat.

Attach the Arm Rests

The last woodworking step to these free plans for an Adirondack Loveseat Glider rocker is to cut and attach the armrests and supports.

Cut two sections of 1x6 to 26" in length. Then, lay out the armrests. Cut the curved sections on the band saw. You may wish to cut the angled section on the band saw, or with your circular saw.

Sand the armrests completely using your random orbital sander before installing them onto the tops of the chair side posts. The flat edge of

the armrest faces the seating section of the chair, and the back edge is flush with the top of the curved back support rail. Attach with pre-drilled, countersunk 2 1/2" deck screws.

Next, using your band saw, cut a pair of supports for the front portion of the armrest. These supports can be of any shape you deem appropriate, so use your creativity as you desire. We chose to make ours 3" wide by 5 1/2" tall, with a similar angle from the bottom toward the top as the angle on the armrests. Center the supports perpendicular to the front posts and the long axis of the armrest on the outside of each front post, and attach using pre-drilled, countersunk 2-1/2" deck screws from the top (through the armrest) and inside of the chair (through the front post).

Finish With Paint or Polyurethane (Optional)

Except for the finish, your Adirondack Loveseat Glider Rocker is now complete. The choice of finish is completely up to you. Although it isn't shown in the images here, we chose to paint our glider rocker. This entailed filling all screw holes with wood putty, disassembling the rocker arm assemblies, sanding every surface, giving each and every exposed joint a good caulking, followed by primer and top coats of paint. Should you choose a stained finish, be sure to give it plenty of protective top coating (such as polyurethane for protection).

Making Dovetail Drawers

Difficulty Level

Moderate

Finishing

Paint or stain, and polyurethane

Time to Complete

2 Hours

Recommended Tools

Miter saw or circular saw

Router and router table with 1/4" straight bit

Dovetail jig and router bits

Eye protection and hearing protection

Materials Needed

1 x 4 poplar or pine for drawer sides

1/4"-thick plywood for the drawer bottom

1 x 6 stock for the drawer front

Drawer handles

Tape measure

Pencil

Woodworker's glue

1" wood screws

Paint or stain in color of choice

Sandpaper

Cut the Sides to Length

The first step is to cut the four sides of the drawer to length. Drawers typically are built from 1x stock, but the widths can be dependent on the height of the drawer required.

Rip the stock with a circular saw or on a table saw to the desired width.

Then, cut the four sides to the finished lengths as required by the project's plans. The two sides of the drawer should be the same length, and the front and back should be the same length. For instance, for a drawer that will have a finished box size of 18" wide x 12" deep, you will need to cut two 18"-long pieces and two 12" pieces.

Cutting the Dovetail Tails and Pins

Once the sides of the drawer are cut to the appropriate lengths, we'll

turn our attention to cutting the dovetails. While traditional dovetails are cut by hand with a dovetailing saw and chisel, we're going to use a dovetail jig and a router.

TIP: Be sure to follow the step-by-step instructions that accompany your dovetail jig for perfectly fitting dovetails, as each dovetail jig has a different set of steps for cutting the tails and pins. For this reason, the following directions are general instructions; your actual process will vary a little depending on your jig.

For best results, always cut the tails first--the center portion of the joint that is shaped like a fish tail. It is much easier to take a bit more off of the pins than to adjust the tails. Set up your dovetail jig for cutting tails, and place the end of one of the two side pieces into the jig. Center the jig appropriately and cut the tails, again following the instructions that accompany your dovetail jig).

After the first tail has been cut, turn the stock 180 degrees and place the opposite side into the jig. Be certain that the side of the board that was facing you when you cut the first set of tails is the same side of the board that faces you now.

Once you've finished cutting the tails on both ends of one side piece, complete the opposite side piece in the same manner.

Change your dovetail jig to a pin configuration. You'll also likely need

to change the bit to a straight-cutting bit. Align the back piece of the drawer box into the jig at the appropriate location and cut the pins.

