Build Your Own

THE MAIN BUILD IN THIS ARTICLE

Hi-fi audio. *Retailers like GR-Research offer world-class components and instructions for a range of high-end speakers, like this compact but powerful pair. "Passive" speakers like these are connected with wires to a separate amplifier or receiver, as part of a high-end audio system. The article covers this build in detail.*

As a furniture maker and luthier with a passion for music, I've had a lot of fun building my own audio components, especially speakers. These projects have given me the chance to learn a number of new skills and concepts. Speakers require a unique approach to material selection, airtight joinery, and careful soldering.

What makes these high-end DIY speakers possible is the range of retailers selling excellent parts kits. These kits include the speakers themselves (drivers) and all of the electrical/electronic parts you'll need, along with detailed instructions on how to assemble them and build the boxes. My favorite retailers include DIY Sound Group, GR-Research, and Parts Express.

The kits we chose for this article include only the electrical components, leaving the customers to build the boxes. While many companies also offer precut box parts, to be glued up and finished as desired, those take away part of the fun for me.

Go with a parts kit—If you have a deep interest in electronics and acoustics, you can select and purchase the drivers, crossovers, wires, capacitors, and other electronics separately. For most of us, however, a high-quality parts kit is the way to go. These ensure that components are matched properly, and they include instructions for a properly designed speaker box, another critical component.

More sound for less—I've built a number of speakers using parts kits like the ones cited below, and in each case the speakers I built perform much better than premade speakers sold at a similar cost.

For example, to get audio quality similar to that produced by the high-end bookshelf speakers featured in this article—built using a $400 component kit from GR-Research—you would likely need to spend $1,000 or more on off-the-shelf speakers. In fact, that's what GR-Research charges for a completed pair using the same kit.

With all but the most basic speaker kits, some soldering is involved. But don't be intimidated; this type of soldering requires very simple tools and is easy to learn.

Speakers

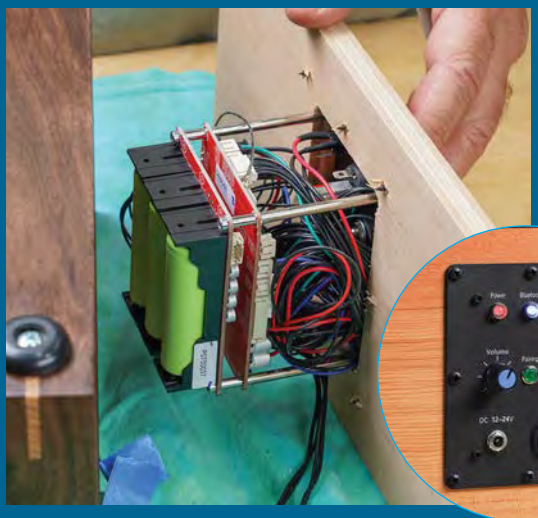
Use a high-quality component kit and get great sound for less

BY ANDREW GIBSON

Two other types to consider

Parts kits are also available for powered speakers, with built-in amplifiers that let them connect directly to smartphones, computers, and TVs.

