Installing Manufactured Stair Parts

Laying the handrail on the stairs is the first step

by Sebastian Eggert

In every cowboy movie there's a barroom brawl where someone crashes through the railing at the top of the stairs. If this could happen as easily as it looks, then our building codes would have outlawed wooden railings long ago. In reality, a well designed and built balustrade is not only beautiful, but it's also strong.

Like most builders today, I use stock parts for much of my stairwork. I buy the treads, tread-return nosing, newel posts, balusters and handrail over the counter (see *FHB* #36, pp. 56-61). All that's left is the challenge of installing them.

There are two types of balustrades that you can build. A post-to-post system has sections of handrail, either straight or with fittings, that fit between newel posts. This system is easier to install than the other. But for all the kids who enjoy sliding down the banister, it'll never do.

An over-the-post system uses straight rail joined to fittings, and flows gracefully over the tops of the newel posts (photo below left). This is the type of balustrade I usually build, and it's the one I'll discuss here.

The rough stair—Whenever I can, I frame the rough stair myself, rather than installing finished treads and risers over someone else's framing. This way I'm sure that the stairs will meet code requirements, and I avoid problems with carelessly installed carriages. At the same time, I can add blocking—for newel posts and wall-rail brackets—that I'll need later. (For more on stair construction see *FHB* #17, pp. 56-62.)

After roughing in the stairs, I pull off the job until most of the other work is done. I like to get back just before the carpeting goes down. Since the stairs are often the only way to move between floors, I work the second shift if possible, to avoid interruptions by other tradespeople working on the house.

Lay it out in place—Some installation instructions included with stair parts tell you just enough to get you into trouble. In particular, the tables that list the heights of newel posts can be misleading. They work fine if your staircase is built just like the diagrams—same rise/run, same handrail heights, and most important, the same newel-post locations. But every installation is different, and most have their quirks.

The best way to build a balustrade is to lay out the handrail, fittings and all, in its exact location, right on top of the stair treads, the same way you lay out the plates of a stud wall (photo below right). Laid on the stairs, the handrail should touch the nose of each tread. The newel-cap fittings should sit directly above the centers of the newel-post locations.

Be aware that there is a procedural catch in the assembly process. The handrails need to be laid out over the locations of the newel posts,

When laying out a balustrade, measuring the components in place works best. Clamp the handrail and fittings in place right on top of the treads to determine where and at what angle to cut them. The finished installation shows a starting newel with a turnout and a two-riser gooseneck that had to be extended because of the location of the landing newel.

and those locations cannot be found easily without the treads in place. But the treads cannot be permanently installed until the risers and mitered stringers are on, and in some cases they can't go on until the newel posts are in. However, if the newel posts are in, you can't lay out the handrail on the treads. To cope with this confusion, I don't install anything permanently until the handrails are assembled.

Newel-post layout—Newel posts are the foundation of any handrail, and their placement is critical. Always plan for a newel post at the top and bottom of a run of stairs, and any place there is a landing or change of direction. Runs of over 10 ft. should have an intermediate newel post to strengthen them.

Except for starting newels with volutes and turnouts, which stand off to the side, newel posts should be laid out on the centerline of the balusters and handrail. Starting newels are usually notched around the corner of the first step. Newel posts at a landing or at the top of the stairs sit on the intersection of baluster centerlines or where dictated by the configuration of the fitting being used.

Turnouts and volutes sit on newel posts that are fastened to starting steps, which extend out from the staircase edge in a semicircle, with the newel post at the center of the circle. The manufacturers supply paper templates with these fittings to show the newel-post and baluster locations on the starting step. With all the newel-post locations marked, you can begin assembling the handrail.

Cutting the fittings—Handrail fittings are used to change the direction or slope of the handrail. Those used to change the slope include a curved piece called an easing or easement that has to be cut for the particular angle (the rake) of the staircase where it's being used.

I use a pitch block to mark the cuts on the fittings. A pitch block is a triangular piece, usually of wood, whose sides represent the rise, run and rake angle of the stair. One of the pieces cut out of the rough stair carriage will serve the purpose, or you can make a new pitch block from a scrap of 2x stock with the same dimensions as the rise and run of the stairway. If you're working on a stair with a landing and you didn't frame it yourself, check that the two flights of stairs have exactly the same rise and run. If they don't, make a separate pitch block for each flight to ensure accuracy.