Remove the piece from the jig and test the fit with one of the tail boards. If you are satisfied with the fit, rotate the stock 180-degrees, and cut the opposite pins.

Cut the pins into the fourth side of the box in the same manner.

Cut the Grooves for the Drawer Bottom

With the pins and tails properly cut in the four sides, we'll turn our attention to cutting the groove in each of the four drawer pieces to accommodate the drawer bottom.

Begin by dry-fitting all four sides of the box together. Make a small pencil mark on the inside lower section of each of the four sides, to denote on which side of each piece the groove should be cut.

Set up your router and router table with a 1/4" straight cutting bit and fence. The bit should be adjusted to a 3/8" height above the table, with the fence 1/4" from the back-side of the bit.

Next, verify the thickness of the four pieces of stock. If you used 1x stock, the thickness would likely be 3/4".

Measure this distance away from the edge of the bit along the fence, and make a pencil mark on the fence on each side of the bit at this distance. This will denote the start and stop points for the groove.

Wearing proper eye and hearing protection, turn on your router. With the side of the stock to be cut facing the table and the bottom edge against the fence, place the butt end (opposite the end at the bit) against the table, with the leading edge just over the bit. Align the end of the board with the far pencil mark and carefully angle the stock down onto the bit.

Slide the stock forward while holding it firmly down onto the table and against the fence until the back edge reaches the first pencil mark. Then carefully angle the stock and lift the back edge off of the bit.

Cut the grooves in the other three pieces of stock in precisely the same manner.

Cut the 1/4" plywood bottom to size. The dimensions of the bottom should be 1/2" longer (in each direction) than the inside dimensions of the dovetail drawer box. For instance, on the aforementioned 18" x 12" box, the bottom should be cut to a size of 17" x 11". This will allow the drawer bottom to float within the grooves, with a small amount of play.

Begin the Assembly of the Drawers

Before we move onto the final assembly, it is a very good idea to dry fit the entire dovetail drawer box. If any adjustments are going to be necessary, it will be much easier to address before any glue is applied to the assembly.

Dry-fit one of the two sides with both the front and back of the drawer assembly. Then slide in the drawer bottom, and dry-fit the fourth side. When you're confident that the fit is perfect, disassemble the five pieces.

To begin the final assembly, apply a drop of woodworking glue into each of the dovetails, as shown in the picture. Spread the glue with either a small bristled brush or a thin piece of scrap stock that will fit into the tails easily. Coat all three edges of each of the dovetails with a thin, even layer of glue.

Attach the Pins to the Tails

With the tail glued properly, slide the appropriate pin board into this dovetail and tap with a rubber mallet, if necessary, until the joint is seated properly. Immediately wipe off any excess glue that may have squeezed out of the joint.

Repeat these steps with the opposite tail on the sideboard, and attach the pinboard to this opposite tail.

Insert the Drawer Bottom

With three of the four sides of the drawer assembled, insert the drawer bottom into the grooves. There should be no glue used to attach the drawer bottom, as the bottom should be allowed to slide freely in the groove to accommodate seasonal movement in the stock.

Simply set the side of the dovetail drawer on your woodworking table

with the two pin boards extending vertically, and slide the drawer bottom into the grooves of the pin boards. Ease the lower edge of the drawer bottom into the groove of the tailboard at the bottom.

Attach the Fourth Side of the Drawer Box

With the bottom of the dovetail drawer in the grooves, apply glue to the tails at each end of the second tailboard and slide the tails onto the pins of the pinboards to complete the drawer box.

Ease the drawer bottom into the groove and tap the drawer side into place with a rubber mallet.

Immediately wipe off any excess glue that may have squeezed out of the joints.

Clamp the Drawer

With the four sides in place, clamp the tail boards together with some long pipe clamps or bar clamps to hold the unit while the glue dries. Be sure to cross-measure to check the unit for square before setting it aside to dry. Adjust the dovetail drawer box if it is out of square and re-clamp.

Set aside the assembly to dry.

