A Sweeping Handrail for a Centerpiece Stair

BY TUCKER WINDOVER

A pitch-block jig and a deadman stand are two keys in transforming a jumble of parts into a continuous over-the-post handrail

Studying a finely made staircase is like opening a good book and reading the thoughts of a master carpenter. All the elements are in place for a reason. I started to appreciate this fact when I began to search out old staircases and study their design. I found them everywhere: in town halls, courthouses, old schools, libraries, and even an old mansion that had been converted into a museum. Taking the time to find these staircases and letting them inform my work was a worthwhile lesson.

Fortunately, most of the basic parts and profiles used by master stairbuilders of the past continue to be produced and are widely available today through catalogs, online suppliers, or local distributors. While the stairbuilder's responsibilities include installing treads, skirtboard trim, and mitered nosing returns, I'm focusing here on the techniques I use to install what's known as an over-the-post handrail. With its graceful curves and continuous form, this type of handrail can turn any home's main stairway into a showcase of finish-carpentry workmanship. As you might imagine,

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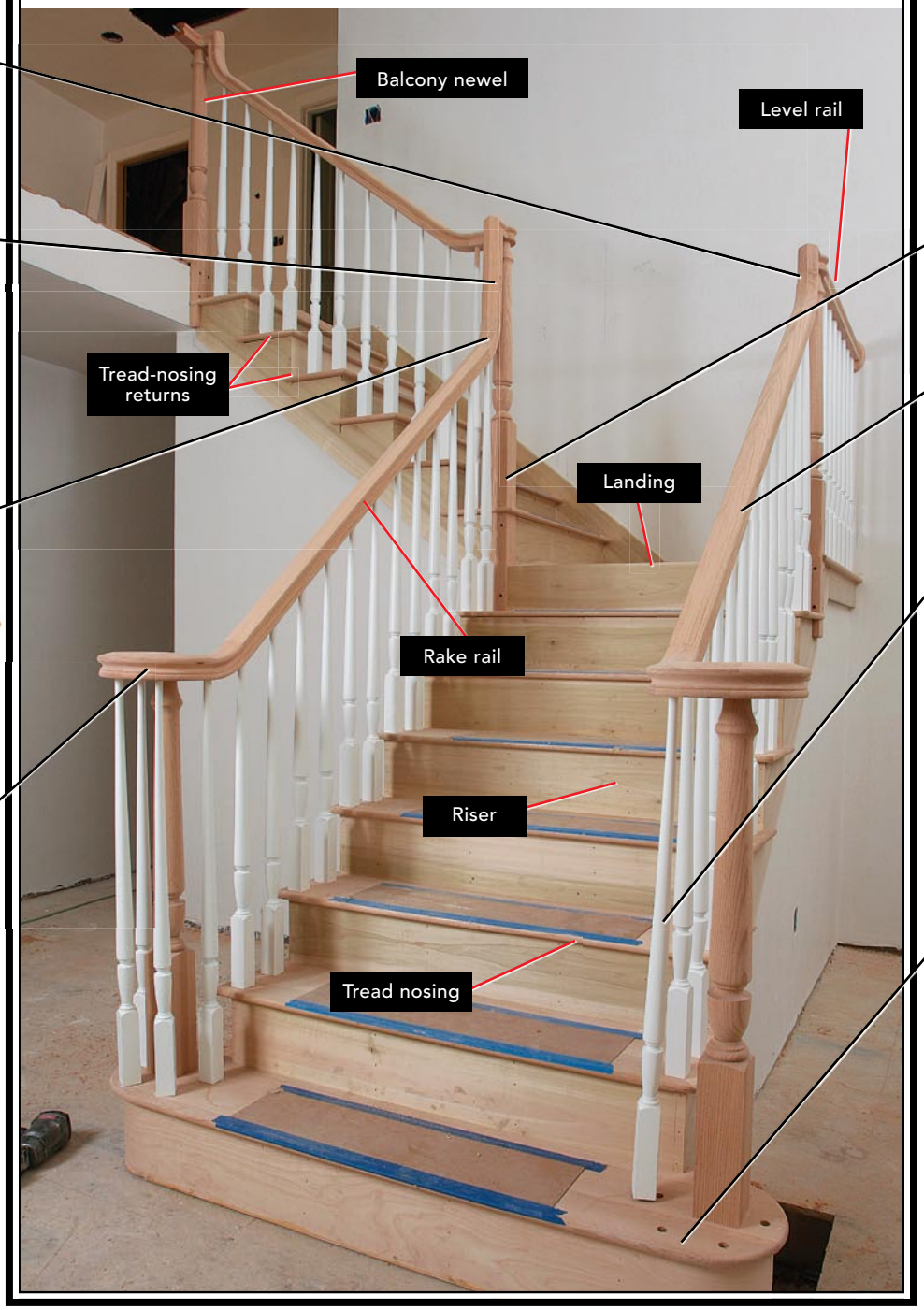
STOCK PARTS: SOME ASSEMBLY REQUIRED