At the bottom of the stairs, the handrail begins with a starting easing, turnout or volute. I set this fitting on a flat surface and snug the pitch block (run side down) to the underside where the easing turns up. Then I mark the point (tangent) where the hypotenuse of the pitch block touches the curve of the fitting (top photo at right). Then I turn the pitch block over on its short leg (rise side down) and scribe a line on the fitting (along the rake side of the pitch block) that passes through the first mark I made (photo at right, second from top). This gives the angle at which to cut the fitting.

It's hard to hold the fittings securely in a miter box, and at the proper angle to get an accurate cut. Sometimes it helps to use the pitch block on the miter-box table to hold the fitting at the right angle. Fittings that have an integral newel cap can't be laid squarely against the fence, so for them I screw a piece of plywood to the bottom that acts as a jig (photo bottom right). With some fittings, like up easings, it's easier just to hold them by hand and hope for the best.

I use a Teflon-coated 80-tooth carbide crosscut blade to make mirror-smooth cuts. Cut just shy of the line, and if the angle looks good, go for the final slice. Take too much and you've got a $50 piece of kindling.

To test the cut, clamp to the stairs a section of straight rail that has a square cut on one end, and while holding the newly cut fitting against the square cut, check the underside of the fitting with a torpedo level. If it reads between the lines, you're alright. Don't try to use your level on the top of the fitting because the millwork is rounded and not consistent enough to give a true reading.

Rail bolts—The next step is to join the fitting to a section of straight rail long enough to reach the next fitting location. I use rail bolts for the connections. These are 3½-in. double-ended bolts, with a machine-screw thread on one end and a lag-screw thread on the other. To locate the holes for the rail bolt, cut a wafer-thin piece of handrail (about 3/16 in.) to use as a template. Drill a small hole through the template on the vertical centerline 15/16 in. from the bottom of the handrail. Match up the template with the adjacent ends of the rail and fitting, and mark the hole locations with your pencil.

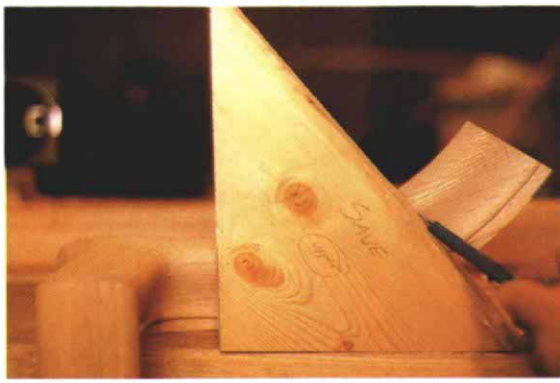
Drill a ¼-in. hole 2 in. deep in the end of the fitting and turn the lag-screw end of the rail bolt into it. To do this, I spin two hex nuts on the machine-screw end and lock them against each other, then use a wrench to turn the bolt into the fitting (photo at right, third from top). You can also just clamp the rail bolt with a pair of vise grips and turn it that way, but be careful not to damage the machine-screw threads.

Next, drill a 3/8-in. dia. hole at least 1 in. deep in the end of the straight rail. Then mark the bottom of the handrail 1 3/8 in. from the end and on the centerline, and drill a 1-in. dia. hole 1 ½ in. deep. Be careful not to drill too deep or the point of the bit will come out the top of the handrail—another expensive mistake.

This last hole is the cavity where the nut is turned on the rail bolt's machine threads to pull the fitting and the straight rail together. After final assembly, you cover the hole with a wooden plug supplied with the rail bolt. I square up a portion of the hole facing the joint with a ½-in. chisel to provide a flat surface for the washer and nut to bear against.

Check the alignment of the fitting to the rail. If it's off, ream the 3/8-in. hole just enough to line the two up. Don't expect a perfect match. The cross sections of straight rail and fittings are always slightly different, so try to line up the bottoms and the side profiles as much as possible.