TIP: Always clamp the drawer with a couple of clamps on the bottom and at least one clamp on the top of the drawer. Check the four joints to make sure they are properly seated. Tap the joint with your rubber

mallet to tighten the joint if needed. It is also a good idea to use a couple of pieces of scrap stock between the jaws of the clamps and the tail boards to prevent any scarring from the clamps.

Sand the Assembly and Attach the Drawer Front

Once the glue in the joints of the drawer box has had time to dry, we'll prepare to complete the drawer.

Begin by sanding the box and the dovetail joints with progressively finer grits of sandpaper until the joints and drawer box are smooth. Set the box aside.

Measure and cut the drawer front as designated by the plans for the project you are building, and apply the decorative edge with the appropriate router bit if necessary. Sand, the drawer front, again employing progressively finer grits of sandpaper.

Place the decorative drawer front onto the front of the drawer box and position it into the exact required location. Clamp the drawer front in place and attach to the dovetail drawer box with a few countersunk wood screws.

After the appropriate finish has been applied, attach the drawer pulls in their proper locations. Be sure to pre-drill the holes for the drawer pulls.

How to Make Louvered Doors and Window Shutters

Difficulty Level

Woodworking: Moderate

Finishing: Paint or Stain

Time to Complete

6 Hours

Recommended Tools

Miter Saw or Circular Saw

Table Saw

Plunge Router with 1/4" Spiral-cutting Straight Bit

Router Table and 1/8" Radius Roundover Bit

Power Drill

Large Clamps

Chisels

Materials Needed

2 - 2x4 x 8' - Pine or hardwood

Materials for rails and stiles for your particular application

Tape Measure

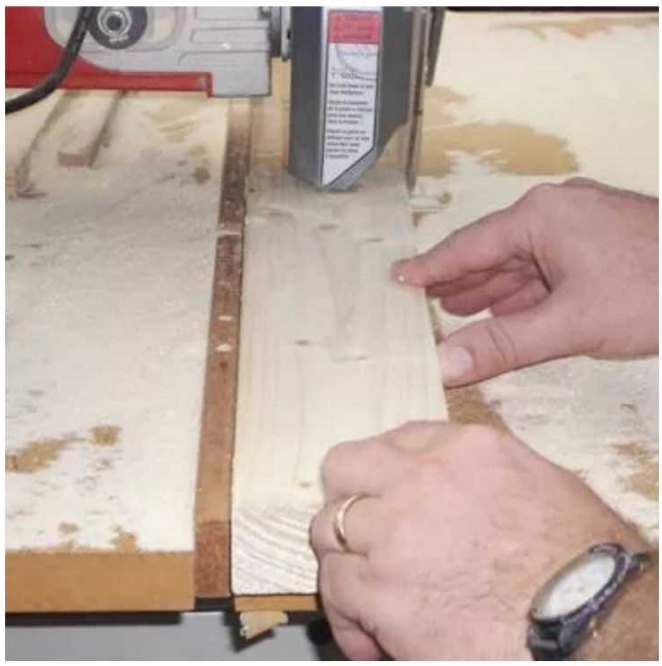
Pencil

Woodworker's Glue

Sandpaper

Cut the Rails, Stiles and Slats

Hands ripping a rail with a table saw



The first step is to cut the rails and stiles for your particular set of louvers. However, since each installation is different, you'll need to know some principles before you can begin your layout.

Each slat in the louvers will cover one vertical inch of space. We'd suggest that you leave a 1/8" gap between the top and bottom slats and the corresponding rails. For instance, if you have approximately a 24" tall opening for the louvers, you'll want to make the opening 24-1/4" and insert 24 angled slats at one-inch intervals. Additionally, each seat will be inserted into a 1/4" deep groove in the stiles, so the slats must be formed as 1/2" longer than the width of the opening.

Once you know the dimensions of the door, window shutter or other installation, you can determine the length and width of the rails and stiles. Use your best judgment as to how wide each of the rails and stiles should be ripped to maintain the integrity of the entire unit.