GOOSENECK

This transitional piece has a vertical drop mitered to a circular cap that sits on top of a newel post. Combined with easements, goosenecks enable the handrail to transition smoothly over the newel posts.

EASEMENTS

Supplied as curved handrail segments, easements are cut on site to transition from rake sections of handrail to vertical or horizontal pieces like goosenecks.

VOLUTE

This turned-out section of handrail at the bottom of the staircase includes a built-in easement that transitions to the rake rail.

LANDING NEWEL

This intermediate post is located where the stairs take a turn. At the landing newel, the inside handrail needs to gain two riser heights in the course of one tread. A gooseneck is the way to handle this.

RAKE RAIL

Straight lengths of rail that follow the incline of the stairs are called rake rails.

BALUSTER

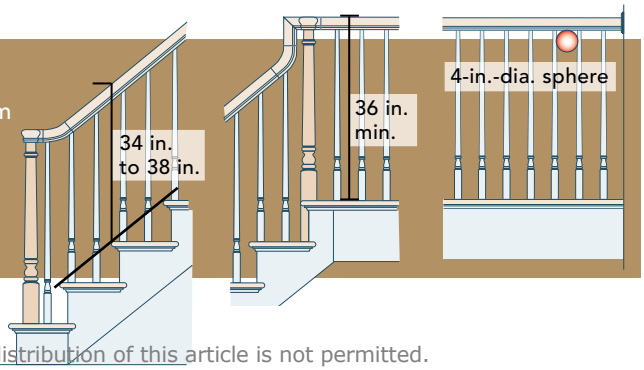
These vertical members are installed between posts. Depending on the pitch of the staircase and the size of the baluster, there are either two or three balusters per tread.

STARTING STEP

The first step is typically wider and has rounded ends. The starting step comes in two pieces, the riser and the tread. The curved ends are hollow and need to be filled with blocking (for attachment, see p. 52).

Basic code

Local code varies, so talk to your local inspector before starting a project. In my area, code requires that rake-rail sections measure 34 in. to 38 in. from the stair-tread nosing to the top of the rail. Balcony railings must be 36 in. above finished-floor heights, and a 5-in. sphere cannot pass through any baluster spacing (the IRC says 4 in.). For more on codes as well as other resource information, visit **www.stairways.org**.



Stair parts courtesy of Stair Parts Inc. Drawings: Dan Thornton.

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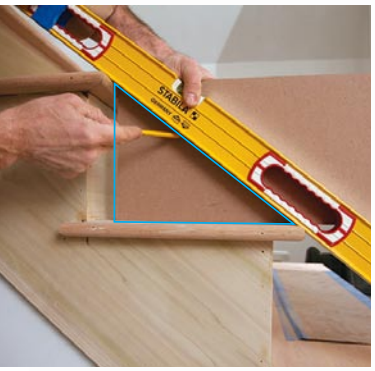
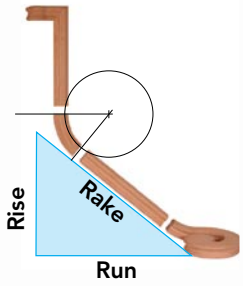
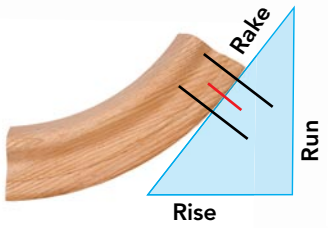
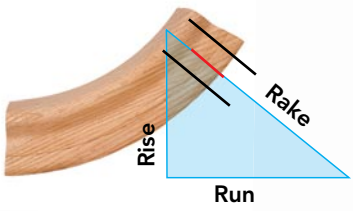
A **PITCH BLOCK** IS THE KEY TO THE HANDRAIL'S **GEOMETRY**