Most companies supply the rail bolts with star-shaped nuts that you turn with a hammer and a nail set. But the tapping upsets the alignment and levering mars the sides of the hole, so



These photos show a gooseneck fitting with a newel cap, quarter turn and an up easing. In the top photo the pitch block is being used (run side down) to locate where to cut the up easing. This procedure is the same as for any starting fitting, since at this point the up easing is the start of a new flight of stairs. In the next photo, the pitch block has been flipped over (rise side down) to mark the angle at which to cut the up easing. The photo above shows the fitting after it has been cut and with a rail bolt attached. The two hex nuts on the rail bolt were locked against each other and used to turn the rail bolt into the up easing.

Wherever the shape of the fitting makes it difficult to maneuver in the miter box, the author screws a piece of plywood to the bottom of the fitting as a jig. Here he's cutting a turnout easing with newel cap.

Ready for final assembly, the joining faces are coated with glue, the rail bolt inserted into the adjacent fitting (top left), and the nut and washer started, then tightened, through the large hole on the bottom of the fitting (middle left). Because they make for a smoother assembly, the author prefers hex nuts and a box wrench to the star-shaped nuts supplied with the rail bolts. The match between straight handrail and fittings is never perfect—some fairing is always needed. At left, a 2-in. dia. sanding disc attached to an electric drill is used to smooth the joint. In the photo above, the newel posts have been installed temporarily in order to calculate the cuts for attaching the easing between the gooseneck and straight rail. A section of straight rail has been attached to the easing and lined up with the vertical leg of the gooseneck to help position the easing correctly.

instead I use hex nuts and a twelve-point box wrench, as in the top two photos above left. This pulls them together carefully and firmly. But I don't glue them yet.

Goosenecks—Goosenecks form the transition from the incline of the stair back to level, either at a landing or at the top of the stairs. They come in two sizes, one-riser of two-riser, the difference being the length of their vertical leg. The size you need usually depends on whether the handrail simply levels off above the gooseneck or turns and continues to rise.

Sometimes two-riser goosenecks come disassembled so you can cut the vertical leg to whatever length you want. Single-rise goosenecks never seem to be long enough, so I always use a two-riser gooseneck, just to be safe.

Instead of landings, some stairs have winders—treads that are wider at one end than at the other, used to effect a turn in a stair while continuing to climb. Winders are awkward and dangerous, so I try to discourage clients from using them. But if you do build them, be aware that they usually involve three rises at one point. You may have to add more straight rail to the vertical leg of the gooseneck to get enough height (photos p. 44).

The length of the vertical leg of the gooseneck depends on the position and height of the newel post. The tables supplied with the gooseneck fittings tell at what length to cut the vertical leg, but again, that measurement is correct only if the newel-post locations and handrail heights are the same as in the diagrams, so check them carefully.

If the installation lays out the way the instructions indicate, the leg can be cut to the assigned length, the up easing joined to the leg with a rail bolt, and the curve where the up easing joins the straight rail cut off using the pitch block.

Lay the assembled gooseneck on the bench top with the back of the leg flat on the surface, set the pitch block on its rise edge and slide it against the underside of the up easing to mark the intersection point. Then turn the pitch block over on the run side. Scribe the angle through the first mark on the up easing, and cut it there;

Photos top and middle left: Rob Gruyé; Other photos: Sebastian Eggert

then attach the easing (without glue) to the gooseneck with a rail bolt.

You have to lay out everything in place again to determine where to cut the straight rail and attach the gooseneck fitting. Position the starting fitting over the newel-post location at the bottom of the stairs, with the straight rail attached and clamped in place on the treads.

Next you have to calculate the correct height to block up the gooseneck. If the height of the handrail coming up the stairs is to be 30 in., then the underside of the handrail will be 27¼ in. from the tread nosing (drawing, below). And if the height of the level handrail along the landing is to be 36 in., then the top of the newel post will be at 33½ in. The difference between these two measurements will be the distance from the underside of the gooseneck cap to the finished floor (33½ - 27¼ = 6¼).

Temporarily block up the gooseneck fitting this distance above the newel-post location. Now mark the point of intersection between the up easing you just cut off and the straight handrail coming up the stairs. Cut the straight rail, drill and attach the rail bolt, and assemble the gooseneck to the railing without glue. Now you can check all the fittings for alignment.

When the layout isn't exactly like the manufacturer's diagram, I stick with my empirical methods and lay everything on the stairs again, just as above, except that the easing isn't attached to anything. So now the straight rail is coming up the stairs and the vertical leg of the gooseneck is standing plumb at the top. The easing is simply an arc of a circle that's tangent to both of these rails.