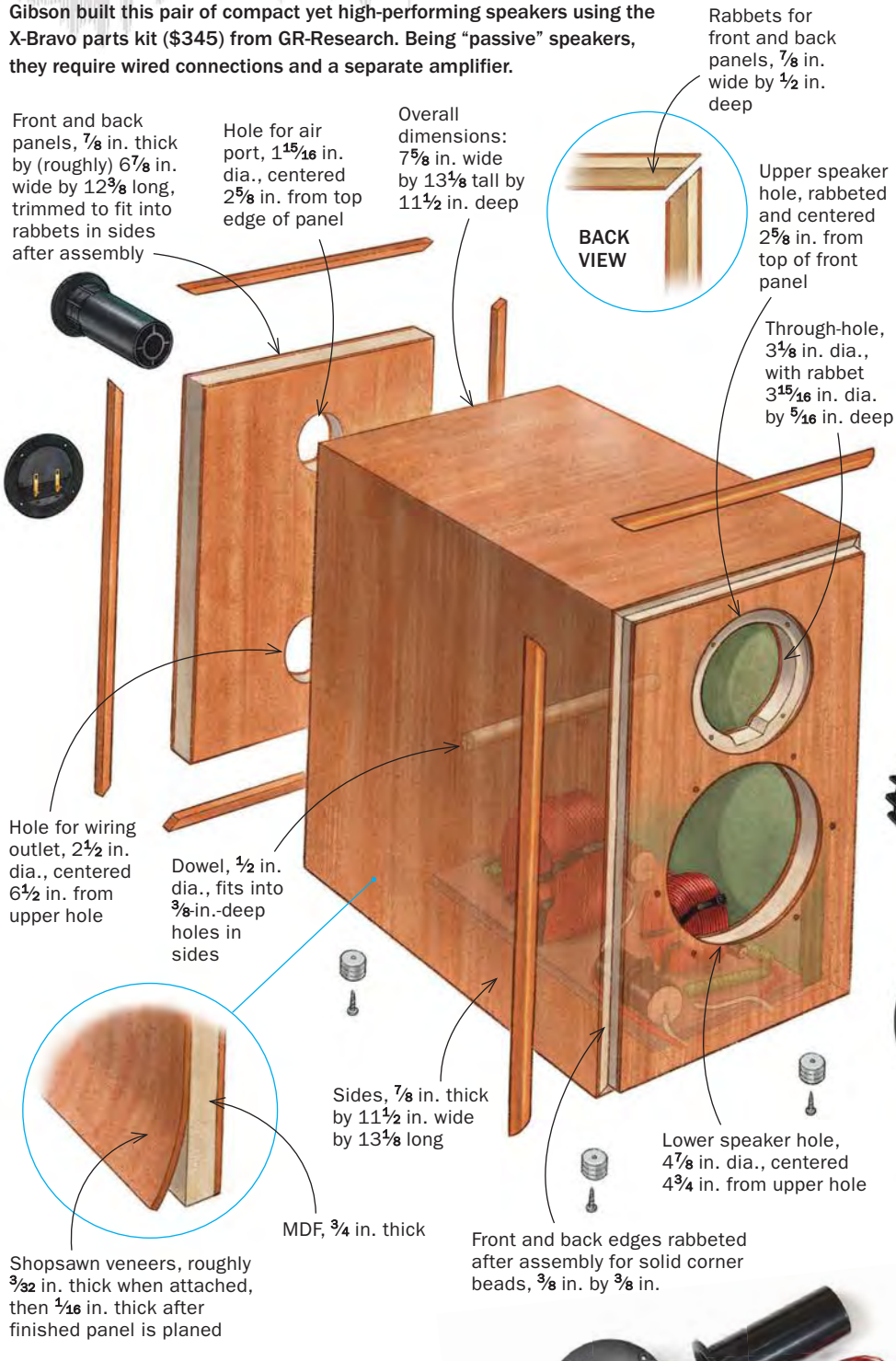
The components for these bookshelf-size speakers include a small amplifier and both wired and Bluetooth connections, so the speakers can be connected directly to a TV, phone, or computer. Gibson added grills to these speakers. The speakers were made using the C-Sharp kit ($190) from Parts Express. A small control panel attaches to one of the speakers.



The Large Portable 100W Bluetooth Ammo Box Speaker Kit from Parts Express ($130) includes everything you need for a portable Bluetooth speaker for the workshop, beach, or backyard. The container is up to you. We aren't presenting the steps involved in this build, but the included instructions make it relatively straightforward.

Anatomy of a hi-fi speaker

Gibson built this pair of compact yet high-performing speakers using the X-Bravo parts kit ($345) from GR-Research. Being "passive" speakers, they require wired connections and a separate amplifier.



Lots of possibilities

For this article I built two different types of speakers, and my editor, Asa Christiana, built a third. The three parts kits demonstrate the wide range of possibilities for speakers. There are also parts kits available for other high-end stereo components.

The main project in this article is a pair of compact but high-quality speakers that can go anywhere in your home. Called passive speakers, this type must be powered by a separate amplifier or receiver.

While there are even higher-level kits available, priced into the thousands for true audiophiles, the X-Bravo kit I used produces speakers that pair well with high-end audio components and/or a home-entertainment system.

Powered bookshelf speakers—The second build, which uses the C-Sharp kit from Parts Express, is a pair of powered bookshelf speakers. The term "powered" means that they have an amplifier built in, so you can attach them directly to your TV, computer, phone, or CD player. This kit also includes a Bluetooth module for a wireless connection.

For more information on this build, see our free companion article at FineWoodworking.com/312.

Portable speaker—Last is the even more compact and portable Bluetooth speaker that Christiana built. This is perfect for use in the backyard, at the beach, or in your workshop. There are fewer restrictions on the container design for this type of kit, so flex your creative muscles and come up with something cool. The kit, from Parts Express, is designed to go inside an ammo box, so your container doesn't even have to be wood.

