Building Interior Doors

Using a shaper to produce coped-and-sticked frames and raised panels

by Joseph Beals

The dark, tired hallway in our Cape Cod-style house badly needed a face-lift. Like the rest of the interior, the hall had been built on a tight budget. With its aging acoustical-tile ceiling, cheap plywood paneling, assortment of ill-fitted stock trim moldings and five prehung hollow-core doors, there was little worth saving. My helper and I gutted the hall of everything but the existing door jambs and vinyl flooring. To give an illusion of height while creating an eye-catching detail, we installed a vaulted ceiling using drywall and curved 2x6 scabs fastened to the ceiling joists. We also applied ½-in. drywall to the walls.

But the heart of the hallway remodel was the construction and trimming out of five solid-wood, frame-and-panel doors (photo right): two 30-in. wide bedroom doors, a 30-in. wide bathroom door, a 34-in. wide cellar door and an 18-in. wide closet door. Four of the five existing doors had been hung on split jambs, with the adjustable portion of the jambs located on the hall side. This enabled us to reset the jambs flush with the new drywall. The closet door was hung on a conventional jamb, which we removed and reinstalled flush with the drywall.

Picking the pattern—The typical commercial frame-and-panel door is the six-panel Federal-style whose almost-flat panels are raised in the most minimal sense of the word. This generic reproduction style would be out of place in our remodel. Rather than subcontract the manufacture of custom doors to a local shop, I decided to design and build my own.

I drew principally on two references for design information: a turn-of-the-century English work called the *Handbook of Doormaking, Windowmaking and Staircasing* (reprinted by the Sterling Publishing Co., Inc.; 212-532-7160); and "Making Period Doors," an article that appeared in *Fine Woodworking* magazine *(FWW* #71, June/July 1988, The Taunton Press, Inc.). After sketching several options, I designed a four-panel Greek-Revival door with panels raised flush to the frames on both sides. This not only creates a very strong play of light and shadow, but it allows the convenience of a single thickness of stock for all door parts. For the master-bedroom door at the end of the hall, I substituted two round-top, leaded-glass panels for the top two raised panels. The narrow closet door has just two raised panels, one above the other.

Although there would be three different door sizes, the dimensions of stiles, rails and mullions would be consistent throughout (drawing facing page). I made the mullions ½ in. narrower than the stiles, and the middle (or *lock)* rails ½ in. narrower than the bottom rails, to give a balanced appearance. The centers of the lock rails are located 36 in. from the bottoms of the doors to produce classic Greek-Revival proportions.

The construction of the doors would echo that of the typical commercial frame-and-panel interior wood door—that is, cope-and-stick joinery reinforced with dowels where rails meet stiles. Coping and sticking involves the cutting of a continuous decorative molding (the *sticking)* along the inside edges of the stiles, rails and mullions, then coping the ends of the rails and mullions so that the end cuts are a perfect inverse of the sticking and fit snugly against it. This method surrounds each door panel with molded edges that appear to be mitered at the comers.

A century ago, cope-and-stick joints were cut using a variety of molding planes, chisels and gouges. Now, they're typically produced with a shaper. I own a ¾ in. shaper and a set of carbide cope-and-stick cutters with an ovolo molding profile on them—just what I needed for this job.

A classical face-lift. Trimmed with custom casings, this shop-built, frame-and-panel door is one of five new doors that highlight the author's hallway remodel.