To make a pitch block, I use a straightedge to strike a line from nosing to nosing on a piece of MDF held against the stair treads. The pitch block can be used to identify the cuts that need to be made on the easement, which represents a segment of a circle. Each cut will always be made at 90° to the adjoining straight sections of the handrail. With the proper orientation, the point where the pitch block touches the curve of the easement identifies where the cut is made (for cutting, see the pitch-block jig, below right).

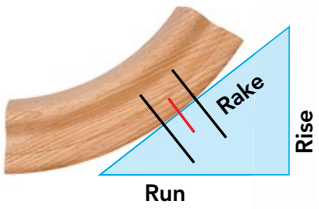


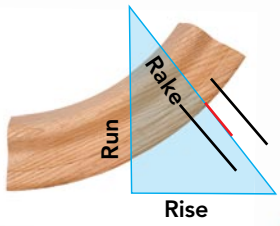






1 Rake-to-plumb cut: The cut location is the point (tangent) where the pitch block (with the "Rise" side down) touches the curve of the easement. Because it is difficult to see exactly where the straight line and the curve meet, identify the range where they could touch (black lines), and mark the middle (red line). To mark the cut angle, reorient the pitch block so that the "Run" side is down.





2 Level-to-rake cut: For this cut, the pitch-block orientation is reversed.

JIGS FOR HANDRAIL CONNECTIONS

The rail joints are connected with rail bolts that have both wood and machine threads. When a nut is cinched down through a 1-in.-dia. hole, two pieces of handrail can be drawn tightly together.

Cradle jigs. I build cradle jigs (above right) to align the rail-bolt pilot holes precisely. One jig has a bushing to guide a ¼-in.-dia bit for the wood threads. The other jig has a ⅜-in.-dia bushing for the machine threads. The jigs are built so that the rail parts fit tightly.

Pitch-block jig. For every staircase that I build, I make two pitch blocks and insert them into a cutting jig (photo below). The jig has slots in the base to align the pitch blocks. The platform that supports the rail piece for cutting has a beveled end that fits tightly against a sacrificial base. Secured with screws, the pitch blocks are oriented "run" or "rise" side down depending on the cut to be made.

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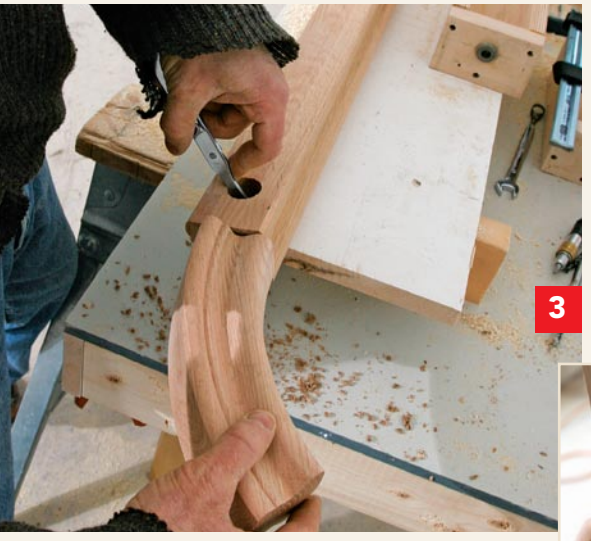
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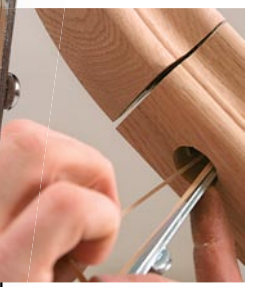
When using the cradle jigs to drill for rail bolts (1), I clamp the piece and the jig to hold them steady. The end of the rail piece is pushed flush against the front of the jig to ensure proper alignment. I identify the depth on the drill bit with a felt-tip marker. On the rail-bolt wrench (made by Universal Building Systems and available from stair-part manufacturers), a nut welded to the side of the wrench is used to drive the bolt into the wood. The machine-threaded end of the rail bolt (2) is used to mark the 1-in.-dia. access hole. With each piece of handrail comes a kit that includes the bolt, a curved nylon spacer, a nut, and a wood plug for the access hole. Threading the nut in the access hole (3) can be a little tricky. The nylon spacer goes on first; then the nut can be lowered into the access hole with the rail-bolt wrench. Because of the reduced travel of the wrench in the access hole, I start the threads and take up the slack by spinning the piece with the bolt instead of moving the wrench. Sometimes this is not possible, so the wrench manufacturer supplies a rubber band that can be used to thread the nut. With the easement connected to a section of straight rail, it's time to locate the tangent (4) and make the first cut. I start at the top, so my first connection is a rake-to-plumb easement. To make the mark, the pitch block is oriented on the bench with the side marked "Rise" facing down. To make the cut (5), secure the pitch block in the jig with the same orientation. The compound-miter saw is set to cut at 90° in both directions.

