The original 1908 Gamble House stairway. Although exquisitely designed and executed, the handrail of this classic Arts and Crafts stair is too low and too thick for current building codes.

A stair that celebrates joinery yet conforms to code. Inspired by the staircase in Charles and Henry Greene's Gamble House, this teak, oak and ebony stair meets height and graspability requirements.

Building an Arts and Crafts Stair

An updated and code-compliant interpretation of the classic Greene and Greene Gamble House staircase

by Lon Schleining

Right photo this page: Marvin Rand

Although the fame and the reputation of Charles and Henry Greene are well-deserved, another pair of brothers had a lot to do with their success. Peter and John Hall, along with their crew, were responsible for building much of what the Greene brothers designed. Interestingly to me, Peter Hall was also a stairbuilder, and together, the Greenes and the Halls created the masterpiece that is the staircase at the Gamble House (photo right, facing page).

A classic Greene and Greene Craftsman-style bungalow, the Gamble House is in Pasadena, California, not far from where I live. The house, built in 1908 and now a National Historic Landmark, has exquisite joinery and furniture that have inspired countless woodworkers over the years, me included. So I was pleased when fellow Greene and Greene aficionados Carl and Hannah Schafer commissioned me to build an updated interpretation of the Gamble House staircase in their own home in Long Beach.

My goal was to build a stair that would capture the spirit of the original and also meet building codes (photo left, facing page). Although I've built some 300 staircases since 1978, this one would prove to be the most challenging.

First, comply with building codes—The Gamble House staircase is a real puzzle. Vertical and horizontal members of different thicknesses intersect from several directions, forming an intricate sculpture of teak, oak and ebony. Beautiful as it is, though, the stair doesn't comply with current building codes because its handrail exceeds the 2-in. maximum width, and its undulations take it below 34 in. in places. The balustrade also has openings that are too large.

To oversimplify my design process a bit, I usually begin with what I have to do, then work toward what I want to do. What I had to do was comply with code. What I wanted to do was to capture as many of the subtle details in the original stair as possible. I was going to have to figure out a way to keep the waterfall look of the handrail without stepping outside that 34-in. to 38-in. height range. In addition, I would have to design the stair panels so that the largest opening would still be smaller than a 4-in. sphere.

At my shop, I have a large drawing table where I draw all of my staircases, a procedure that I've followed for many years. I encounter a lot of twists and turns in the course of building staircases, and I find that drawing full scale is the easiest and fastest way for me to work out tricky designs. Once finished, the drawings show me some of the hurdles I have to get past to make the project work, and I can lay the parts right on the paper to verify angles and sizes. I don't have to dimension anything because I can measure right off the drawing (top photo).

Bottom photo this page: Alec Waters

The staircase is conventionally framed—In this neck of the woods, the framing crew typically does the rough-framing of a stair. They build a conventional 2-in. by 14-in. stringer stair to my specifications using plywood subtreads and risers. These parts are installed early on so that the job can proceed through the messy stages without potential for damage to an expensive finished staircase. Later on, I come along and cover the subtreads and risers with the finish materials.

In this case, we chose to use oak, teak and ebony for the staircase because these were the types of wood that the Greenes used on their original staircase. I will admit to having some misgivings about using ebony and teak for the staircase, however. Although the issues surrounding the harvesting of these tropical hardwoods are complex, the bottom line is that these woods are getting ever scarcer. But I just could not come up with acceptable substitutes.

While work was progressing on the house, I began milling the teak for the risers and balustrade, and ebony for the plugs. Neither teak nor ebony is all that appealing to work with. The silica in teak dulls my blades and cutters, and working with ebony is like working with aluminum: When I cut it, the byproduct is a lot like coal dust, leaving black, greasy powder everywhere. It doesn't smell wonderful, either. But ebony polishes like some strange metal and contrasts beautifully with the dark streaks in teak.

Using patterns and jigs to duplicate pieces safely and accurately—I built several jigs in the course of making the components for this staircase. Pattern jigs help me to cut interchangeable parts safely, quickly and more accurately, and I used the jigs I made to help in cutting the handrail, the balusters and the balustrade panels.

