An Elegant Site-Built Door

Build a custom interior or exterior door with common job-site tools and readily available materials

by John Birchard

To my eye, nothing adds to the handmade feeling of a home like custom doors do. They are, after all, constantly being touched and used. It stands to reason then that a few extra dollars are well spent on upgraded doors. But a lot of people balk at the idea because custom doors cost plenty. Well, they don't have to.

I make simple, economical doors that also are beautiful. I don't skimp on the materials when I make these doors ($100 worth of materials is about average), and I typically match them with the predominant trim or furniture woods found in the rest of the house. My doors are affordable because they don't take long to make, and they don't require a lot of specialized tools. If you've got a router, a drill, a circular saw and a flat work table, you can build doors right on the job site.

My doors are updated versions of the frame-and-panel style, with simple, clean lines. Instead of using panels that are milled from a single, thick piece of stock, I make the panels for my interior doors out of three layers of plywood (bottom right photo, p. 59). The middle layer is ½-in. birch or mahogany plywood. To this core I glue ¼-in. plywood with the appropriate veneer.

One of the trickiest parts of building doors is joining the stiles and the rails (these are the vertical and horizontal parts, respectively, of the frame). I use two different methods to make this joint. Interior doors don't get the wear and tear of exterior doors, so their frames can be joined with dowels (top left photo, p. 58). This method is less work but not as strong as the loose tenons I use to join exterior doors. More on them later.

On-site door shop—A door-building work station must be outfitted with at least one sturdy work table. The ideal size is around 40 in. by 84 in. I made the one in my shop out of 2x6s. An even simpler version can be constructed easily from ¾-in. A/C plywood (good side up) with a 2x4 frame on edge. Position the table so that you can move around at least three sides of it. On a job site, I prefer to affix one of the short sides to a stud wall and support the other end with 2x6 legs braced with plywood gussets.

This table will be used for laying out the pieces of the door, cutting the joints, planing edges and dry fitting the parts. If you've got room, another nearby table is handy for a tool rest.

One of the most important tools for on-site door building is a heavy-duty ½-in. plunge router. In addition to all the things an ordinary router can do, such as jointing the edges of frame members and cutting slots for panels, a plunge router can also cut loose-tenon mortises for exterior doors.

A half-dozen pipe clamps are essential. I use ¾-in. black-pipe sections that are 48 in. long. This length will clamp the width of most doors, and you can link them with pipe couplings to make clamps long enough to clamp the height of the door if necessary.

Choosing materials—I live on the North Coast of California where redwood is the material of choice for door frames. I use it because of its workability, beauty and resistance to rot and weathering. Folks in other parts of the country will have other local woods to choose from. Pine, poplar (interior only), Douglas fir and oak are all good native species for door making.

I built the interior doors shown in the photo above for a studio addition that has white plastered walls, a light-gray carpet and open-beam ceilings. I think a backdrop like this is a perfect opportunity to showcase the color and figure of varnished or oiled wood. I chose vertical-grain redwood for the door's rails and stiles, and cherry plywood for the panels. Both woods have a compatible reddish tone to them.

I choose the pieces for the stiles carefully. The grain should be straight on both the face and the edges. I avoid stock with twists, large knots or wild grain patterns. Because the rails are much

All it takes are butt joints. **Cherry panels floating in a redwood frame warm a room otherwise dominated by a gray carpet and white walls (photo above). The author made the doors on site to match the trim details found throughout the house. The panels in the exterior door (photo below) are narrower, which reduces seasonal swelling and shrinking.**

shorter, I can cut up boards with knots and crazy grain to get sound pieces.

If you are working without the benefit of a planer or a jointer, you will have to buy surfaced lumber and use it at whatever thickness it comes. You can use 1½-in. thick lumber for either interior or exterior doors, but 1⅝-in. thick lumber is preferable for exterior doors. Interior doors can be made even thinner—1⅜-in. and 1¼-in. thick doors are common.