it's also one of the more difficult railings to assemble and install.

Handrail design is all about the curves

Continuous handrail design has two key principles. The first is simple but important. As with many staircase styles, the balusters, the handrail, and the newel posts all share the same centerlines. Where the staircase turns, the intersection of the centerlines locates the newel at that turn. In about 15 minutes, using these layout guides, I can have centerlines drawn directly on stair treads and have all the newel posts located save for the starting newel. (For the starting newels, see the sidebar on p. 52.)

The second key to design has to do with the curved railing sections, called easements, that need to be cut and joined to straight railing sections. Despite the complicated look of a continuous handrail, there are only two types of curves to worry about: the curve that connects the rail from level to rake (or incline); and the curve that transitions the rail from rake to plumb (or vertical).



The easement pieces supplied by the manufacturer are milled to the same radius. Also, the cuts on the easement are always made at 90° to the adjoining straight sections. To locate and make the cuts, I use a pitch block and a pitch-block jig (details, facing page).

Work from the top down

It's generally true that we build from the ground up, from foundation to roof. But with an over-the-post rail, this sequence doesn't work. I work from the top down, and I begin with the handrail held in its finished position, supported by a pair of deadman stands. I've found this technique to be a foolproof way to mark and measure for final cuts because I'm working from final locations instead of laying the handrail on the nosings of the stairs, then adding or subtracting to get layout or cut lengths.

I typically use a short section of handrail (about 4 ft.) to set on the deadman stands when figuring the easement and gooseneck cuts. A short section of rail is easier to han-

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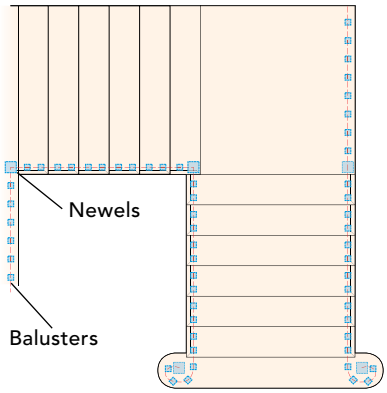
The handrail, the balusters, and the posts share the same centerline



1 Use a baluster to find the centerline. At the base of a baluster, mark half its width on one side. Hold a straightedge against the skirt; then place the baluster against the straightedge. Transfer the center mark to the tread, and mark the centerline squarely across the run of the tread.

2 Where the staircase turns at a landing, the centerlines of the separate stair runs intersect to pinpoint the center of a newel post.