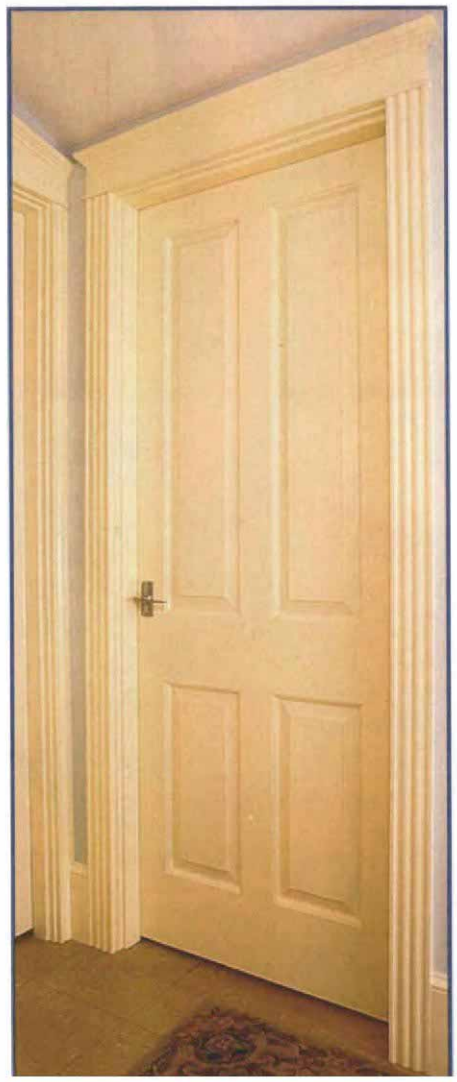


Photo: Bruce Greenlaw

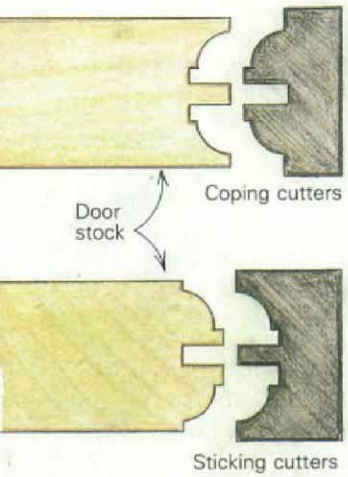
The choice is poplar—Most commercial paint-grade interior doors are made of pine or fir. I built mine out of 8/4 poplar planed to a thickness of 1⅜ in., a standard dimension for interior doors. Poplar is a relatively stable, straight-grained hardwood that's harder than most softwoods, works easily and takes a painted finish extremely well. Poplar isn't particularly rot-resistant, however; I wouldn't recommend it for exterior doors.

The poplar cost $1.40 per bd. ft. I don't own a thickness planer, so my local supplier planed the poplar for me for an extra 15¢ per bd. ft. To reduce waste and help cut costs, I planned to make no spare parts, a risky practice that leaves no room for error.

Roughing out the pieces—Each door was built to the exact dimensions of its existing opening, then trimmed to fit. I ripped the door parts on a table saw and cut them to length on a radial-arm saw. When determining the lengths of the rails and mullions, I allowed for the depth of the coping profile—in this case 17/32 in. The mullions were left long until the stiles and rails were machined and assembled dry. That allowed me to lay out the exact lengths of the mullions before cutting them.