Ripping and crosscutting the frame parts—I usually buy 2x6 lumber for doors because the 5½-in. wide pieces are about the right width for the stiles and the top and middle rails. For added strength (and a pleasing look) I use 2x10s or 2x12s for bottom rails. For doors less than 30 in. wide, I'll rip the stiles down to 4¾ in. Most residential locksets and doorknobs are backset 2⅜ in. from the edge of the door, and therefore centered in a 4¾-in. stile. Stiles or rails narrower than about 4½ in. will look out of proportion unless the doors are very narrow.

One of the most important operations in frame-and-panel door building is crosscutting the rails. They abut the stiles, so the crosscuts must be perfectly square, and the rails must all be exactly the same length. Chopsaws (power miter saws) are quite accurate for this work, but many chopsaws don't have a large-enough blade to cut all the way through the wide bottom rail. A carefully tuned radial-arm saw will crosscut door rails, but a table saw with a sliding bed is ideal.

In a pinch, you can also make crosscuts with a fine-toothed plywood blade in a circular saw. To keep the cut perfectly straight and square, use a square for a guide, or use a jig made by screwing two pieces of wood together at right angles. If you're a bit unsteady with the saw, clamp the workpiece and the guide to the bench so that you can use both hands to hold the saw. Check your finished cuts with a square to be sure they're right.

Dowel making. **Interior door frames can be held together with dowels. You can make your own dowels with either a quarter-round bit or the half-round bit shown above. The half-round bit should be used in a router table with a fence.**

Router jointing. **If you don't have a jointer, you can still straighten the edge of a stile if you've got a router. Here, the bearing of a ½-in. by 4-in. flush-cutting bit rides on a plywood straightedge. The bit trims the edge of the stile accordingly**

Dowel drilling. **A doweling jig makes it easy to bore perfectly aligned holes that are perpendicular to the workpiece. Here the jig is being used to drill a rail.**

Jointing with a router—Lumber typically comes from the supplier with rounded corners called eased edges. These edges need to be milled square on the stiles where they abut the rails, and if the edges are a bit warped, they need to be straightened. The jointer is the best tool for this task, but lacking that machine you can accomplish the same thing with a straightedge and a router with a long flush-cutting bit (½-in. by 4-in. spiral fluted bit available from MSM Carbide Tooling & Design, 1232 51st Ave., Oakland, Calif. 94601; 510-532-7669). I make the straightedge out of a strip of ½-in. birch plywood 6 in. wide by 81½ in. long (top right photo, this page). I affix 1x2 blocks to the ends of the straightedge, and a 1x2 fence to one side to cradle the 80-in. long stiles as they are jointed with the router. I drive screws through the blocks and into the ends of the stile to secure it.

As the bit's bearing rides along the plywood straightedge, the cutters mill the edge of the stile. Once I've straightened one edge of the stile, I run it through the table saw to straighten the other edge. If you don't have a table saw, you can add a thin shim to the jig's fence, flip the stile over and joint the remaining edge.

Dowel joinery for interior doors—Dowel joints are quick and easy to make and are plenty strong enough for interior doors. When all the frame pieces for an interior door are prepared, I lay them out on my work table and clamp them together as they will go in the finished door. I center the middle rail (or lock rail) 36 in. from the bottom of the door. The top and bottom rails are flush to the ends of the stiles. I use a square to mark across the joints where the centers of the dowel holes will be. These marks are registration points for a doweling jig (bottom photo, this page).

I put at least three dowels in the bottom rail joints and two each in the middle and top rail joints. I space the dowels evenly and am careful not to put them too close to the inside edges of the rails where the ½-in. deep slots for the panels will be cut later.

I make my own dowels (top left photo, facing page) out of the same wood as the framework, using a ½-in. half-round bit in a router table. It probably doesn't make any significant difference, but I like to think that making the dowels out of the same wood as the rails and the stiles will mean that the parts will all expand and contract at the same rates. I plane a flat edge onto each dowel for a glue channel.

You can also use 3-in. long birch dowel pins—the kind that are cut to length, beveled and grooved. Don't use smooth dowels because they act like a piston, compressing the air and the glue when you drive the dowels into the holes, and the resulting pressure can split the wood.