Sometimes 1 can just hold the easing in place against the sides of the other pieces and calculate where to make the cuts by eye. But most of the time I attach a short section of straight rail temporarily to the easing and line this up with either of the other rails to find where to make the cuts (photo facing page, top right).

Newel-post installation—Once the handrail has been assembled, the newel posts can be cut to length and installed. With the assembled handrail lying on the stairs, measure the distance between the bottom of the fitting and the stair tread below it. This measurement plus the height to the bottom of the handrail will be the height of the newel posts. Remember to add any additional length needed below the tread or landing to install the post.

The bases of the newel posts almost always have to be notched around the first step, into the corner at a landing, etc., so the alignment with the balusters is correct. Often the walls aren't plumb, so check them and lay out the notches accordingly.

1 use 5/16-in. hex-head lag screws long enough to reach the rough carriage or other framing members and pull the posts securely to the wall. With three lags per newel in different directions, they should never come loose. Plug the countersunk holes with the same 1-in. plugs used with the rail bolts and line up the grain so they disappear. At times I've had to pull the flat bottom of the newel post directly to the subfloor with a rail bolt, and count on the adjacent sections of rail and newel posts to steady it.

The newel posts manufactured for use with starting steps have a long pin or dowel turned on the bottom. Usually you can attach the newel to the step first, and then install both as a unit to the base of the stairs. Start by drilling a hole the size of the pin through the tread, then through the starting step's horizontal core. Secure the newel with a lag screw and washer through the bottom of the starting step into the newel pin.

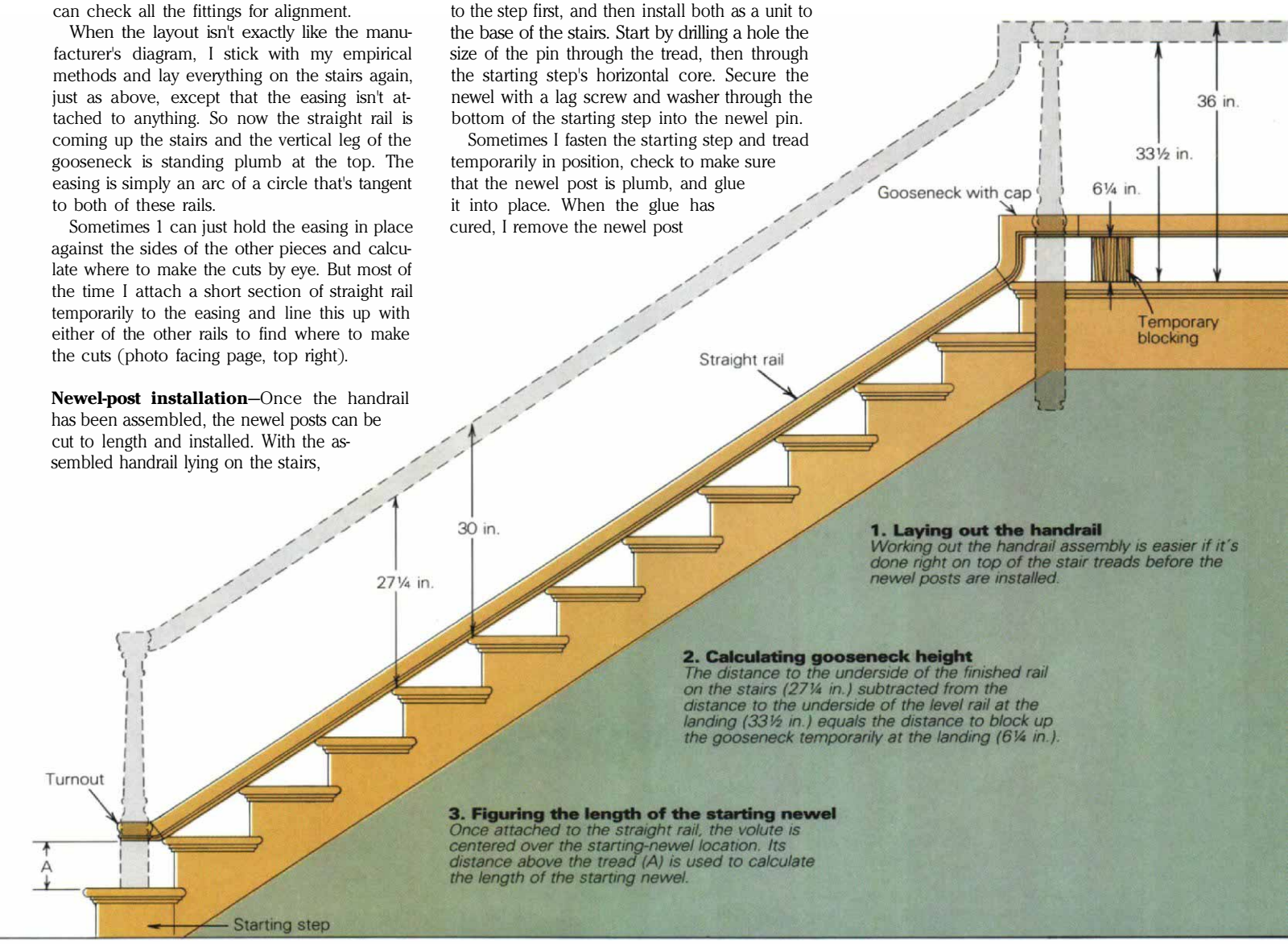
Sometimes I fasten the starting step and tread temporarily in position, check to make sure that the newel post is plumb, and glue it into place. When the glue has cured, I remove the newel post and step in one piece to screw them together under the framework; then I return the starting step and newel-post assembly to its location for final installation.