SMART APPROACH TO CABINET CONSTRUCTION

High-end speakers should be airtight, with a sound-deadening box. This makes MDF a great material choice. Veneer it to add beauty, and use miter joints for a seamless look. Solid corner strips are rounded to allow sound waves to disperse without interference.

***What's in the box.** These are the parts for one speaker. The electronic components are soldered together and mounted on a thin MDF board. The tube is an air port that goes in the back of the speaker box.*

Photos: Asa Christiana. Drawings: Derek Lavoie.

Veneer the panels

Gibson used shopsawn veneer, which is thicker than commercial veneer. That let him glue on clamping blocks to assemble the miter joints and then remove the blocks without fear of sanding through the veneers.

Dial in your resawing setup. *Use a fresh blade, at least ⅜ in. wide, with three or fewer teeth per inch, and center it on the upper wheel. Saw the veneers a little over ⅛ in. thick.*

Plane them smooth. *It helps to place an auxiliary table in your planer, made of MDF or melamine, with a small cleat to keep it from sliding through the machine. Flex the veneers as they enter the planer to keep them from being pulled up into the cutterhead.*

Join veneers if necessary. *To create wider veneers, join strips. Stretch blue tape across one side of the joint, fold the joint open, spread glue on the edges, fold the panel flat again, and then stretch tape across the other side.*

Applying the veneers. *Gibson used polyurethane glue here, which doesn't introduce much moisture to the assembly. Spread glue on the MDF, give it a light mist of water, and lay down the veneer, holding it in place with blue tape. Do the same on the other side of the panel.*

Clamp the sandwich. *Add a sheet of plastic to each side to resist glue; add more of the ¾-in.-thick MDF on both sides to spread clamping pressure; and place clamps 6 to 8 in. apart.*

Back through the planer. *After the glue has cured, plane both sides evenly, bringing the panel down to ⅞ in. thick in the process. Use the table saw to clean up the edges.*

Build the box parts

The sides go together with miter joints, and the fronts and backs drop into a rabbet. Then solid corner strips are added to hide the veneer edges and allow the corners to be rounded.

Miter the sides. *Cut the parts to exact size, and use a crosscut sled to cut the miters. Use a stop block to ensure that the cuts end right at the edges of the workpiece.*

Rabbet the sides. *Bury a dado set slightly into an auxiliary fence, and cut the rabbets on the table saw.*

Cut the fronts and backs to size. *Dry-fit the sides with blue tape, and trim the front and back panels until they drop into their rabbets.*

Cut the openings

The front and back panels need openings of various shapes, depending on the speaker design. If you can't cut them with a Forstner drill bit, use a router and template to do the job.

Make a template for the driver holes. *Drivers need large holes, sometimes rabbeted. Use a circle cutter in the drill press to make templates, factoring in the offset between the router bit and the guide bushing you'll be using.*

Two-step template. *The smaller driver needs a rabbeted hole, which is notched. So this template has two different circles for routing the same driver hole. Place a sacrificial board under the workpiece, and use double-stick tape to attach the template in each position.*

There is nothing different about the techniques needed for this type of build, so we'll just show you the components and the result.

How speaker components work together

For a speaker to reproduce sound effectively, all of its components need to work together well, including the boxes.

Crossovers filter the signal—The crossover is a set of electronic parts—capacitors, resisters, and inductors—that filter the signal from the amplifier, breaking it into different frequency ranges and sending those signals to different-size speaker cones, or "drivers."

Drivers create the sound—The driver is the part that we typically think of as the speaker. It moves air in waves that we perceive as sound. Drivers come in different sizes, designed to reproduce different frequency ranges. Tweeters reproduce higher frequencies, woofers reproduce mid-range frequencies, and subwoofers reproduce bass frequencies.

The two pairs of bookshelf speakers we built are "two-way" speakers. This means that they have a tweeter and a woofer, with the latter handling both low- and mid-range signals. There are also speaker designs that use single, full-range drivers, and there are 2.5-, 3-, and 4-way designs, usually on the higher end.

The box is the foundation—The third component is the box, or cabinet, and its

Finish up the box

After the box is glued up, the front and back edges are rabbeted to accept solid-wood strips, which are rounded on the router table.

