# *Building a cantilevered-tread spiral stair*

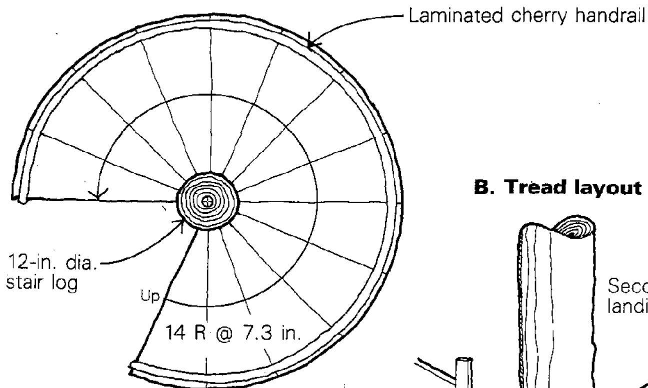
**Throughout the Saks house there is a feeling of openness, and we wanted the spiral stair to the bedroom and lookout tower to echo this feeling. We wanted it to be a structure with delicate lines, unencumbered by external support systems and limited to the tones and textures of wood. For me, each aspect of this 6-ft. dia. spiral construction was a challenge, always an adventure, and often a headache. More than once I considered selling my tools and opening a restaurant.**

***Layout***—**The central support for the staircase is a 20-ft. long yellow cedar driftwood log, about 1 ft. in dia. at the base. As a structural member of the house, the log was standing when I came on the scene, and it had to be laid out and worked in place. It was neither completely round, nor straight. Consequently, the tread-mortise positions had to be projected inward from a 6-ft. dia. imaginary cylinder symmetrically enclosing the assumed centerline of the log. Since the position of the outside end of each tread was fairly critical, individual tread lengths had to vary by an inch or two depending on the warp of the log. The entire layout for the tread positions had to be completely independent of the log, with the projected mortise positions falling arbitrarily on the log's uneven surface.**

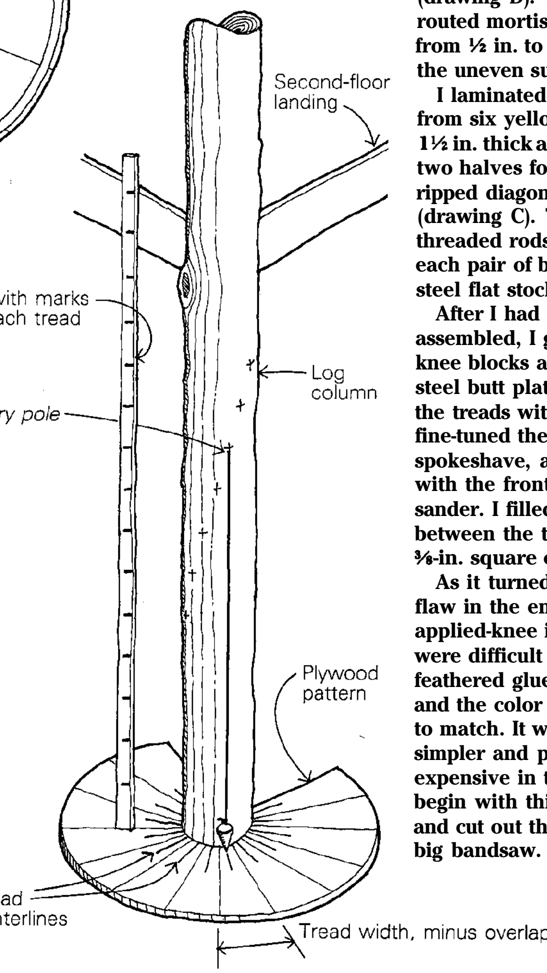
**The rise of each step is 7.3 in. To climb the distance from the ground-floor landing to the bedroom landing, 13 treads travel an arc of 292° (drawing A)—one tread per 22½°. This let me find the centerline of each tread, and ignore the overlap of the treads, which was an inch on each side.**

**To get the mortise positions for the treads, I made a flat plywood pattern of the 292½° arc, as shown in drawing B. I drew lines on the pattern dividing it into 13 segments, and made a mark for the centerline of each segment. Then I cut out the center of the pattern so it would fit around the base of the log column, and positioned it on the floor where the first tread would start, minus the overlap. I put some index marks on the pattern and the column for future reference points, then I transferred the centerlines of each tread onto the log using a pencil and a plumb bob. I marked the rise intervals on a story stick and transferred them as top-of-tread lines to the corresponding tread centers already scribed on the pole.**

