Plunge-Router Stairs

An adjustable mortising jig simplifies the construction of an open-riser stairway

by Bill Young

Leaving the risers out of a stairway can make a big difference in some houses. The open spaces between the treads allow for air circulation, and also a way for natural light to get into a sometimes claustrophobic corridor. Last summer, I built a pair of these riserless stairways for a three-story house, and it gave me two good problems to solve.

First, I wanted to mortise, or house, the treads into the stringer rather than notch them. I think housed treads look better, and this method also leaves the stringer intact, allowing for longer spans and a stairway with less bounce. The problem was how to cut the mortises quickly and accurately.

I knew all along that I would be making these cuts with my plunge router. This kind of router allows the bit to be lowered directly into the work, rather than let into it from the side (see *FHB* #27, pp. 36-42). My job. was to figure out what kind of a jig would do the job precisely, yet still be easy to move along the stringer.

The second problem was to make the jig adjustable. Although the rises and runs for the two stairways were nearly equal, they had enough variation from floor to floor to require a different setup for each pair of stringers. My solution to both of these problems is the device I call the universal stair-stringer jig (photo facing page).

The jig consists of two basic parts: a rotating circular template and a cradle. A slot centered on the template's axis duplicates the cross section of the tread material, and guides the bit. Because I use a router bit that has a ball-bearing pilot mounted over the cutter—instead of under the cutter as is the usual case—I can size the cutout in the template to the exact profile of the stair tread. The cradle is a rectangular piece of plywood with a circular hole that is slightly larger than the template. Parallel fences on the bottom of the cradle position the jig on the stair stringer. So that it will be easy to move the jig along the stringer, I put the fences about ⅛ in. farther apart than the width of the stringer.

To use the jig, I lay the cradle over the stringer and I rotate the template until it aligns with the tread layout. This is where the universal part comes in. The jig can accommodate any tread layout, no matter what the rise or run of the stairs. When I'm satisfied with the alignment, I shim the fence against one side of the stringer (photo facing page). Then I use a bar clamp to lock the template inside the cradle, and to hold the jig in place as the stringer is routed.

Building the jig—I use ½-in. MDO plywood for my stair jigs. The letters stand for medium-density overlay. The overlay is a thin layer of plastic, which gives the plywood a smooth, hard finish. Around here a sheet of it costs less than $20. I've found MDO to be the perfect material for router jigs because it's strong and stable, it takes layout marks well and the router glides easily across its smooth finish.

I began building this jig by making the cradle from a 16-in. by 24-in. piece of MDO plywood (drawing, below left), I scribed a 13-in. dia. circle onto the rectangle, leaving three equal margins at one end of the rectangle. The wheel could be larger, but not much smaller. My treads were 11 in. wide, so a 13-in. template wheel gave me room for 1 in. of material at each end of the mortising slot. I drilled a ½-in. starter hole just touching the inside edge of the scribed circle, and I adjusted my electric jigsaw circle-cutting attachment to cut a 13-in. dia. hole. I began and ended the cut at the ½-in. starter hole.

I then cut a relief gap about ⅛ in. to 3/16 in. wide from the far end of the rectangle to the middle of the circle. The relief gap allows me simultaneously to clamp the template wheel at the correct angle, and to secure the cradle to the stair stringer.

Next, I attached 2x3 fences to either side of the cradle with 1-in. bugle-headed drywall screws. I used a piece of the stringer material to align the guides as I screwed them to the cradle.