Attach clamp blocks. *After stretching blue tape across the joints, Gibson uses CA glue to attach 45° MDF blocks (near right). Hold each one in place for 15 seconds before moving on. To stiffen the box, the X-Bravo design includes a dowel that connects one side to the other. Drill for this dowel ahead of time, and insert it during assembly (far right).*

Glue and clamp the parts. *Spread yellow glue on the miter joints, close up the box, and tape the last corner closed. Then spread glue in the rabbets, add the front and back panels, and clamp lightly across the miter joints. Add more clamps to tighten the panels in their rabbets.*

Rabbet the corners. *After assembly, the front and back edges get a ⅜-in.-square rabbet for solid corner strips.*

Glue in the corner strips. *These are cut a bit thicker than ⅜ in. Dry-fit them to dial in the miter joints, and attach them with glue and blue tape.*

Round the corners. *After the glue dries, plane and/or sand the strips flush, and use a ⅜-in. roundover bit to round them.*

Build the crossover

The electronic components are soldered together and then attached to a small MDF base, which is screwed into the bottom of the box.

Plan the layout. *Cut a piece of ¼-in. MDF narrow enough to fit into the large driver hole, and read the X-Bravo instructions to understand how the parts should be arranged and connected. Position the parts as tightly as possible, and mark and drill holes for zip ties.*

shape, materials, and construction are critical for getting the best performance from high-quality crossovers and drivers.

The air inside the box acts like the shock absorbers on a car. As the driver cones move in and out, the trapped air behind them keeps the cones from bouncing out of control.

As the driver cones are pushing sound outward, they are also making sound waves inside the box. If those waves bounce around too much in there, they can push back on the cones and cause distortion. Think of children jumping on a trampoline. If they all jump at different times, the bounces are unpredictable. A well-designed speaker box allows the driver to act as though there is only one child on the trampoline, with all frequencies happening at the same volume.

Solder the connections. *Twist the wires as shown, add flux, and solder the joints. The solder should flow along the entire joint. Check the opposite page for more soldering advice.*

Tie down the parts and attach the finished crossover. *Once their joints are soldered, lock down the main parts with zip ties that pass through holes in the base board (left). The panel slips through the larger driver hole and is screwed to the bottom of the speaker box.*

Soldering basics

Look for a soldering iron with adjustable temperature that can reach 700°F, and set it to 650°F for the tasks shown here. The solder itself comes in a number of varieties and sizes. I like 63/37 or 60/40 "no-clean solder," which has flux compound added to help it flow and bond with the parts being joined, so it's less critical to clean the parts beforehand. A thin 18- to 22-gauge (0.7 to 1.2mm) solder is ideal for electronic connections like these. Do not use plumbing solder, which contains a corrosive type of flux that will damage electronics over time.

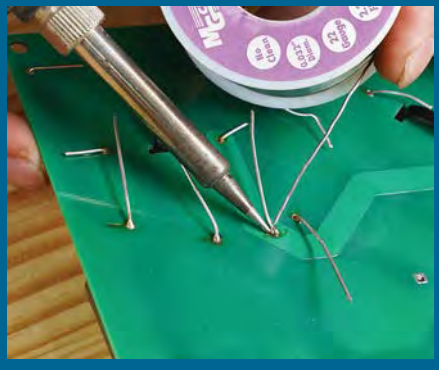
The key to successful soldering is to heat the metal parts being connected and let those melt the solder, drawing it around them as it does. Don't apply heat directly to the solder and then try to apply it to cold parts; it will not flow and bond them. If the solder globs up and/or doesn't flow, you might need to add flux or heat the parts longer before applying the solder.

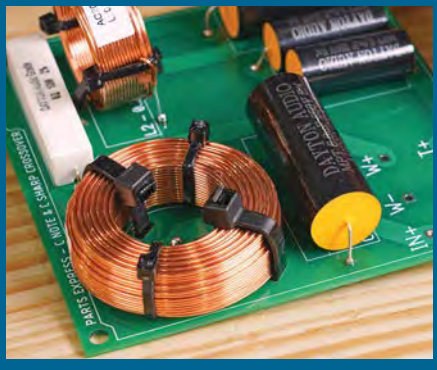
—A.G.