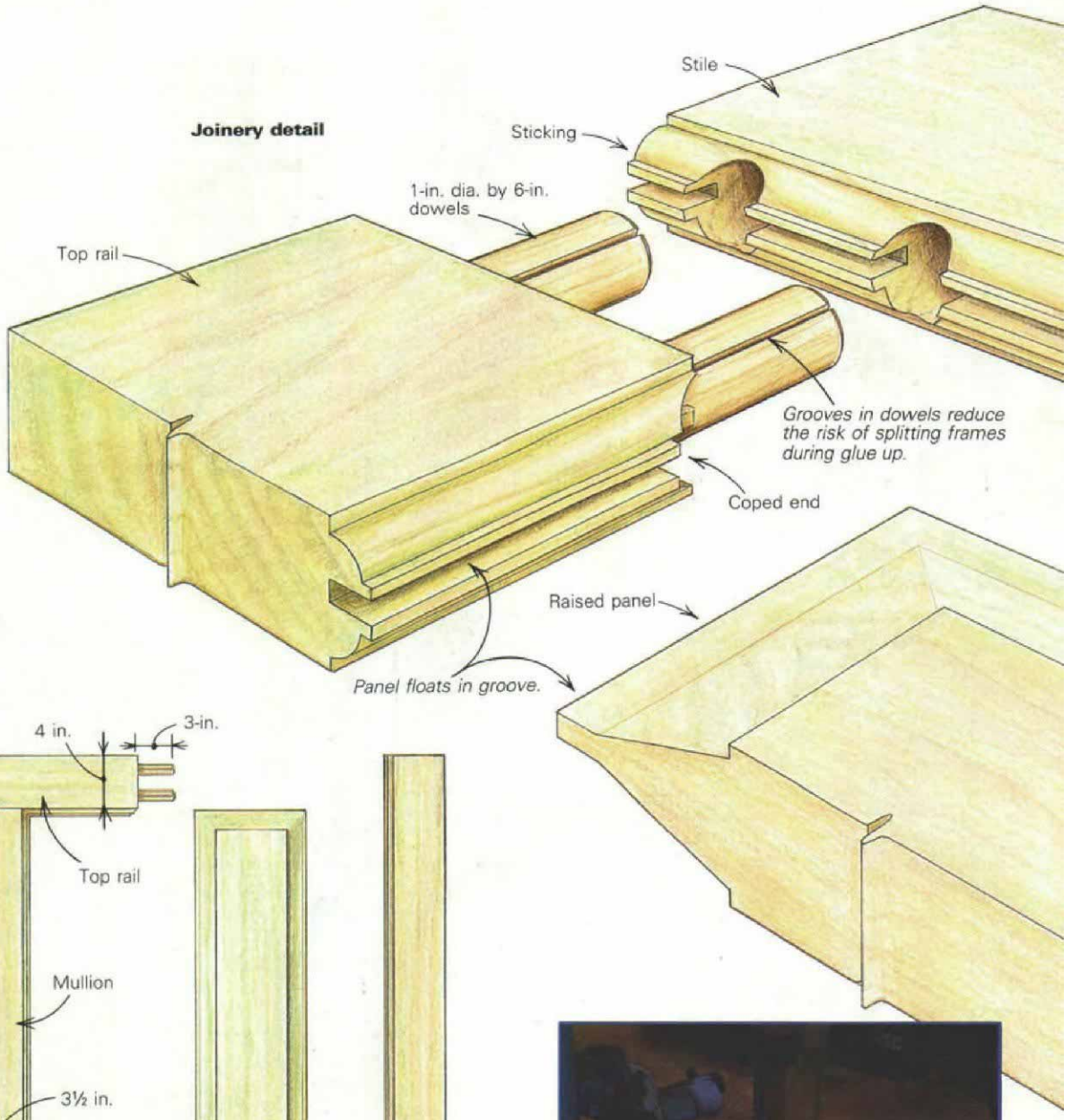
Doweling—Dowels replace traditional mortise-and-tenon joints and are a critical adjunct to cope-and-stick joinery. Doweling typically precedes coping and sticking because layout and drilling are most easily accomplished before the frames are molded. I used 1-in. dia.