I'm a big advocate of pattern-cutting on the shaper. With the right setup, it is a safe, fast way to make repetitive cuts in complex shapes, which this stair has plenty of. I used a custom-made flush-cutting setup on my shaper for trim-

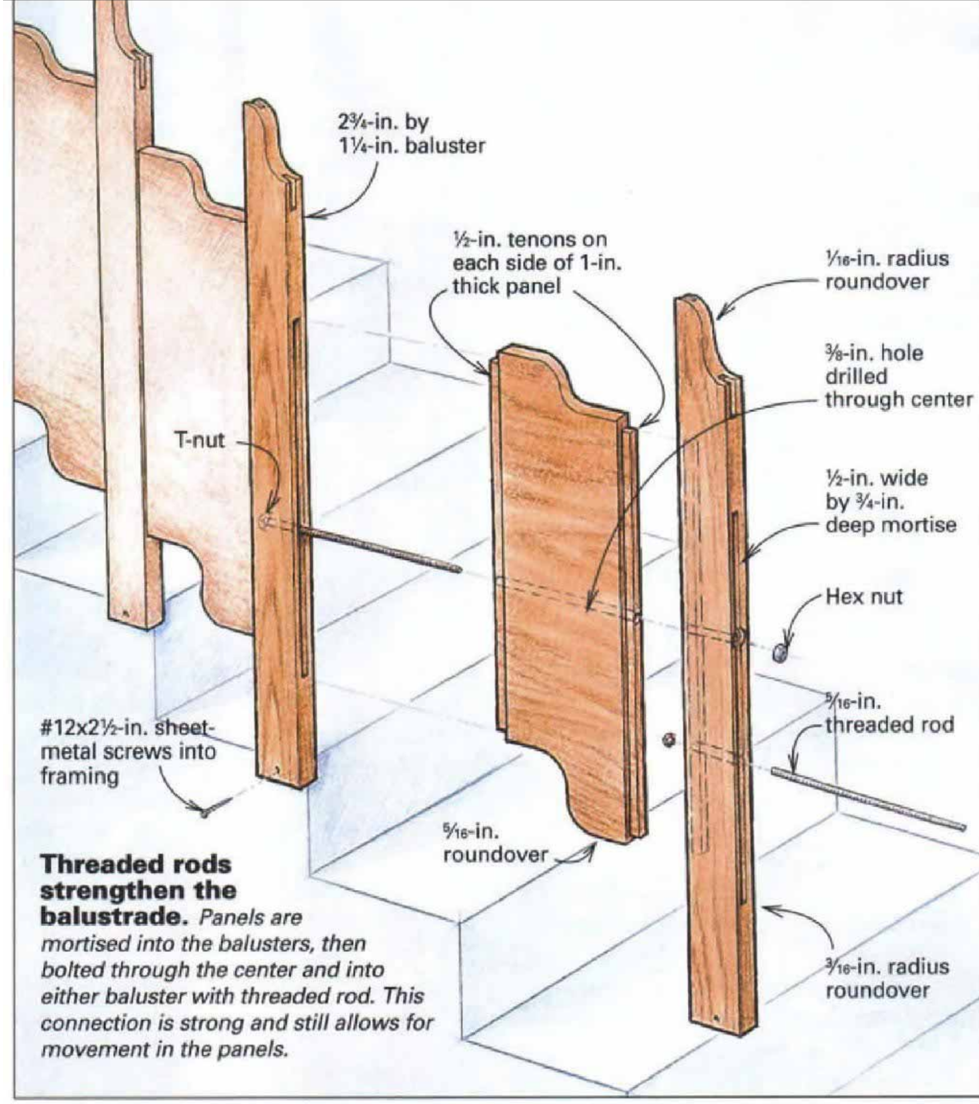
Getting the details right with full-scale drawings. The author's working drawings help him work accurately and solve layout and joinery problems in the design stage.

Use pattern-cutting jigs and a shaper for accuracy. Clamps hold the handrail securely in the jig, blocks align the piece for the cut, and entry and exit ramps stop tearout.

ming these parts. It is made up of several ½-in. straight cutters 2½ in. in diameter that can be stacked up to 3 in. high. A 2½-in. bearing runs against my plywood pattern, which has clamps that hold the workpiece securely in place (bottom photo, p. 89). My rule of thumb is that if a part can be pried out of a jig with a screwdriver, then it isn't being held in place tightly enough.

In addition, I make entry and exit ramps as part of the jig. That way, the bearing comes in contact with the jig before the cutters engage the workpiece. The ramps make sure the cutters engage the workpiece gradually; otherwise, the cutters could grab the piece and throw it. Pressure applied to the bearing with the infeed ramp will stop the bearing's rotation. Then the piece can be fed into the cutter in a controlled way, and the exit ramp helps to prevent tearout at the end of the cut.

I rough-cut each part first on the bandsaw, leaving only ⅛ in. or so to be trimmed. As each part is flush-cut using the pattern, it comes out exactly the same as the others.



Threaded rods strengthen the balustrade. *Panels are mortised into the balusters, then bolted through the center and into either baluster with threaded rod. This connection is strong and still allows for movement in the panels.*

Mortises and tenons tie the balustrade together—The panels on the stair railing needed room to expand and contract, so I mortised them into the balusters on both sides (drawing right). This allows them to move and also helps to prevent the panels from cupping.