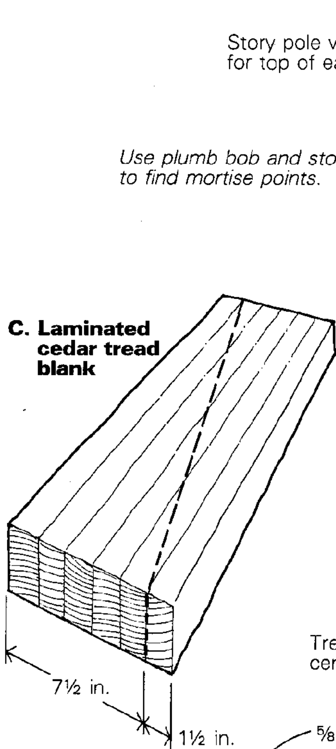
**A. Plan of stair**



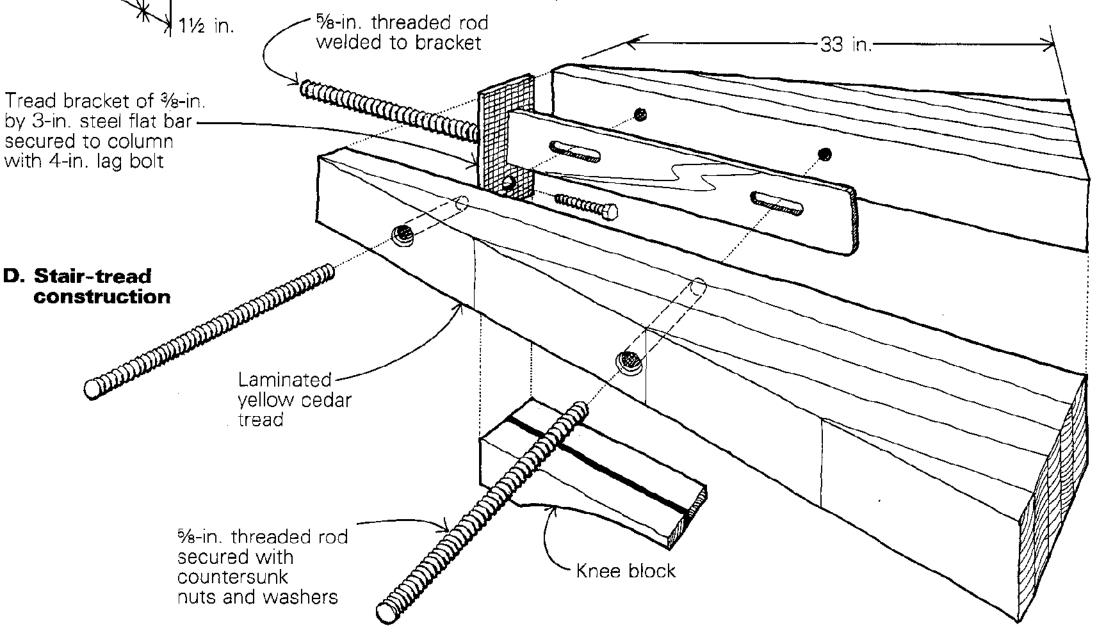

**B. Tread layout**




**C. Laminated cedar tread blank**




**D. Stair-tread construction**




***Tread construction***—**Each tread is completely self supporting. They cantilever from the pole on brackets made from ⅜-in. by 3-in. by 24-in. steel bar stock welded to a ⅜-in. by 3-in. by 6-in. butt plate. A ⅝-in. piece of threaded rod welded to each butt plate extends through the log (drawing D). The butt plates sit in routed mortises ranging in depth from ½ in. to 1½ in., because of the uneven surface of the log.**

**I laminated the tread blanks from six yellow cedar boards, 1½ in. thick and 3½ in. wide—two halves for each tread were ripped diagonally from a block (drawing C). Two ⅝-in. dia. threaded rods extend through each pair of blanks, capturing the steel flat stock.**

**After I had the rough treads assembled, I glued on separate knee blocks at the base of the steel butt plates. I rough-shaped the treads with a drawknife, and fine-tuned them with a scorp, spokeshave, and where possible, with the front roller of a belt sander. I filled the gap left between the tread halves with a ⅜-in. square cherry strip.**

**As it turned out, the biggest flaw in the entire process was the applied-knee idea. The knees were difficult to position, their feathered gluelines often showed, and the color and grain were hard to match. It would have been simpler and probably less expensive in the long run to begin with thicker blanks of cedar and cut out the basic shape on a big bandsaw.**



Drawings: Vince Babak

*Mortising the column*—For each tread I had to cut mortises for the tread butts, drill the bolt holes through the column, and counterbore for nuts and oversized washers.