Cutting panel slots—After the dowel holes have been bored, I assemble all the parts using a 1-in. long dowel at each joint to align the frame members. I sand the dowels so that they easily slide in and out of the holes. When the parts are all flush to one another, I clamp the frame pieces together while I rout slots in the rails and the stiles for the ½-in. plywood core panels.

I use a ¼-in. slot cutter for this operation (bottom left photo, this page). I set its depth so that it cuts completely to one side of the centerline on the edge of the frame pieces. Then I flip the door over and rout it again. By cutting two ¼-in. slots from both sides of the door, I end up with a perfectly centered ½-in. wide slot for the panels.

Cutting slots this way leaves rounded corners in the bottoms of the slots where the rails meet the stiles. This can be dealt with by rounding the corners of the plywood core panels (top photo, this page) or by using a chisel to chop the corners square. I find it easier to round the corners of the plywood for interior doors. For exterior doors, I think it is better to chop the corners of the slots square to minimize air leakage.

While the framework is still clamped together, I measure carefully from bottom of slot to bottom of slot in both directions to get the sizes for the plywood core panels. I cut these panels from a cheaper grade of plywood, like shop-grade mahogany or birch. I cut them about ⅛ in. small in both directions so that there won't be any danger of the panel holding the framework apart if the frame pieces swell. To make sure everything fits, I dry assemble the door with panels in place.

Glue up—When everything is ready for assembly, I spread the pieces on the workbench in an exploded fashion. I prefer to glue doors with a urea-resin glue like Weldwood. It's a brownish powder that comes in a can and is mixed with water. This is a weather-resistant glue suitable for exterior doors, but I use it for all my doors because it has a slow setup time—about eight hours at 75°. Doors are complicated enough to glue up, and white or yellow aliphatic-resin glues can start to set up while you are still struggling to get all the pieces aligned. Furthermore, urea-resin glue doesn't creep, which is the tendency of pieces to move slightly after the glue has cured. Creep can occur with white and yellow glues because of their relative flexibility.

I brush glue into all the dowel holes and onto all the meeting surfaces of the joints before in-

Radiused and beveled core panels. **Cutting the slots in the frame with a router makes for rounded corners. The plywood core panels need to be rounded to match. The panels will fit into their slots easier if their edges are beveled with a hand plane.**

Slot cutting. **The author uses a ¼-in. slot cutter to mill the ½-in. slot for the panel. With the bottom of the cutter aligned with the center of the workpiece, he makes a pass from one side of the door. A second pass from the other side brings the slot to its required width and ensures that it is perfectly centered.**

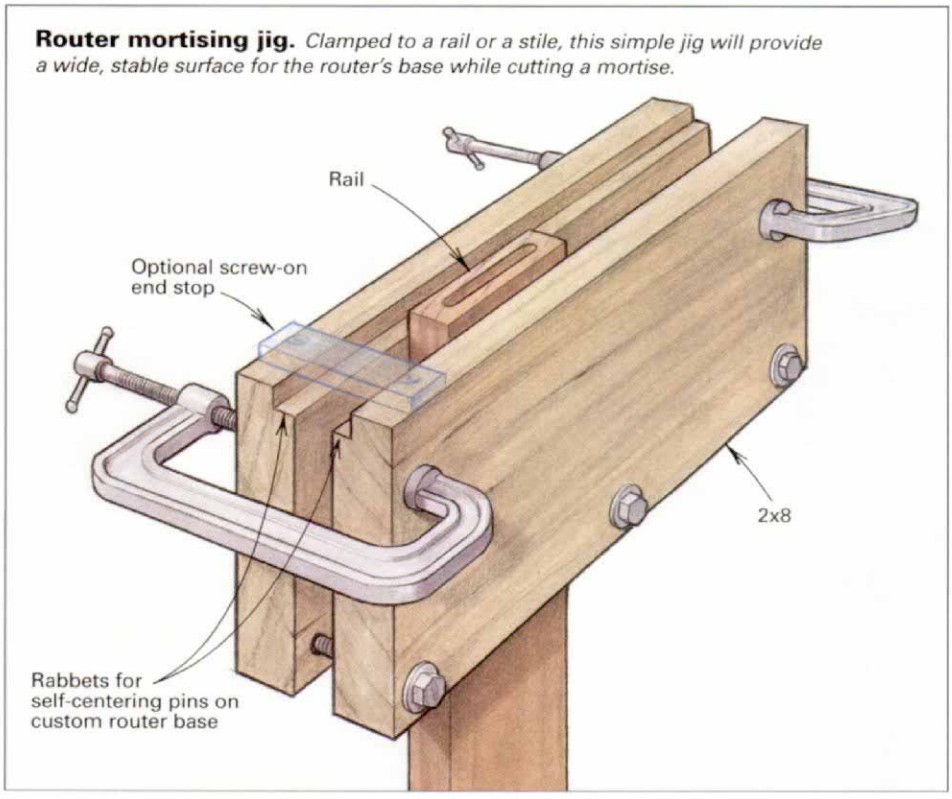
Applying the outer panels. **Panels of ¼-in. plywood with cherry veneer cover the core panels. The outer plywood panels are cut smaller than the frame opening to give a ⅛-in. reveal around the edges. The panels are held fast by glue drizzled on the cores and brads at the corners.**