Every panel in the staircase is mortised into the vertical baluster or newel on either side of the panel. I don't make cheek cuts for the panel tenons in the conventional way. Although this is usually done by making two passes on a table saw with the panel held upright, I've found that if the panel is cupped or if one panel is slightly thicker than another, the tenon thickness will not remain consistent enough for the parts to be interchangeable and still fit as they should.

I wanted the tenons to be exactly 0.010 in. thinner than the width of the mortises. To do this job with that kind of accuracy, I set up what I call twins. They are two identical sawblades separated by ⅝-in. washers used as spacers on the table-saw arbor. One pass on the saw with the piece on edge is all it takes to cut both sides of the tenon. Even if the thickness of the piece varies a little or if a panel is slightly cupped, the tenon thickness remains the same. For fine adjustment, I either use paper shims to make the tenon thicker or sand the washers a little to make the tenon thinner. I made trial cuts on scrap and measured the tenon thickness with a micrometer, making adjustments to the setup until I got it just right.

I didn't want to glue the panels to the balusters and instead decided to through-bolt them, which was the only way I could think of both to strengthen the entire assembly and to allow the panels to expand and contract. I realized that once each panel was bolted in place, I would no longer have access to the nut on the far side, so I substituted modified T-nuts ground to fit into the ½-in. wide mortises in place of the conventional nut and washer. When I finally assembled the balusters and panels, every tenon fit into every mortise with about the same effort it takes to pull on a pair of boots.

In the steps of the Greene brothers—When it came time to put the stair together, I began by assembling the balustrade on the rough stairs, bolting the newels and screwing the balusters to the framing. Usually I install skirtboards, treads and risers first, but on this stair that sequence wouldn't work.

In the lower section, the balustrade pieces were assembled from the landing down to the starting newel. AH of those railing components had to be exactly the right size because the width of the bolted-together railing assembly is what locates the lower newel post. The drawing and planning paid off because the post came within ¼ in. of its intended position. This degree of accuracy is crucial because the final look of the stair depends on it. If I had missed the widths by even 1⁄16 in., the accumulated error would have moved the bottom newel out of position by more than 1¼ in.

A jigsaw puzzle. A characteristic feature of the Greene brothers' architecture is the way intersecting vertical and horizontal surfaces seldom meet on the same plane.

After the balusters and panels were in place, I screwed the subrails into the balusters (top drawing, facing page). The subrails help to strengthen the balustrade even before the installation of the continuous handrail sections. Pattern-cut in my shop from 2-in. sq. stock, the

Drawings: Dan Thornton. Photo this page: Alec Waters.

Woodwork that invites the hands to touch. Rounded-over edges are comfortable to grasp and emphasize the joinery of the teak and ebony handrail.

handrail sits on top of the balustrade assembly and is screwed to the balusters and subrail. Rounding over all of the edges with various radiused bits emphasizes the joinery (photo left).

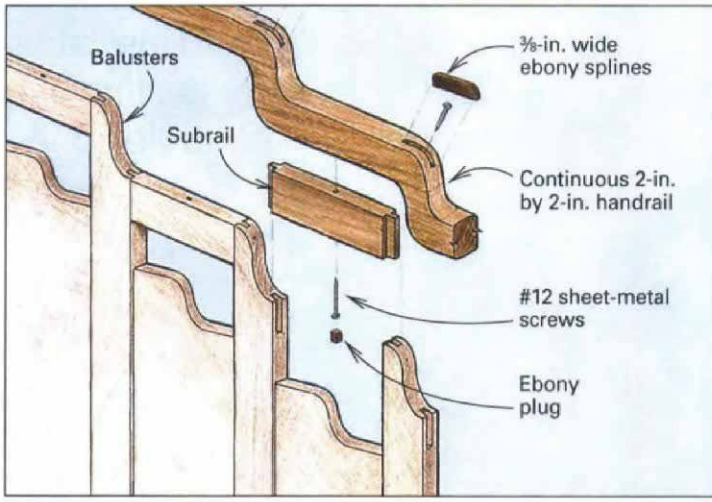
The box joints at each stair riser make the connection between the riser, the tread, the baluster and the horizontal skirtboards all at once (bottom drawing). Cut with a router and by hand, these box joints look simple and elegant like the Greenes' designs, but the joinery was a real challenge. To oversimplify vastly the process I used, the horizontal skirtboards meet the risers in a box joint and sandwich the balusters in the process. In comparison, mitering skirtboards to risers, which is a fairly complicated procedure, seems easy.