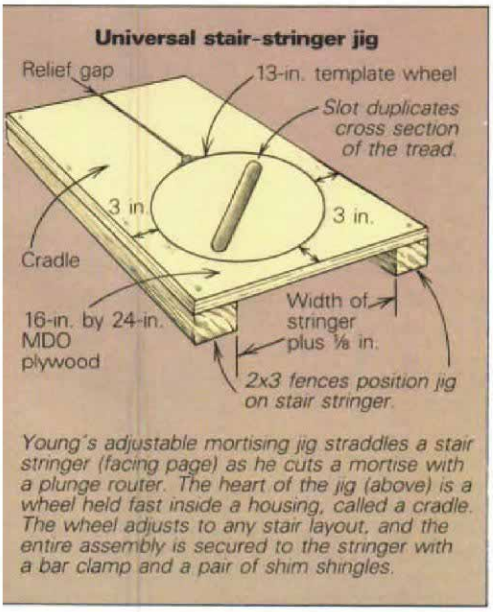
It took some trial-and-error experimentation to get a correctly fitting template wheel. The tolerances are close, and the cutout left over from making the cradle was a bit too small to fit properly. I increased the radius of my jigsaw circle-cutting attachment by 1/16 in., and got the right diameter wheel. When you finally achieve a correctly fitting template wheel, make several. Extras can be used for other tread dimensions.

To cut a precise slot in the template wheel I first placed the blank wheel inside the cradle and clamped the assembly to a suitable stringer board (photo next page, left). Then I scribed a centerline through the wheel and aligned it parallel to the long sides of the cradle. I used small nails to attach fences parallel to the centerline. The space between the parallel fences must be figured exactly since the fences will guide the router as it mills the template. This stair uses treads that are called 5/4 stock by the lumberyard, but they net out at about 1 1/16 in. thick. Since I was using a ¾-in. bit to make my mortises, I had to gain 5/16 in. to arrive at the right mortise width. That meant that the space between the parallel fences had to be the width of the router baseplate plus 5/16 in.

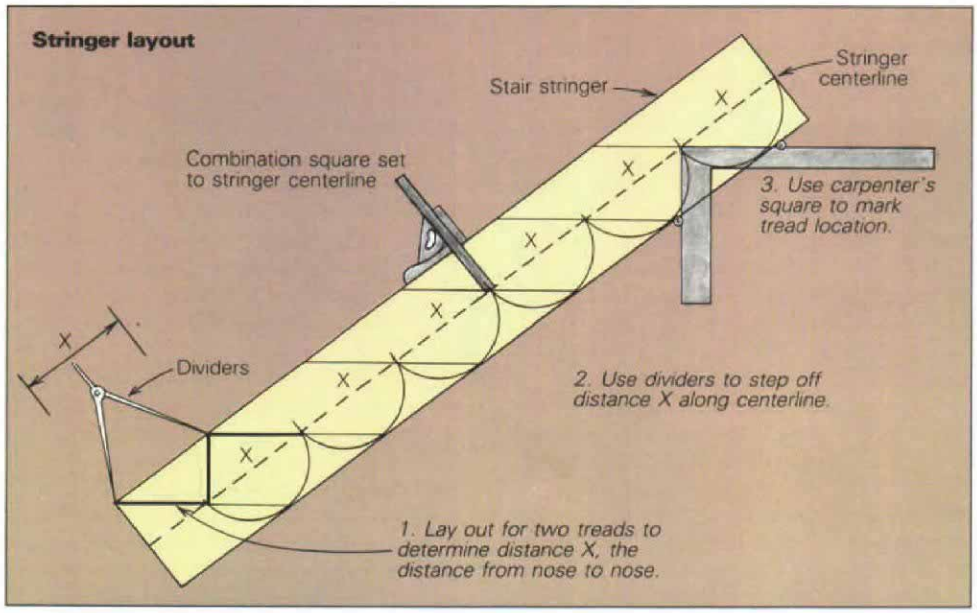
To dimension the tread width, I scribed the outline of the tread on the template blank (photo next page, center) and cut to it freehand (photo next page, right).

Matching the treads—Most stock stair-tread material is rounded over on one edge to form the nose. On the oak tread stock we used, the factory-rounded edge could be used as it was, but we had to mill the unfinished edge with a ⅜-in. roundover bit to each side. This created an edge that fits perfectly into a mortise cut by a ¾-in. dia. straight bit. This matching of the roundover bit to the straight mortising bit will occur again when the stair handrails are matched to the newel posts.