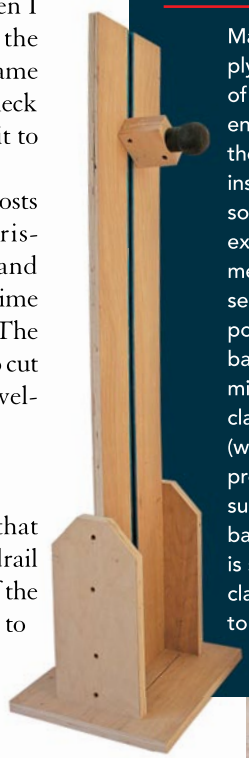
dle than a full-length piece, and as I work through marking and cutting the gooseneck assemblies, I might connect and disconnect an easement several times. I measure for and assemble the upper gooseneck first to establish the balcony newel-post height. Then I move on to measuring and cutting for the landing newel post. The process is the same for the balcony newel. I attach the gooseneck assembly to a straight rail and position it to measure the post height.

Some stairbuilders prefer setting the posts first, then installing the treads and risers. However, by installing the treads and risers first, I can focus on one phase at a time and keep the project area less cluttered. The drawback to this sequence is that I have to cut back the skirt and tread during the newel-post installation.

Finish with the starting newels

The starting newels are the last posts that are installed before I make the final handrail connections. No staircase passes muster if the starting newels are loose. It's worthwhile to take extra care to fasten the starting-step assembly securely because it's difficult to

Deadman stands are better than a second set of hands



Made from ¾-in. plywood, a pair of these stands enables me to hold the railing in its installed position so that I can get exact measurements for railing sections, newel posts, and even balusters. An aluminum T-slot and clamping knob (www.rockler.com) provide adjustable support, and the base of the stand is set up either to clamp or to screw to a tread.

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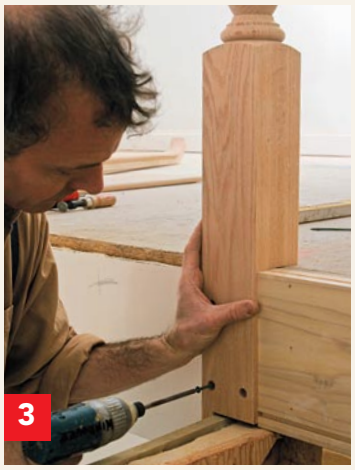
DEADMAN **STANDS** HOLD THE HANDRAIL AT **FINISHED HEIGHT**

I adjust the support blocks on the deadman stands to hold the uncut handrail (with easement attached) at exactly 34 in. above the stair-tread nosings. Then I can slide the handrail up and down along the rake to help me determine the height of the newel posts and the location to cut the goosenecks.



The easement location **(1)** is determined by the gooseneck offset from the centerpoint of the newel-post fitting to the inside edge of the gooseneck's drop. I plumb up from the layout point that marks the center of the newel. Then I slide the handrail up or down the rake until the location of the easement is perfect. When I determine the cut on the gooseneck **(2)**, my chief consideration is leaving enough on the vertical section of the gooseneck to make a rail-bolt connection. But I also double-check that the balcony-rail height complies with code (see "Basic code," p. 47). Now that I know the height of the balcony newel, I can lay out and cut the notches to position it on the handrail centerline, then secure it to the framing **(3)**. I double-check the gooseneck cut location once the newel is secured **(4)**.

To measure the height of the landing newel **(5)**, I have to backtrack a little. Remembering that the rake rail is still uncut, I remove the balcony-gooseneck assembly and set it aside. Then, using the same pitch-block principle as before, I measure, cut, and dry-fit the landing gooseneck to the handrail. The handrail can slide up or down the rake on the deadman stands until the newel-post fitting in the gooseneck is directly over the centerline layout mark where it makes a turn at the landing. The landing newel is attached **(6)** by notching the stringer and tread to fasten the landing newel directly to the framing. Marking and dry-fitting the upper-rake rail **(7)** is the last step before moving to the starting-step assembly.

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A SOLID **STARTING STEP** AND **NEWEL POST** ANCHOR THE **HANDRAIL ASSEMBLY**

The lower handrail is set on deadman stands, then marked and dry-fit like the upper section. The newel posts are then measured, cut to length, and fastened to the starting tread. The starting step's riser is filled with blocking at the curved ends and fastened to the subfloor. Then the handrail assembly gets a final fit.