Coping and sticking

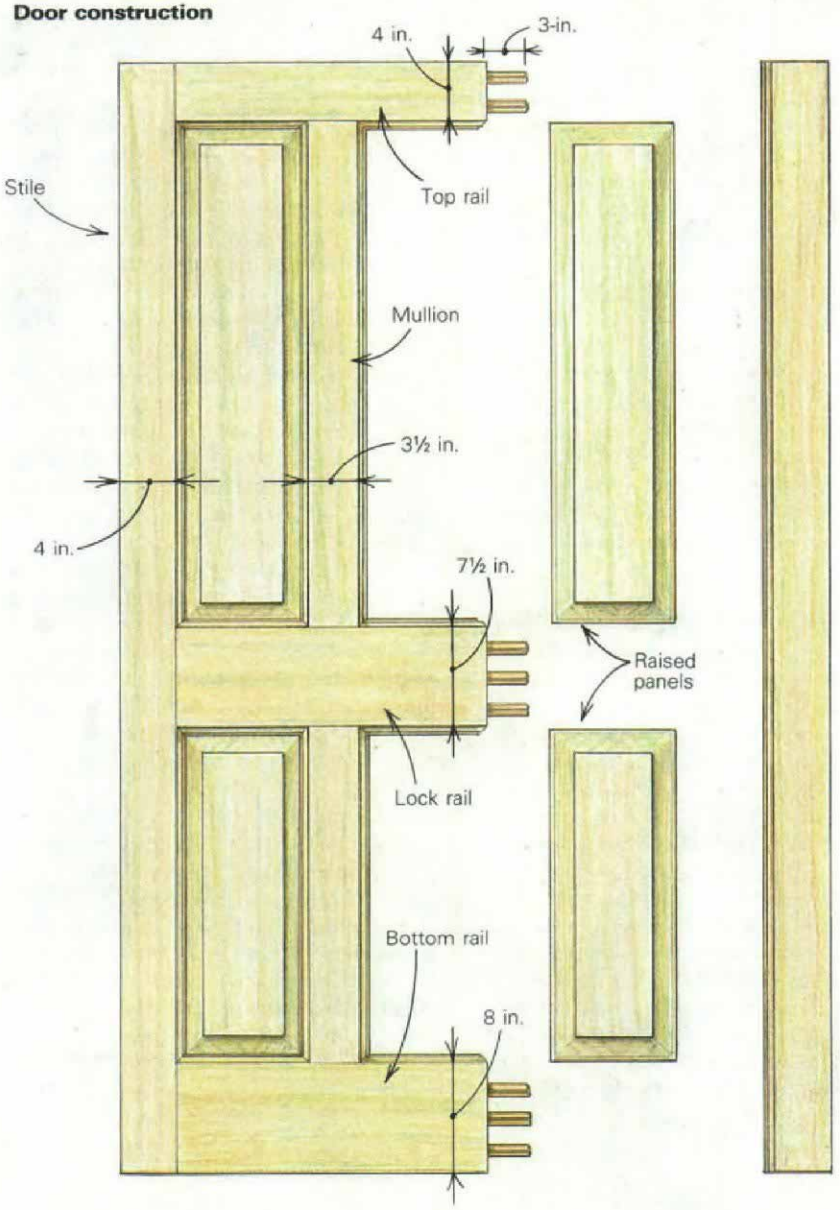


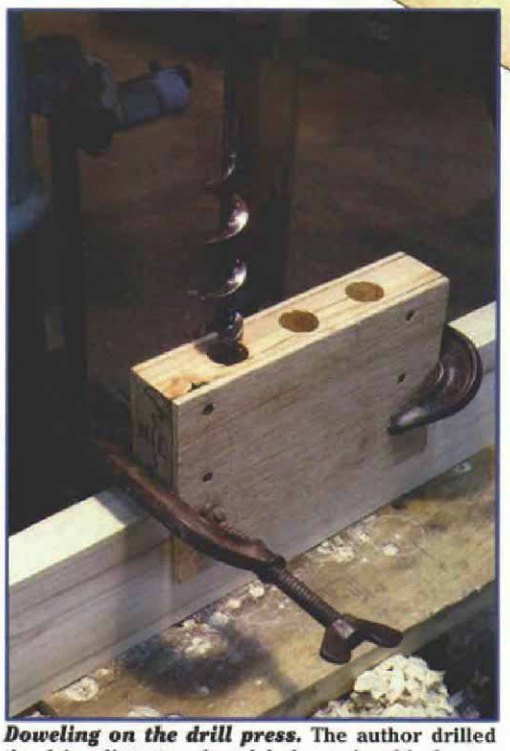
Coping and sticking was accomplished using a shaper and a matched set of carbide coping and sticking cutters.