Laying out the stringers—My colleague Malcolm McDaniel came up with a slick way to determine tread layout for the router jig. The unit rise and run are drawn on the stringer using a carpenter's square in the usual way, but just for two treads—enough to measure directly with dividers the distance from nose to nose (drawing, below right). Next set your combination square

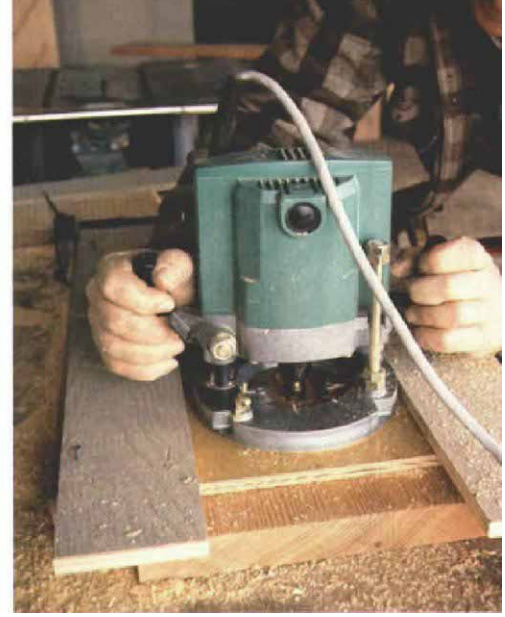


Young's adjustable mortising jig straddles a stair stringer (facing page) as he cuts a mortise with a plunge router. The heart of the jig (above) is a wheel held fast inside a housing, called a cradle. The wheel adjusts to any stair layout, and the entire assembly is secured to the stringer with a bar clamp and a pair of shim shingles.



Drawings: Elizabeth Eaton





Making the template. **To cut the template, Young first draws a centerline through the wheel, left, and aligns it parallel with the long edges of the brake. Next he tacks a pair of parallel fences to the cradle to guide the router as it cuts the template. Young uses a section of the tread material to scribe its dimensions onto the wheel, center. Then he routs freehand to the scribe marks, right.**

for half the width of the stair stringer. Holding the combination square against one edge of the stringer with one hand, swing the dividers with the other to step off the nose-to-nose increments down the middle of the stringer. At every point marked by the dividers, use the carpenter's square to mark the location of each tread.

To cut a mortise, place the jig onto the stringer and rotate the template wheel to the first run line. Now clamp the jig securely to the stringer and recheck the alignment. You may line up either side of the slot to the tread line so long as you are consistent for the entire stringer. To avoid confusion, I make a mark on the side of the line that I intend to mortise. Once I'm satisfied with the alignment, I carefully plunge my mortising bit through the slot in the template and into the workpiece.

I cut ¾-in. deep mortises for this stair. Each one needed two passes with the plunge router—a ⅜-in. depth setting followed by a ¾-in. setting. Because you will need tail pieces to clamp the jig, the stringer should not be cut to length until the last mortise is routed.

Assembling the treads and stringers— After the treads are rounded over and cut to length, they can be let into one of the stringers that has been laid on the floor, mortise side up. Our fit was snug enough to require a gentle assist with a hammer, interceded, of course, by a piece of scrap. We placed the second stringer atop the standing treads and tapped it home, starting at one end and working little by little to the other end. We didn't use any glue because there is little lateral force on the stair. Instead, we predrilled the stringers and counterbored at each mortise for three 2¼-in. bugle-headed screws—primarily to keep the stair together during installation. On the exposed stringer, the screw holes are filled with hardwood plugs.