As an example, in the case of the louvered window covering we built as a prototype, our opening was 30-5/8" tall by 23" wide. As such, we made our two styles 30-5/8" x 2-1/2", and our rails 20" (to accommodate a 1" long tenon on each end) x 2-11/16" wide. We cut all of these parts out of a very straight, clean 2x4. (For a louvered door, you'll likely need to use stock thicker than the 1-1/2" width of the 2x4.)

These rails and stiles left us with an opening of 18" x 25-1/4". This means that we needed 25 seats of 18-1/2" x 1/4" thickness ripped out of a second 2x4.

TIP: Be sure to cut a few extra slats, as you'll likely want to cull a few that have some knots or other imperfections.

Round Over the Long Edges of Each Slat

The next step of this woodworking project is to round over the four long edges of each of the louver slats.

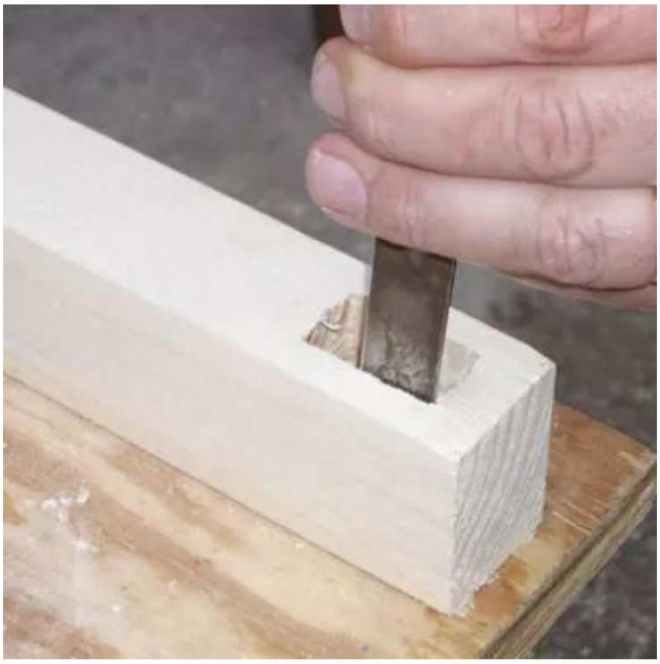
Set up your router in your router table with a 1/8" radius round over bit equipped with a bearing tip. Adjust the depth so that the lower edge of the round over is flush with the top of the router table. Then, place one salt flat on the router table (as shown in the picture) and ease the four long edges by pushing the seat along the bearing and down each of the long edges. On a router table, always move the stock from left to right, against the rotation of the bit. Any attempt to move the stock in the opposite direction may cause the bit to grab

the stock and force it out of your hands.

After the four long edges on all of the slats have been rounded-over, sand all of the slats with a random orbital sander or 1/4-sheet sander. Use progressively finer grits of sandpaper to remove the sanding marks from the previous sanding. If you plan to paint your project, 300-grit final sanding should be sufficient to remove all sander marks and leave a smooth surface for painting. If you plan to stain your project, or if you want to ensure an optimum surface, consider a hand sanding with some 400-grit sandpaper for a very smooth finish.

Set the seats aside for the time being.

Cutting the Mortises in the Stiles



We'll now turn our attention to the mortise and tenon joints that will hold the frame together. You'll need to cut a mortise in each style for each of the tenons (to be cut on the ends of the rails in the next step).

TIP: Remember, when forming mortise and tenon joints, it is always easier to cut the mortises first then fit the tenons to the mortises rather than the other way around.

Probably the easiest way to form mortises is with a dedicated mortise, which is essentially a drill press with a square chisel surrounding a drill bit. The drill bit in the center removes most of the stock, while

the square chisel does the rest. This allows the operator to drill square holes, perfect for a mortise. Some drill press manufacturers offer optional mortise attachments with various sizes of square chisel bits.