Joinery detail



Door construction





Doweling on the drill press. **The author drilled the 1-in. diameter dowel holes using his heavy-duty drill press. A simple jig clamped to the workpiece assured perfect alignment of mating parts.**

Drawings: Bob Goodfellow

by 6-in. long dowels: two at each end of the top rails and three at each end of the bottom and middle rails. Spaced 2¼-in. o. c., the dowels are held at least ⅝ in. away from the edges of the rails to allow milling and trimming of the doors without cutting into the dowels. The cope-and-stick joinery alone suffices for anchoring the ends of the mullions to the rails.

I drilled 3⅛-in. deep dowel holes using a shop-made guide in tandem with a heavy-duty drill press to ensure precise alignment of the mating parts (photo p. 51). The dowels were cut from 3-ft. lengths of standard 1-in. dowel stock, but not before I ripped on the table saw a pair of ⅛-in. deep saw kerfs 180° apart. These grooves would allow glue to squeeze out the bottoms of the dowel holes during glue up, relieving pressure and reducing the risk of splitting the frames. When cutting the grooves, I guided the dowel stock by feeding it between the standard rip fence and an auxiliary fence, which were installed about 1 in. apart on opposite sides of the sawblade. Because the depth of cut was a meager ⅛ in., I felt safe using this method for cutting the saw kerfs. I would devise a different method for making deeper cuts in round stock, however, because the stock *could* rotate while being fed through the saw and kick back.

Once I cut the dowels to length, I drove each one through a 1-in. dia. hole that I drilled through a ⅜-in. thick steel plate, ensuring dimensional consistency (the dowels initially measured slightly more than 1 in. in diameter and were slightly oval). Finally, using a stationary disk sander, I tapered the ends of the dowels to ease installation. The completed dowels were then set aside until glue up.

Coping and sticking—There are a variety of carbide cope-and-stick shaper cutters on the market. Most come in matched sets: a sticking set and a coping set. The sticking set typically consists of two molding cutters separated by a straight cutter; the straight cutter mills a groove for holding door panels. The coping set consists of two molding cutters ground to an exact inverse of the sticking cutters and includes a spacer instead of a straight cutter (detail drawing previous page). The spacer leaves a tongue on the ends of the rails and mullions that engages the panel groove produced by the sticking cutters.

My carbide cutters, which are made by Freud (218 Feld Ave., High Point, N. C. 27264; 800-334-4107), come with shims for fine-tuning the fit between the coped tongue and the panel groove, but I've never had to use them.

Before coping and sticking the door parts, I experimented on wood scraps, adjusting the setups where necessary. When cutting the door parts, I cut all the copes first, then the sticks. That way, any splintering produced by the coping cutters at the trailing edge of the stock (common when cutting wood across the grain) would be removed by the sticking cut. I also limited tearout during coping by backing up the work with a wood scrap. When sticking the stiles, I used infeed and outfeed rollers to help support the ends, and hold-downs (steel clips) to keep the work flat against the table.

Panel raising—Panel dimensions can be calculated from plan drawings, but that method invites mistakes. I prefer to knock the door frames together dry, without dowels, and to measure for the dimensions of the panels directly from the frames. I measure to the bottoms of the panel grooves, then subtract about ⅛ in. per foot of panel width to allow for seasonal expansion of the wood (for more on the seasonal movement of solid wood, see *FHB* #69, p. 54).

The panels were raised on the shaper using a carbide raised-panel cutter. Prior to shaping, however, I roughed out the bevel cuts on the table saw to remove the bulk of the material. This allowed me to run the finish cut on the shaper in one easy pass, reducing both machine time and wear on the panel-raising cutter. The panels are raised on both sides, so I adjusted the finish cut to leave the correct tongue thickness (about ¼ in.) where the panel edge is captured in the door frame.