The handrail is set on the deadman stands **(1)** at the finished height. With the easements attached, I can directly mark the gooseneck's drop cut. The starting tread **(2)** is notched around the skirting. It should be snug but not too tight because the tread will be dry-fit in place at least a couple of times during the process. The newel-post and baluster layout can be copied from the template included with the starting step. To establish the newel-post height **(3)**, I center the volute over the newel-post location that I just marked on the starting step. The handrail can slide up or down on the deadman stands until the volute is in the correct position. The newel post is secured to the tread with four 4-in. screws driven from underneath. Before the tread is installed **(4)**, the curved ends of the riser are filled with solid blocking glued in place. The riser is secured with three 8-in. Timberlok screws fastened through the blocking into the subfloor. To hide the fasteners securing the tread **(5)**, I drive the 4-in. screws through the countersunk baluster locations. Gluing the volute section in place **(6)** is always satisfying. With just the balusters left to install, I'm almost done.


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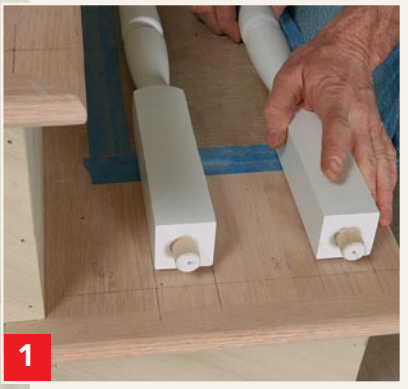
Inside gooseneck makes up for two risers.

Baluster installation



The lead baluster's face **(1)** always lines up with the front of the riser below it. The second baluster is centered between the front baluster and the next riser. I transfer this layout to all the treads and drill ½-in.-deep tenon holes. Then the baluster tenons are trimmed to ⅜-in. length. To secure each baluster to its tread **(2)**, a 1½-in. drywall screw is driven from under the tread. This secures the baluster while the glue dries and keeps it from turning in the future. The molding under the tread will cover the screw head. To drill the holes in the underside of the handrail, I grind down a spade bit until it matches the balusters' taper. To secure the baluster to the rail **(3)**, I chuck a 6d finish nail in my drill and drive it through the top of the baluster and into the handrail, tapping it home with a nailset.

Baluster stretcher

Longer balusters are required for certain parts of the stair. If you're lucky, your supplier has anticipated this and sent a few extralong balusters. If not, you can order one and wait a week to finish the handrail, or you can stretch one like this. Drill a pilot hole, and drive a 2-in. drywall screw into the end of a baluster. Grind off the head of the screw, glue and thread on a matching scrap of tapered end, then sand it flush.

shore up a wobbly post after the stair is finished. Only sufficient blocking and fasteners make for a solid starting newel post and a firm handrail.

In many ways, the starting newel is the most challenging post to secure. I have developed a reliable method that can be applied in most situations and doesn't require me to retrofit the floor framing. I screw the newel post to the starting tread with four 4-in. Torx-head screws. Then I fill the hollow curved section of the riser with solid blocking and attach the riser to the floor. This process not only makes a solid connection, but it also leaves open the possibility of adjusting the assembly for level by shimming under the tread before it has been attached. Once I secure the starting tread and newel post, I glue up the handrail connections and attach the handrail to the posts starting from the top down.

Secure the balusters with hidden fasteners

With the railing in place, I drill baluster holes in the treads and in the underside of the handrail. I keep the bit plumb when drilling the handrail, and I bore the holes extradeep so that I can slip the balusters up into the rail and then down into the treads.

Like a loose newel post, a loose baluster compromises the staircase. In the old days, balusters dovetailed into treads and were covered with the tread's nosing return. That method is too time intensive for most projects today, but I aim for the same secure results. I want a baluster that neither spins nor rattles and stays secure over time. To accomplish this, I secure them as shown at left.

The balusters under the volutes are the last pieces to install, but they often make the first impression. On the one hand, I want to maintain equal baluster spacing along the distance of the rail; however, this can result in balusters too close together under the volute. The volute template included with the stair parts is a good layout guide. Before I finish, I mock up the layout to make sure it looks good. □

Tucker Windover is a finish carpenter in Arlington, Mass. Job-site photos by John Ross. Product photos by Krysta S. Doerfler.

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