However, if you don't have a mortise, there are some other ways to create an appropriate mortise. You could mark out the mortises and remove most of the material with a drill press or power drill, then clean up the mortise with a sharp chisel.

You could also use a straight bit on your router table in place of the drill bit, by easing the stock down onto the bit, moving along the fence and then raising the stock back off of the bit. To make a wider mortise, simply move the fence a bit and take another pass. Then, clean up the mortise with a sharp chisel.

Your mortises should be about half the width of the stock. In our case, the stock is 1-1/2" wide, so we made our mortises 3/4" thick, centered in the width of the stile. And since we won't want to see the edge of the tendon in the bottom of the frame, we'll cut the mortise back 1/2" from each end. On our 2-11/16" wide rails, we made a 1-11/16" wide tenon, so we were sure to start the mortise back 1/2" from the edge.

Cutting the Tenons in the Rails

After the mortises have been cleanly cut, we'll make the corresponding tenons. These tenons can be cut a number of ways: you could cut them by hand with a small hand saw, use a band saw or cut them on a table saw with a tenoning jig. In our case, we chose to cut them on a radial-arm saw using a stacked dado blade set. (You could accomplish the same task with a table saw using the miter gauge.)

Set the depth of cut to match the width of the amount of material you left behind when you cut the mortise - in our case; we will be cutting out 3/8" off of each wide edge to leave behind a 3/4" thick

tenon. If you're using stock thicker than 1-1/2" then you'll need to adjust the depth of cut.

After cutting the two flat sides of each of your tenons, adjust for a deeper cut (1/2" in our case). Then turn the stock on its side and make the remaining cuts of the tenons.

TIP: Always cut your tenons a bit larger than their finished size to begin, then try to dry fit the tenons. If they don't fit, cut them a little further and make any adjustments that you deem appropriate to ensure a perfect fit.

After all of the mortise and tenon joints have been cut and dry-fitted properly, disassemble the joints and mark the corresponding joints in discreet locations, so you know how to re-assemble the frame in the final assembly. Then, sand all of the exposed sides of the rails and stiles.

Make a Louver Jig for Your Router

The key to making louvers is in the grooves for the slots in the stiles. If the grooves aren't properly spaced or parallel, the louvers will look odd.

There is a simple solution to this potential problem: a louver jig for your plunge router. That can be built out of scrap stock and will ensure every groove will be perfect.

If you check back to the plans you downloaded in step 1; you'll find a four-view measured drawing of the router jig.

To begin, you'll need two long (at least 24") boards that are a bit thicker than the width of the style that you'll be routing. These don't have to be solid boards; you could use a couple of pieces of scrap 3/4" plywood and shim some other scrap stock beneath the two boards to raise them to the proper height. Make sure that the channel between the two long boards is clear.

Next, position one piece of 1x2 in a 45-degree angle (using a layout square) a few inches to the right of center on the two parallel boards. Adjust the width of the parallel boards so that they match the thickness of the stile (on edge - this would be 1-1/2" if you used 2x4s to make the stiles). Affix this 1x2 to the two long boards with screws.

Now, position your router with a 1/4" radius straight-cutting bit on the two long boards, butted against the left side of the angled board you just attached. Position a second board parallel to the first angled board, on the other side of the router base. Attach with screws.

Next, you'll need a piece of scrap the same size as the style to be grooved. Mark a line across the width of the same edge of the board as the groove to be cut in style. Make a mark at the center of this line, then make a 45-degree mark (in the same direction that you

positioned the router guides in the last step) through the intersection. Make a mark at 3/4" in each direction from a center point on this line.

Cutting the Grooves for the Louvers

Position this board with the center mark directly under your router bit on the jig. Remove the router, and make a pencil mark on the jig that that corresponds to the first 90-degree mark you made on your test board. This will be the alignment mark for positioning your style when you cut the grooves (as shown in the image above).

Put the router back on the jig and move it forward to the point where the edge of the bit meets the far 3/4" mark on the diagonal. Find a short piece of scrap 1x2 and position it against the router base on the jig and screw it into place. This is a stop to keep you from routing too close to the edge of the stile.