I began by notching each skirtboard to fit over a baluster, starting at the first step. In addition, two pieces are glued to the inside face of the skirtboard to mimic the look of thicker stock and to help hide the baluster connection. The upper piece is notched to fit around the upper baluster, and the lower piece is tapered to create an offset where it butts into the lower baluster. After this part of the puzzle is put together, the riser completes the box joint. Then it's on to the next step, where the process is repeated. After all of the risers were in place, I installed the oak treads with mastic and plugged screws.

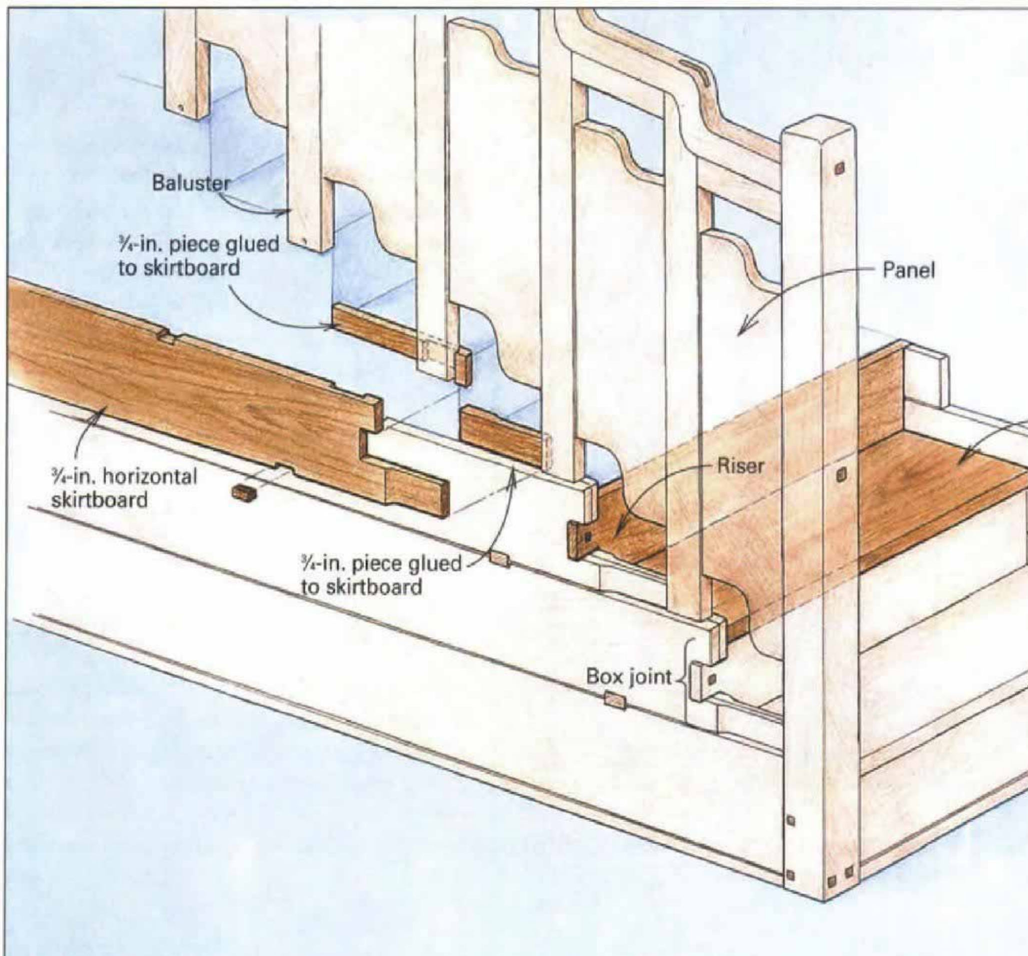
Once everything was put together, precut ebony splines were inserted in the handrail, and all of the bolt holes were plugged with the square ebony plugs (top drawing). The Greenes used ebony plugs both as functional elements—to hide holes—and as design elements.

The stairs have five coats of teak oil, and the oak treads were stained to match the prefinished floor and finished with Duraseal polyurethane floor finish (Thompson Minwax Co., 10 Mountain View Road, Upper Saddle River, N. J. 07458; 800-526-0495). □

Lon Schleining is a custom stairbuilder in Long Beach, California, and also teaches woodworking at Cerritos College in Norwalk, California. Photos by Andrew Wormer, except where noted.



A continuous handrail completes the balustrade *Because the handrail sits on top of the assembled balustrade, precision is essential in layout, milling and installation of the separate components.*



Box joints connect riser to skirtboard. *Horizontal skirtboards are installed starting from the bottom and are notched to fit tightly around the balusters, which are already screwed to the framing. After the ¾-in. thick skirtboard is screwed in place, ¾-in. thick pieces are glued to the inside face of the skirtboard to create the illusion of 1½-in. thick stock. The riser is then installed to complete the box joint, and an oak tread completes the step.*