Safety on the shaper—For convenience with the long, heavy door panels, I ran the shaper cutter submerged (rotating clockwise below the stock). This is opposite the usual procedure, in which the cutter rotates counterclockwise *above* the stock. My method has two advantages: the stock shields the cutter from fingers, and if the panel is inadvertently bumped on the shaper table, the only result is a crown that can be removed quickly with a second pass. The only drawback to this method is the mass of chips that can accumulate around the cutter, often in sufficient volume to heat the table and bog down the motor. I stopped the shaper after raising each panel and blew out the waste with compressed air. This interruption can be annoying, but it leaves you with perfect panels and a full complement of fingers.

Gluing up—I assembled the doors with aliphatic-resin glue, which is sufficient for interior work. When assembling the four, four-panel doors, I began by gluing up sub-assemblies of three rails and two muntins. Then I slid the panels into place, brushed glue into the dowel holes, drove the dowels into the stiles and, finally, drove the stiles onto the rails. Using a pair of pipe clamps across each rail, one over and one under, I drew the joints up tight and true. On the two-panel closet door, I simply assembled a stile and the three rails, inserted the raised panels, drove on the opposing stile and clamped the door tight.

Because of the long bearing surface at the ends of the wide rails, the doors drew up square without effort. If they hadn't, I would have corrected them by skewing the clamps off square to pull the doors into alignment and checking for square by measuring the diagonals (diagonals that are equal in length indicate a square door). The long dowels kept the joints relatively flat, and any deviations were straightened out by tweaking the clamping pressure. Shortly after assembly, I moved all the panels within their grooves to ensure that they weren't inadvertently caught by squeezed-out glue inside the joints.

Coping in the round—To add light at the end of the hall, I fitted the master-bedroom door with a pair of round-top, leaded-glass panels that I made in the shop (photos facing page). The semicircular panel heads echo the vaulted ceiling above, and the colored glass casts a soft, almost ecclesiastical light at the dark end of the hall without compromising privacy in the bedroom.

The door was assembled like the others but without raised panels in the upper two openings. After assembly, I glued up four simple filler blocks, coped them on the shaper and glued them into the upper corners of the panel openings. Next, I laid out curved cutlines on the blocks using a pencil compass and rough-cut the curves with a jigsaw. That done, I molded the rough-cut curves on the shaper, guiding the cut with a ball bearing stacked on top of the sticking cutters and a plywood template screwed to the door.

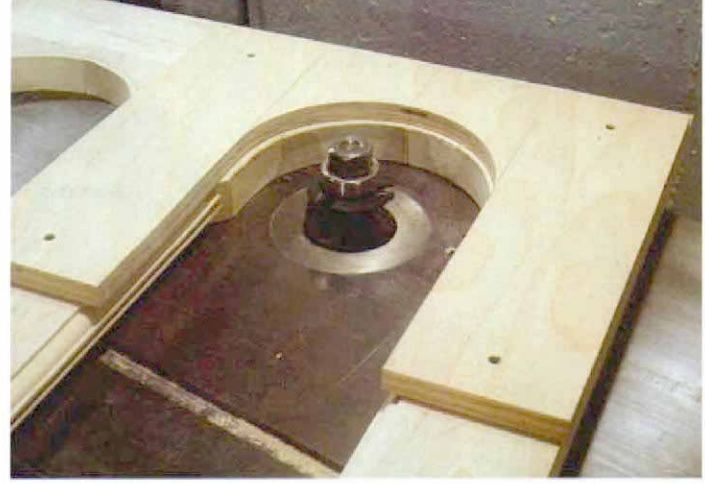
To permit the installation of the leaded-glass panels, I removed the molded edge on the back side of the door using a router chucked with a straight bit and guided by another ¼-in. plywood template clamped to the door. The glass panels are centered in the openings with several daubs of clear silicone caulk and locked in place with removable molded wood stops.