I've done some jobs where the pin-bottom newel post wasn't long enough. I had to buy a regular square-bottom newel and cut a tenon on the bottom. At every step, double-check everything and proceed with caution, especially if you're in the land beyond the diagrams.

When all the newel posts are securely fastened, all mitered skirt boards, risers and treads can be installed. As you fasten the return nosing to the tread, try to avoid putting the screws or nails where the tread has to be drilled for the balusters. I seem to ruin a drill bit on every job by running into my own screws.

Handrail assembly—With the newels in place, check the fit of the handrail assembly. You may have to rasp the pins on top of the newels so the handrail fittings will slide onto them without pounding. Check that the posts aren't pushed out of plumb by a rail section that's too long, and that the fittings are sitting level on the newels.

When I'm satisfied that the handrail is accu-



1. Laying out the handrail
Working out the handrail assembly is easier if it's done right on top of the stair treads before the newel posts are installed.

2. Calculating gooseneck height
The distance to the underside of the finished rail on the stairs (27¼ in.) subtracted from the distance to the underside of the level rail at the landing (33½ in.) equals the distance to block up the gooseneck temporarily at the landing (6¼ in.).

3. Figuring the length of the starting newel
Once attached to the straight rail, the volute is centered over the starting-newel location. Its distance above the tread (A) is used to calculate the length of the starting newel.

rately assembled, I pencil index marks across all the joints before 1 take it apart. These make it easier to line up the fittings when they're being glued. Where handrails level off, change direction and drop, the alignments are critical. A slight twist can throw off everything. If you're not sure that it will be a perfect fit when put in position, leave the joint dry and glue it together after all the balusters are in place.

If the handrail is fairly simple (one or two fittings), you can assemble the whole thing, plug the holes for the rail bolts, and fair and sand the joints before installing it permanently. If there are several changes in direction, you may have to assemble and install the handrail in sections. Assemble as much as possible beforehand, and plan the sequence of the final assembly to avoid problems tightening and sanding joints later. For instance, a joint at the vertical leg of a gooseneck and an up easing may be impossible to tighten in place, since the newel post will be in the way. Before the final assembly, I coat both sides of the joint with glue, then wipe off the excess with a damp sponge as soon as the parts are pulled together.

A heavy-tooth half-round file is useful for fairing the handrail joints, but I've also been using a small disc-sanding attachment on my drill to get into difficult places (photo p. 46, bottom left). The discs I use are 80-grit and 2 in. in diameter. I've heard that a Dremel tool with a selection of small burrs also works well for this, though it might be tough to fair out the joints smoothly with such a small tool. I have used a belt sander, but usually just on the underside of the railing to smooth off plugs.