serting the dowels. I dip the dowels into the glue before I insert them in the ends of the rails, then I brush glue along their protruding ends before working them into the holes. This way I can be sure all the meeting surfaces, including the dowels, are covered with glue. I work the rails onto one stile first, slide the panels into place, then insert the dowels into the opposing stile. I use a mallet to tap the pieces together, then I use bar clamps when the pieces are engaged.

As the rail ends come together with the stiles, I put clamps on both sides of the door to keep all the pieces in the same plane. Uneven clamp pressure can cause the stiles to tilt toward the side with the most clamps. I lay a straightedge across the assembled door to be sure it is flat, then I wipe away all excess glue with a damp rag and set the door in a warm place to cure the glue. If your shop is cold, try covering the door with an electric blanket or using heat lamps.

Loose tenons. **While interior doors can be joined with dowels, the abuse experienced by exterior doors requires the broader gluing surface of a spline, or loose tenon. The spline should be a bit narrower than the mortise to allow the pieces to be adjusted during glue up.**

Routing a mortise. **A bench vise is the best tool for securing a rail or stile as it is routed. Here, the bit is guided by a fence attached to the router's base. A block clamped to the bench provides a broad surface for the plunge router to ride on.**



Router mortising jig. *Clamped to a rail or a stile, this simple jig will provide a wide, stable surface for the router's base while cutting a mortise.*

Planing and panels—Once the glue has cured, I go over the entire framework with a sharp hand plane to flatten the joints and remove defects. This could also be done with a belt sander, but the hand plane is better for flattening uneven pieces and leaves less work for the final sanding with 100-grit paper in an orbital sander. It is also important to go over the edges by hand, both inside and outside, to round them slightly. This is most easily done before the veneered plywood panels are applied.

I cut the veneered plywood carefully with a fine-toothed blade to avoid tearing out the grain. The pieces should be ¼-in. smaller in each direction than the distance from stile to stile and rail to rail. This will leave an ⅛-in. shadow line (or reveal) all around the panel, which to my eye looks much nicer than a flat panel. The space between the edge of the framework and the veneered plywood panel is so narrow that the core layers can't be seen.

I sand the edges around the outside face of the veneered plywood panel to round them slightly. This is a subtle touch, but it improves the finished feel of the door. This takes a light hand—too much sanding will eat through the veneer to reveal the core layers.

When affixing the veneered panels, I dribble white glue over the core piece, being careful to lay a line of glue near the edge but not so thick a line that it will squeeze out around the panel (bottom right photo, 59). Then I tack the panel in place with a couple of small brads near each edge. Later I'll set and putty them.

Loose-tenon joinery for exterior doors—Dowels don't make a strong enough joint for exterior doors, especially in the stiles where most of the contact between the dowel and the stile is end grain—a notoriously weak glue joint. Traditionally, doors have been built with mortise-and-tenon joints, where part of the rail (the tenon) extends into a corresponding hole in the stile (the mortise). This is a difficult and time-consuming joint to cut, but with a plunge router you can make an equally strong joint with ease. It's called a loose-tenon (or spline-tenon) joint. To make it, mortises are routed in the edges of the stiles and in the ends of the rails, and a spline is inserted to hold the pieces together (left photo, this page). The spline has vastly more solid gluing surface than dowels do and is quite strong.