I made the straight stops by sticking the jointed edge of a poplar board, then ripping off the molded stop on the table saw. To make the curved stops, I began by gluing up a block of scrap poplar, bandsawing a radius in it and sticking the radiused edges on the shaper using the same bearing/template system used for sticking the curved edges in the door. The curved stops were then cut from the blocks on the bandsaw and dressed to a precise fit on their convex sides using the disk sander.

With the glue ups completed, it was time to clean up the doors and smooth the joints. Some doormakers accomplish this with a belt sander, but I prefer to use a sharp bench plane.

Making casings—Before hanging the doors, we made and installed poplar casings to match. The casings (photo p. 50) are designed to echo the classic colonial detailing in the recently renovated living room adjoining the hall. I milled a double-ogee pattern into the 4-in. wide side casings using a single-knife molding head on the table saw. This molding head is an old tool that looks primitive, but it can produce a very fine finish. Because there is only one knife to grind for any particular segment of a profile, custom patterns can be set up with little difficulty. I achieved the desired profile by making two

1, Filling the corners. **To accommodate the arched, leaded-glass panels in the master-bedroom door, the author glued up four filler blocks, coped them on a shaper and glued the blocks into the panel openings.**



2. Shaping round the bend. **Next, Beals rough-cut the arches using a jigsaw and molded the radiused edges on the shaper, guiding the cut with a ball bearing riding against a plywood template screwed to the door.**

3. Routing recesses. **To allow installation of the panels, the author then removed the sticking on one side of the door using a router guided by a second plywood template screwed to the door.**

4. Curved stops. **Curved stops were made by bandsawing their Inside radius in a poplar scrap, molding the radiused edge on the shaper (guided by a template), bandsawing the outside radius and smoothing with a disk sander.**

passes with a concave cutter and two passes with a convex cutter.

The side casings are cut square at the top and surmounted by an architrave head casing, sometimes called a cabinet head. Architrave head casings range from straight and simple to ornate arched and gabled designs, all of which represent the entablature of classical architecture. In contemporary work, where mitered casings prevail, even a simple architrave head casing has an air of classic elegance.

I fitted four of the five new doors with a straight head casing. This casing consists of ¾-in. by 5¼-in. pine, with a simple shaper-cut bead applied to the bottom edges and a standard 1¼-in. pine bed molding applied across the tops. I returned the ends of the beads using a sharp block plane and sandpaper. The bed moldings have full mitered returns, glued and bradded in place.

The head casing on the leaded-glass door takes the classic shape of a broken pediment and urn, a detail that flows gracefully below the arch of the curved ceiling directly above (photo right). A 1x backplate is bandsawn to the pattern and, like the straight head cases, has a bead applied to the bottom and bed moldings applied and returned on the top.

A glass-top door. **The master-bedroom door is fitted with a two leaded-glass top panels, which help illuminate the hall without sacrificing privacy in the bedroom.**

Next, I turned the urn on the lathe in a simple, classic profile and then bisected it on the bandsaw. The head case is coped against the closet head case on the left-hand side.

The urn was installed last. I simply put several daubs of silicone adhesive on the back and pressed it into place.

Hanging and finishing—The doors were trimmed to fit their openings with a hand plane and beveled at a 3° degree angle on the lock stiles so the doors would swing clear of the jambs. I cut hinge mortises in the new doors to match the existing jamb mortises, and then hung the new doors on the old hinges. Rather than reuse the old passage locksets, we installed new lever locksets.

After covering everything with an oil-based primer, we painted the hall ceiling a standard latex flat white, the walls a latex semigloss sky blue and the woodwork a semigloss ivory oil enamel. The transformation of the hall is very satisfying, from cheap and dark to a pleasing harmony of crisp, bright details. □

Joseph Beals is a designer and builder in Marshfield, Mass. Photos by author except where noted.

Photo: Bruce Greenlaw