I made multiple passes with a ½-in. straight-flute bit in a heavy-duty router to cut the mortises. To guide the router, I used a jig that could be positioned and secured to the column with clamps (top photo). Accuracy here was crucial because the flat bottom of the mortise formed the seat for the butt block of the tread bracket. The slightest inaccuracy in any plane would translate out to the end of the tread, putting it hopelessly out of position.

I made the jig from a piece of ½-in. plywood, 12 in. by 18 in., with 1x2 fences for the four sides of the mortise. For clamp jaws, I used 18-in. long pieces of 2x2 at the top and bottom of the jig, and opposite the column. They were linked by threaded rods. To bring the jig into plumb, I checked the bed on which the router moved for plumb in both planes, and adjusted it with wooden wedges.

Tangential orientation of the jig was the most crucial, and the most difficult. The jig's flat surface had to be perpendicular to the final centerline of the tread, and this angle had to be set from a point as far from the pole as possible in order to minimize error. To do this I added a 14-in. plywood tongue extending horizontally from the lower edge of the jig, with the tread centerline marked on it. I adjusted the jig with wedges between its base and the column until the centerline on the tongue was plumb with the corresponding center marked on the plywood pattern on the floor.

Mortises routed, I drilled bolt holes using a guide block that fit into the mortises. It both indexed the hole position and trued the ⅞-in. auger bit so that I could drill a hole perpendicular with the mortise bottom. I did my counterbores with an expansion bit. To center the spur on the bit, I tapped square wood plugs into the last 2 in. of the bolt holes, and then drilled them out during the counterboring. Leftover plug ends came out easily using a length of dowel as a drift pin.

*The test*—At this point the finished treads were bolted in, and the staircase was ready for a test climb. Since the railing had not yet been built, the treads were supported only by the center pole. Up to this point the engineering had been theoretical. For a practical test, I asked an unbiased (and well-insured) friend to try out the stairs and to report on three things: bounce, wiggle and ease of ascent. After a couple of trips he said that the stairs were easy enough to climb and didn't deflect much vertically, but that they wiggled unnervingly.

It was clear that the treads had to be tied together to stiffen the whole structure. The obvious solution was to use the balusters, fastening them into one tread and against the face of the next tread up. But this couldn't be done until the handrail was built.

To cut the tread mortises in the column, Grunewald used this jig to guide the router. For this cut near the landing, he removed the top pair of 2x2 clamping jaws, and nailed the jig to the log column.

By clamping gusseted brackets to the stair treads, Grunewald was able to use the stair as the form for the laminated handrail. The edge of each bracket was positioned to correspond with the line of the handrail, and their upright legs served as clamping surfaces during glue-up.

*Handrail*—I laminated the rail out of nine layers of $\frac{5}{16}$-in. by 3-in. cherry strips, with the joints staggered at 2-ft. intervals. The staircase became the form, with gusseted angle brackets on the treads providing clamping points and forming the helical curve (bottom photo).

I had originally thought to glue up all nine layers at once. But since the weather was hot and I was working alone I elected to do two separate gluings, one of four layers, the next of five, hoping to avoid some of the panic that glue-laminating can cause. That turned out to be a wise decision.

After it cured, we plucked the handrail from its form and planed it on the Hitachi jointer/planer. To do this, I laid the machine on its side on the porch, and fed the rail through like a huge corkscrew to a helper stationed downhill. Once it was planed, I put it back in place and marked the baluster positions. I drilled these using an angled guide block that clamped to the outside face of the rail. I cut the balusters from 1-in. square cherry blanks. Rather than turning them on the lathe, I found it quicker and easier to do four passes over a table-mounted router with a ½-in. roundover bit. I split the bottom of each baluster for a blind wedge, and filed a flat spot to seat firmly with the edge of the adjacent tread.

Each baluster was then wedged and pinned into the top face of a tread and screwed to the front edge of the tread above, effectively tying the staircase together and eliminating almost all of the movement. The predrilled rail was then tapped onto the upper ends of the balusters, and except for the many hours of sanding with 150-grit paper and applying tung oil, the job was finished. □

*John Grunewald lives on Hornby Island, B. C.*

Photos this page: Bob Helliwell