To make the loose-tenon joint with the router, you need a ½-in. by 4-in. plunge bit for your router (either the straight or spiral fluted cutters will work, but the spiral bits cut more smoothly). You also need either a fence attachment (right photo, this page) or a self-centering base to keep the bit centered on the work (see sidebar, facing page).

I start a loose-tenon joint by first marking the positions of the mortises on the workpieces. I lay out the framework of the door on the bench, then I pencil across the joints about 1 in. in from the edges of the joint. So where a 5-in. wide rail meets a stile, the mortises would be 3 in. wide. With a square I extend the marks around the edges of the stiles and the ends of the rails.

To cut the mortises I clamp the workpiece in a vise. Lacking a vise, you could use a bar clamp to

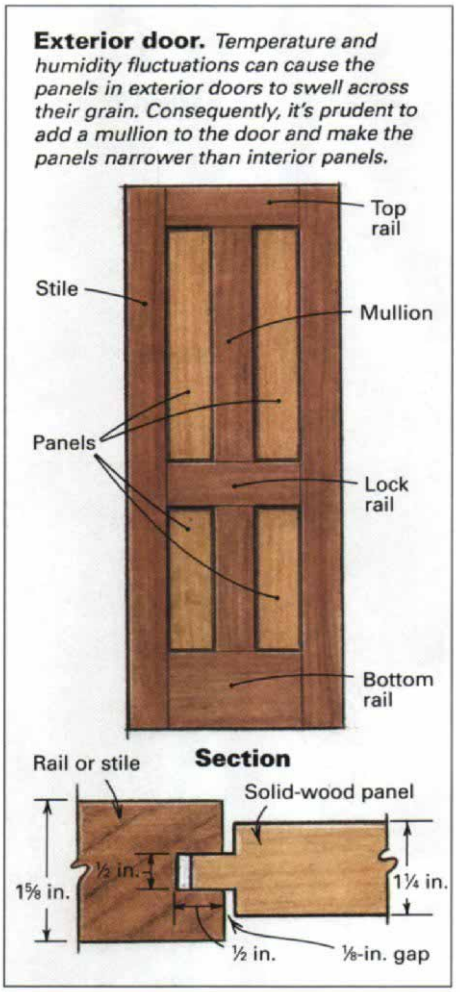
Drawings: Bob La Pointe

hold the piece on the bench. I like to bore a ½-in. dia. hole at the end of the mortise where I'll be starting my cuts because the router bits don't plunge very easily. I plunge the router in about ½ in. deep and draw it along the mortise until I reach the other end mark, then pull the bit out, go back to my starting point and plunge it in again, repeating the process. It may take four to six passes to cut the mortise to a depth of 2¾ in., which is about as deep as you can go with a 4-in. bit. I find that it's easy to control the length of the mortise by eye.

Cutting the mortises on the ends of the rails is a little more difficult. I often clamp a board next to the rail so that it is flush to the end to provide a larger surface for the router to ride on. A jig can also be made from two lengths of 2x8 that are bolted together at one edge (drawing facing page). The workpiece is held between the two pieces by tightening the bolts and with C-clamps at the top so that it is flush to the top edges of the jig pieces.

The splines should be made from the same wood as the frame pieces, with the grain running parallel to the rails. I leave the splines about ¼-in. narrower than the mortises so that the rails can be adjusted up or down a little on the stiles. With a ¼-in. roundover bit in my router, I radius the edges of my spline stock to match the mortise. I typically use a planer to mill ½-in. thick stock for the splines. Lacking a planer, you can also use ½-in. wide rippings cut on the table saw and ganged together to make up the correct width.

The panels for the exterior door look the same as the ones for the interior door, but they are smaller (top drawing, right), and I make them from solid wood. It would be possible to make solid-wood panels as wide as the ones in the interior door, but I don't recommend it. Wider panels swell and shrink more than narrow ones do, especially when subjected to exterior humidity and temperature swings. As a consequence they are more likely to crack when they shrink or burst the door frame when they swell.