Move the router toward you in the jig until you reach the other 3/4" mark on the diagonal line and attach another stop block against the router base for the bottom side of the jig. You should now have 1-1/2" of travel perfectly centered on the test style.

Set your router to make a 1/4" deep cut and clamp the jig and test style to your table. Route a test groove, remove the style and dry-fit test the fit with one slat. Adjust the jig if you aren't happy with the fit.

Next, we'll set up one style for cutting by making a perpendicular mark every one inch along the edge of the stile to be grooved. Start by making a mark at the halfway point of the length of the style. If you have an odd number of grooves to cut, make one mark on each side of the center every inch until you have the requisite number. If you need to cut an even number of grooves, you must make a mark 1/2" on each side of the centerline, then a mark every inch on each

side until you reach the desired number of slats.

With all of the marks completed, clamp the style to the table and route the first groove. Then, remove the clamp, slide the style to the next mark, clamp, and route. Continue until all grooves have been routed.

Assembling the Louvers

With all of the grooves cut in one style, you'll need to build a second jig (or disassemble the first jig) and repeat the same instructions from

the past two steps in the opposite 45-degree angle.

Once you have a matched set of grooved stiles, dry-fit the slats in one of the styles as shown in the picture on this page.

Then, evenly brush a bit of glue into the two mortises (three if you're making a door) on this style and the appropriate rail tenons, then slip the tenons into the mortises. Immediately wipe off any glue that squeezes out of the joints.

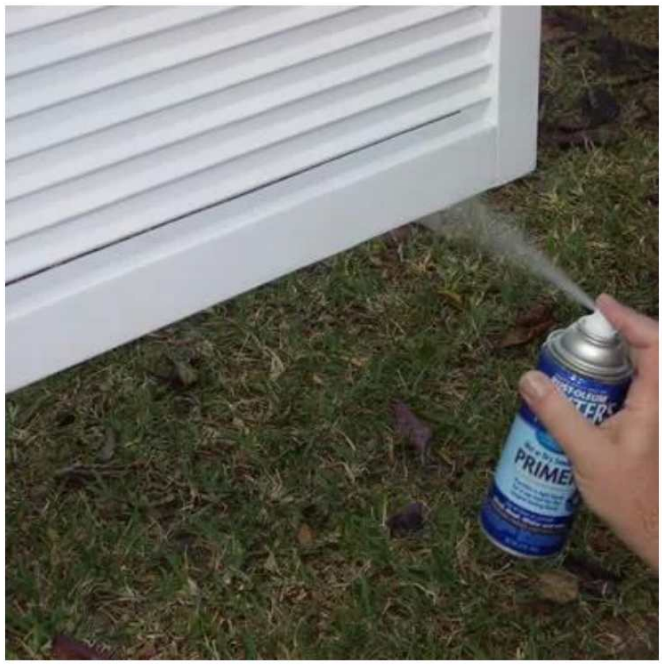
Next, brush some glue into the mortises on the remaining style and the two (or three) remaining tenons. Position the tenons into the mortises and, working quickly from one rail toward the other, place the individual slats into the proper grooves of this style.

Completing the Louver Assembly

Once you have all of the louvers in their appropriate slots and the tenons securely into their mortises, clamp the styles together using some long clamps. Be sure to clean up any glue that squeezes out of the joints.

You should also check the unit for square by cross-measuring the assembly from diagonal to diagonal. If the cross-diagonal measurement across two corners matches the measurement across the other two corners, the unit is square.

Finish the Louvers



The final step applies the finish of your choice to the louvered assembly. While you may choose to brush on your finish, I find it easier to spray the finish.

If you choose to paint the louvers, be sure to give it a couple of thorough coats of primer before adding a couple of coats of the final color.

Should you choose to stain the louvers, you'll likely need to apply the stain with a brush, but you can spray on a few coats of polyurethane or lacquer as a final finish.

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