Newel posts—We made our newel posts from clear, kiln-dried Douglas fir 4x4 stock, reduced to 3 in. by 3 in. for a slimmer profile. Each post is secured by a ⅝-in. threaded steel rod, which is screwed into a steel flange mounted to the floor (drawing, facing page, bottom left). I began making the newel posts by sinking a deep counterbore into one end of each 4x4. I used a 2-in. Planetor bit (Rule Industries, Planetor Div., Cape Ann Industrial Park, Gloucester, Mass. 01930) for this operation because it cuts well in end grain. I chucked the bit in a floor-standing drill press and mounted the 4x4 stock on a stop-jig that kept it vertical and resisted the bit's torque. I used the same arrangement to drill a shallower, smaller-diameter counterbore in the opposite end for the floor-mounted flange nut.

The next step was to rip the 4x4s down the middle with a bandsaw and surface the sawn sides smooth on a jointer. Then I routed a groove down the center of each half with a ¾-in. core-box bit, connecting the counterbores at each end. During all of this milling, I was careful to keep track of the matching halves. Milling completed, I glued and clamped each pair back together. After removing the clamps, I brought the still oversized newel posts down to their final dimension of 3 in. by 3 in. on a planer, removing equal waste on every side so that the rod hole remained centered in the post. The result of this procedure was a solid-looking newel post, almost indistinguishable from a post that hadn't been cut in half and reassembled.

I had the mounting plates made up at a local sheet-metal shop from 3/16-in. steel, with a ⅝-in. nut welded to the center of each one. The plates are held in place by four 3-in. #10 screws, driven into doubled joists at each landing. The finish floor is covered with tile, so I didn't bother to mortise the plates into the floor.

Handrails and balusters—Like the stringers and newel posts, the handrails and balusters are kiln-dried Douglas fir. The handrails are 2x4s that have been rounded over on all their edges. The balusters are 1x2s. To house the balusters, I plowed a ¾-in. wide groove in the underside of all the handrails, and a corresponding groove on the top edges of the stringers. The balusters are positioned and secured by 1x spacers.

Mortising the newel posts—Each newel post is mortised to receive both the handrail and stringer. I cut both these mortises with the same kind of template that I used on the stringers, but I used a 1-in. dia. bit to match the ½-in. roundover on the handrails. Before I made any cuts, I temporarily installed the newel posts and made sure that they were plumb. This let me accurately measure the length of the handrails, and determine the plumb-cut face of both the handrails and the stringers.

The mortises in the newel posts are ½ in. deep, and the handrails are glued in place. The sharp angles at the end of the handrails and stringers have to be squared off so the assembly will fit properly (drawing facing page, top right).

Assembly—After threading the steel rods into their floor-mounted nuts, we lowered each newel post over its rod. Then we glued the stringers and handrails into their mortises, and cinched down the posts with a deep socket wrench. Next, we inserted the balusters into the slots on the top of the stringer and the bottom of the rail, alternating spacers and balusters and gluing the entire assembly. We topped the newel posts with an oak cap.

After cleaning up excess glue and sanding, we varnished the entire stairway with four coats of satin marine spar varnish. The result is a clean, spare and surprisingly strong stairway (photo facing page). The universal stair-stringer jig did what we needed it to do. It guided the router bit with precision, and it reduced the time spent preparing each stringer to less than is spent cutting a conventional stringer. □

Bill Young is a contractor in the San Francisco Bay Area.

The finished stair (facing page) is a light yet strong assembly of mortised parts that lets light and air into the stairwell. Except for the newel posts, which have been planed to 3x3s, all of the stair parts are made of dimension boards straight from the lumberyard.


Section of handrail at newel post
Newel post
Top corner is squared off on rising handrail.
Handrail
½-in. deep mortise
Newel post
Handrail
Bottom corner is squared off on descending handrail.
Section at newel post
Oak cap
2-in. counterbore
⅝-in. threaded rod
⅝-in. washer
¾-in. hole for threaded rod
Nut welded to plate
3-in. by 3-in. by ⅜-in. steel plate
Doubled joists
3-in. #10 screws