***Step 1:* Tin the iron.** *Melting a little bit of solder on the tip of the iron helps the iron transfer heat to whatever you touch.*

***Step 2:* Add some flux.** *For wire-to-wire connections like these, it helps to add a small amount of liquid flux to the joint.*

***Step 3:* Heat the joint and add solder.** *Apply heat to the joint for a few seconds, and then melt solder into it. Be sure to heat the wires and let them melt the solder, rather than trying to melt solder onto a cold joint.*





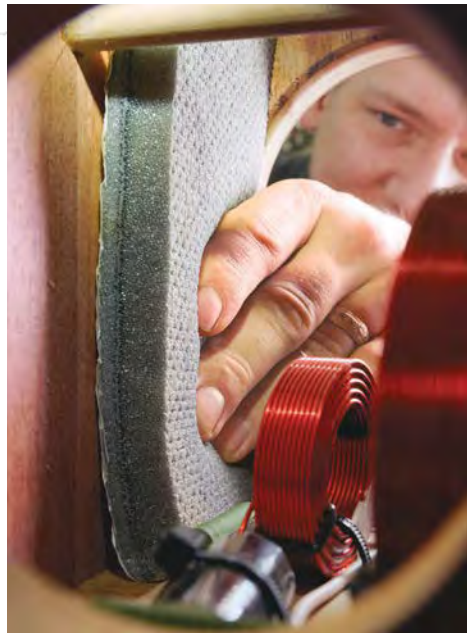
Circuit-board connections. *Push the component wires through the board, and hold the soldering iron in place for an extra moment (far left) to allow solder to flow through the holes. Then flip the board to check that it did (near left).*

The details matter here. If the internal shape and overall volume of the cabinet are changed, that can have a significant effect on the system. The front of the box also matters; shaped correctly, it will help the sound waves radiate smoothly into the room.

Powered speakers have a built-in amp—Powered, or active, speakers include a small amplifier, which is typically installed in one of the speakers but powers both. The amp needs a power source, such as a cord or battery pack, and some have both.

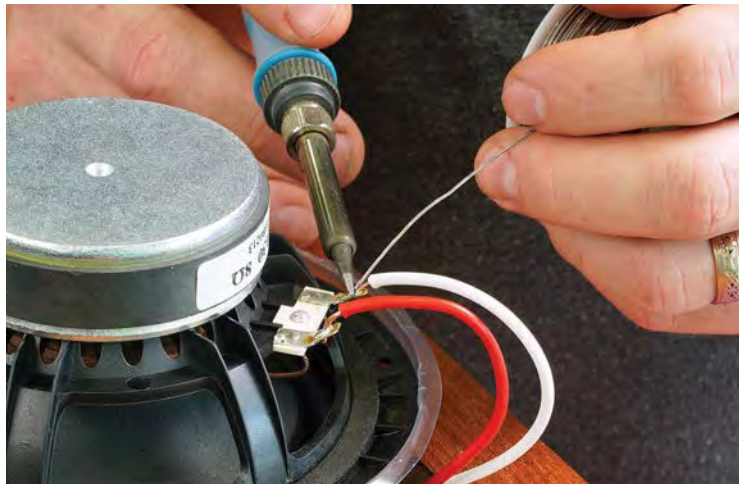
Finishing touches

Once the boxes and crossovers are done, the rest is easy.



Add acoustic foam. *This self-adhesive foam (from Parts Express) lines the box to prevent echoes inside. It's easiest to position the pieces with the backer attached and then peel it off with the pieces in place.*

Add the drivers. *Leave the speaker wires extralong, and solder them to the drivers. Then screw the drivers carefully in place. Drill pilot holes to help you avoid slipping with the screwdriver and puncturing the driver cones.*



Solid construction approach for most speakers

Because the electronic components in these kits have been carefully matched to each other, we don't have to worry about their design or compatibility. But the speaker boxes are another story.

For the two higher-end pairs of speakers, I went with the exact internal sizes recommended by the designers who put the parts kits together. I also followed some of their recommendations for materials and joinery. That still left me plenty of room to add custom touches that make the speakers look like fine woodworking.

Whether custom-built or purchased, speaker boxes need to be airtight. That's difficult to do with solid wood, which shrinks and expands. The boxes also need to be strong and stiff. If a box resonates like a guitar, it will absorb some of the drivers' energy and cause distortion.

To build airtight boxes with as little resonance as possible, I used MDF covered with shopsawn veneer. Christiana, on the other hand, used a mix of solid wood and plywood for his boom box, because that kit has less-exacting acoustics.

MDF is an ideal substrate for veneering, and it has great acoustic properties for speakers. Luckily, our speakers are small enough that normal clamps, used in conjunction with MDF clamping cauls, will work great for applying the veneer. So you won't need a vacuum bag.