After fairing the joints, I finish the sanding by hand with 100-grit and then 120-grit aluminum-oxide production sandpaper until all of the scratches are gone. The stair-part manufacturers say that the newel posts and balusters are ready to finish, but don't believe it. Go over them all just to make sure all the scratches are gone. I spin the balusters and newels on my lathe and sand them all with 120-grit paper for a really smooth finish. Don't use steel wool or sandpaper with a black grit on oak: it gets into the open grain and discolors it badly.

Baluster layout—Now that the newel posts are in place and the handrail is assembled, set the handrail up to mark the holes for the balusters. Traditionally, there are two balusters per tread, with the downstair face of the first baluster on each step in line with the face of the riser below it. The on-center spacing then should be half the run of the stair. I mark these locations on the treads, and plumb up to the handrail with a level or plumb bob, marking the underside for drilling the baluster holes. This layout can also be done when assembling the handrail on the treads, before the newel posts go in, simply by marking the baluster locations on the treads and then transferring the marks to the handrail with a combination square.

Some manufacturers suggest using a pitch block with a hole drilled in it as a jig to drill the holes in the handrail. But I just leave the handrail in place, line up the back of the drill motor with the mark on the tread below and drill carefully 1 in. into the handrail.

Sometimes a baluster layout will fall where a joint has to be made in the handrail. In this case, leave the baluster out until the joint is glued, plugged and allowed to cure. Then you can drill the hole for the top of the baluster. Cut the baluster just long enough to slide up into the top hole and drop into the hole in the tread. Glue and nail the baluster securely.

Always check the handrail for crowns or dips before cutting the balusters. I've had to pull crowns down by first toenailing a few key balusters and then pulling the rail down and toenailing the top of the baluster into the handrail. I measure the overall length of each baluster, subtract a whisker or two for glue, and cut each baluster to fit in its place. Be sure that the bottom pin is short enough for the depth of the hole in the tread and cut it off if necessary. The balusters I use come with a tip diameter of ⅝ in. for the top 3 in., so they usually slide into the handrail without trouble.

Final installation—With the balusters all cut, the real fun is about to begin. I apply a good grade of construction adhesive like Max-Bond or Liquid Nails to all the holes in the handrail and treads, making certain that there's good contact all around. These glues seem to allow a bit of flexibility without compromising strength (unlike yellow glues, which tend to be brittle and don't fill voids as well). I also smear some glue on the pegs of the newel posts and balusters. Too much in the holes may prevent the balusters from sliding all the way in.

Set all the balusters quickly into the tread holes, spin them around once to make good glue contact, and then, starting at the bottom, begin setting the handrail in place. Trying to get all those balusters to line up and slide into place is like trying to get a roomful of children to sit still and pay attention. The ideal helper would be an octopus. It helps to slide each baluster up into its handrail hole, but without pulling its bottom pin out of the hole in the tread.

When all the balusters and newel-post pins are in their holes, gently but firmly tap the handrail down with a rubber mallet (photo below left). The balusters may jump a bit, so you have to check that their bases are tight to the treads and that they are lined up parallel to each other. Some pins are turned a bit off center, and those balusters may need to be rotated 90° or 180° to line up with the others. Check their alignment with a straightedge. Eyeball down the length of the rail for crowns and adjust with the mallet. Make sure the fittings are all the way down on the newel posts.

Sometimes I'll drift a long screw from the side of the fitting into the newel post to pull them together. Countersinking one through the top is easier, but if you do this be sure to find a plug that matches the wood grain around the hole and line it up carefully. Staircases are great rainy-day jungle gyms, so in houses with kids, I'll toenail all the balusters, top and bottom, just to be on the safe side.

After all the rails are on and the balusters are in, check for scratch marks from assembly and sanding. I use penetrating oil stains and clear finishes, applying several coats to bring up a smooth shine. Some parts like balusters can be prefinished, but wherever there is a nail hole to be filled or a plug to be sanded it can botch a nice finish, so it's better to finish the whole staircase after it's installed.

Take your time and do the best job you can. A beautifully Crafted staircase is the centerpiece of a house, a delight to the eye and to the touch, and an example of the finest skill a carpenter has to offer. □

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Lining up the balusters and worrying them into place for the final installation is a tricky job. It helps to have an extra pair of hands. Tapping with a rubber mallet ensures that the handrail and fittings are all the way down on the balusters and newels.