I divide exterior doors into smaller panels by adding a mullion in the center of the frame or by adding additional rails, such as the five-panel door I made for a rustic studio (bottom photo, p. 57). The mullion pieces are joined to the rails with loose tenons, just like the stiles.

I typically make the panels by edge joining pieces of 2x6 and then planing them down to 1¼-in. thickness. Then I use the table saw to cut rabbets around both sides of the panels. The rabbets are ⅜ in. by ⅝ in. so that a ½-in. thick tongue is left around the panel that can fit into the slots in the frame parts (bottom drawing, left).

Good old enamel paint provides the best protection for an exterior door, but if you want to see the grain of the wood on the exterior side, I suggest you use a semiopaque stain and be prepared to do some yearly maintenance. You can renew this kind of finish without a lot of surface preparation. Avoid varnish. It will break down, then you'll have to scrape to get it off. In only a season or two a spiffy-looking varnished door can turn into a disaster. □

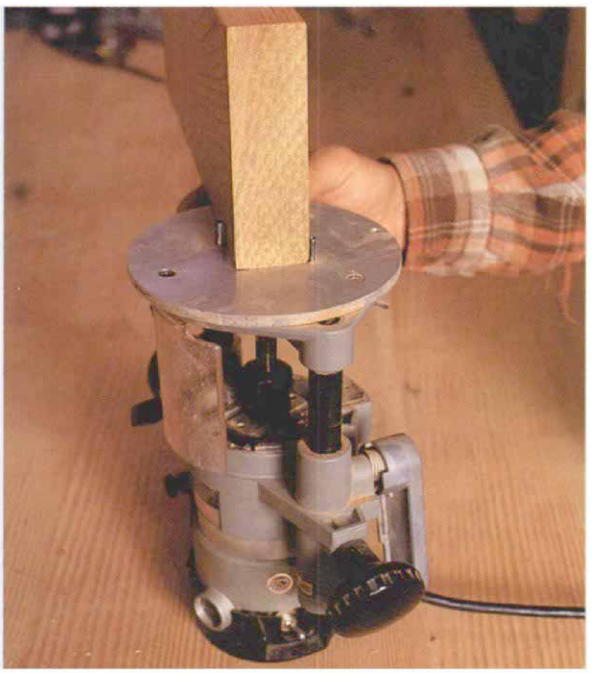
John Birchard is a woodworker and writer living in Mendocino, Calif. He is the author of Make Your Own Handcrafted Doors and Windows *and* Doormaking Patterns and Ideas *(Sterling Publishers). Photos by Charles Miller.*

Self-centering router base

The self-centering base allows you to position the plunge router quickly in the center of the stock without measuring and using a fence (photo right). To make a self-centering base, I started by duplicating my router base (minus the hole in the middle for the bit) with a piece of ¼-in. thick aluminum plate. Then I chucked a pointed bit in the collet and mounted the aluminum base on the router.

With the bit retracted, I turned on the router and slowly plunged the bit toward the base until the bit just marked the exact center of the base. This gave me the centerpoint I needed to mark a 3-in. dia. circle on the base. I removed the base, drew my circle with a compass and drew another line through the center of the circle across the base. At the two points where the line intersected the circle, I drilled ¼-in. holes using a drill press. They accommodate a pair of posts made of roll pins, which are metal cylinders with a slit along their lengths. They have chamfered ends that allow them to be driven into a hole a little smaller than their diameter. As they are driven, the slits narrow, and the pin is held in place by the spring action. You can get roll pins at a well-stocked hardware store. Once I got the posts installed, I put the custom base back on the drill press and made the ¾-in. hole for the bit.

To use the rig, I lift the router to its retracted position atop its posts and put the base on the workpiece. Then I rotate the router clockwise until the posts snug up against the opposite sides of the work. The bit is now centered and poised for plunging. —*J. B.*



Posts are the secret. **Posts mounted equidistant from the router bit can be used to center a router on the work quickly.**