To join the veneered parts, I prefer mitered corners with glued-in front and

Two more components, and then feet. *The port is simply pressed into its hole, and the speaker-wire cup is screwed in place (left). Self-adhesive felt circles are all it takes to keep speakers from rattling, but these speaker feet (Amazon.com) look and perform even better (above).*

Grills are a nice option

Speaker grills hide the drivers and add a measure of protection. They can also affect the sound a little bit, but that's only a factor on very high-end speakers.

Grills can be as simple as a pair of mitered frames, with speaker cloth hot-glued into a rabbet on the back side.

The design details are up to you. These grill frames have a slight inward taper on their front faces, and shallow arcs along their inside edges.

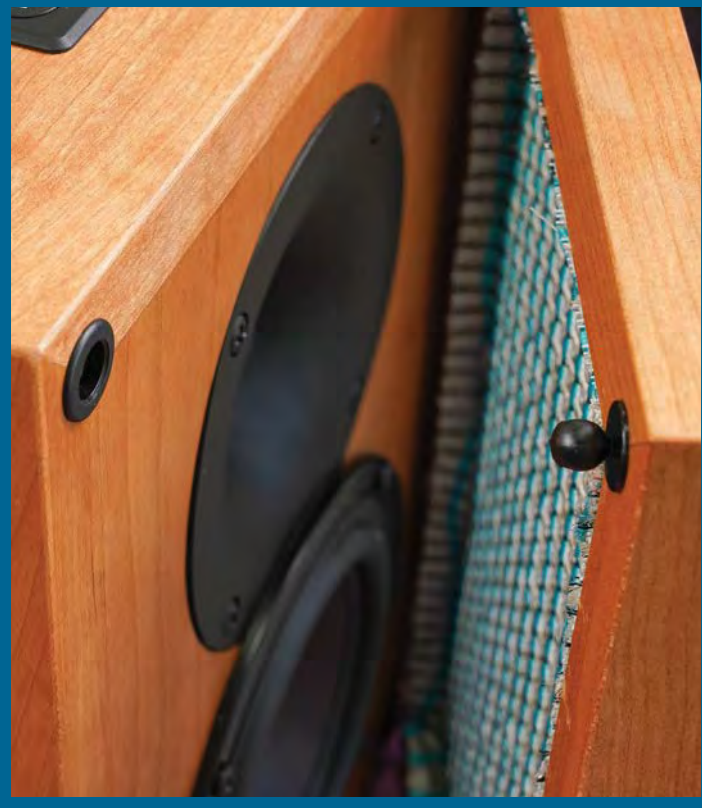
Grill fabrics, widely available in a variety of looks and colors, are another way to personalize the look.

—A.G.

Shape the parts. *Bevel the edges of the parts, rabbet them for the grill fabric, and bandsaw curves along their inside edges.*

Smooth the sawcuts. *After mitering the ends of the parts, plane and/or sand them smooth.*

Add the fabric and install the grill guides. *To anchor the grill fabric in the rabbets, squirt a bead of hot-melt glue into the corner, and push the fabric into the rabbet using a paint scraper, holding it there while the glue cools. Start at the centers of the short sides and work toward the corners, applying glue by folding back the fabric (above). Then do the same along the long edges. Next, install the grill guides (right). These inexpensive but handy guides (from Parts Express) include a little knob and a small receiver that click together, making it easy to attach and detach the grills.*



back panels. The mitered corners join the veneered parts seamlessly, and the MDF substrate lets me glue the front and back panels into rabbets or grooves without having to worry about expansion.

I used ¾-in. MDF to build the box and then veneered it with quartersawn sapele veneer—with ribbon figure. Commercial veneers would also work for this project, but I sawed mine on the bandsaw, leaving them a little over ⅛ in. thick. To assemble the miter joints, I glued on angled clamping blocks, which I sawed and sanded off after assembly. It would have been easy to sand through thin veneers, but that danger was eliminated with shopsawn veneers.

So the panels don't warp, the veneer is applied to both sides of the MDF, equalizing the tension it applies. While I often use a vacuum bag to apply veneers, many woodworkers don't own one. So for this article I used a simple sandwich that includes a layer of plastic to resist glue, a couple layers of ¾-in. MDF to spread clamping pressure, and a pile of F-style clamps. As for the adhesive, I like polyurethane glue. Yellow glue also works, but polyurethane glue dries harder, so the veneer won't creep, and it introduces little to no water, which helps with stability. □

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