# Building a Winding Outdoor Stair

## Fitting stairs to a complicated site called for an accurate sketch and some job-site improvising

by Thor Matteson

A couple of summers ago, I was helping my father build a house in El Portal, California, when some neighbors, Ron and Liz Skelton, asked if I'd be interested in building a deck for them. They offered to *pay* me for my work; my father understood the lure of fortune and fame and encouraged me to accept the job, which I did.

The Skeltons wanted a redwood deck to replace a sagging fir assembly built over a rock garden. That part of the job would be tricky enough, but there was more. Ron is the local mechanic, and he had no stairs leading from the house down to his shop located one level below. After several years of skidding down the bank to work, he was ready for a stairway. Ron described to me where he and Liz envisioned the stairs—"starting about here, winding down between these rocks and ending up at the slab in front of the shop," he narrated while scampering down the bank around several boulders. Suddenly I felt slightly dizzy. I was barely getting the hang of *straight* stairs, let alone double-inflected variable-radius curved stairs. Nevertheless, I forged ahead with the deck and extended a landing from which to start the stairs.

Liz and Ron wanted a sturdy-looking stair, so we settled on 42-in. wide (approximately) open-string stairs with 2x12 stringers and 2x6 risers, both of redwood, and 4x redwood treads (photo facing page). Four-in. thick redwood can be tough to find, and we needed 4xs for the deck framing, too. Luckily, a local contractor gave Ron a tip on where to get it, and the supplier sent the most stunning redwood I'll probably ever see—vertical grain, surfaced full-dimension 4x6s and 4x8s, 16 to 20 ft. long with hardly a defect in them. I saved the nicest stuff for the treads and sentenced the rest to life beneath the decking.

**Measuring and sketching**—When building an unconventional stair such as this one, it's a good idea to start with a drawing (drawing facing page). I mapped out a plan view first, scaled ½ in. to the foot and identified the critical elevations. That called for a few hours scaling the hillside with a tape measure, a plumb bob and a builder's level.

To figure out the total rise of the stair, I perched the builder's level near the top-landing location and shot the elevations of both the top landing and the shop slab (the bottom slab of the stair would butt up level to the shop slab). Then I subtracted the top elevation from the bottom and came up with a total rise of 127 in. I don't have a leveling rod to use with my level, but a tape measure attached to a straight 2x4 served me just as well.

Next, using framing members of the new deck as reference points, I measured horizontally and dropped a plumb bob to locate the relative positions of the three boulders around which the stairs would wind, plus the location of the bottom landing. I used all of these measurements that evening to draft a plan view of the entire project. The path the stair would have to take was now obvious, and I penciled it into the drawing.

Now I drew in a line which I thought best represented the line of travel someone was likely to take in traversing the stairs, picturing myself swinging around the end post on the deck railing and trotting down the steps, brushing past the boulders while taking the shortest route to the shop. Then I laid out the stair so that the rise and run of each step would be consistent along that line of travel. I walked my architect's scale along the curved path line, and I decreed the scaled length of the path line to be the total run of the stairs—20 ft. even (by coincidence). I converted this figure to inches and used this number, along with the 127-in. rise to figure out the rise and run of each step. The rule of thumb for stairs states that rise plus run should be between 17 and 18 in. and that rise times run should equal about 75 in. I decided on a rise of 6³⁄₆₄ in. and a run of 12 in., which added up to 21 risers and 20 treads. Though the rise and run weren't quite what the time-honored formulas sanctioned, in the end they worked just fine.

Now I knew how many treads to put into my sketch, but I still had to figure out their orientation and shape. This I did mostly by instinct. I put a tick mark every 12 in. along the path line in my sketch and used the marks as points on which to pivot the tread nosing. I simply tried to keep the taper of consecutive treads from changing too abruptly.

Once I was happy with the tread layout, I sketched in stringers as close to the ends of the treads as possible to avoid excessive cantilever. It took five pairs of stringers to skirt all the obstacles, and each of them was of a different length and slope (in any circular stair, inside stringers are steeper than outside stringers). The shortest stringers would carry three treads and the longest stringer would support seven treads.

**Placing the piers**—I knew where to place the piers to support the stringers, but I still had to determine their elevations. To do this, I calculated the elevations of all the treads above the shop slab and labeled them on my drawing. Then I drew a cross section of each tread and stringer that fell directly over a pier and figured as best I could the distance between the tops of the treads and the tops of the corresponding piers (the slopes of the stringers varied, so these measurements varied). By subtracting these numbers from the tread elevations, I obtained the heights of the piers.

With the drawing complete, it was time to return to the site and locate the piers, again using the deck framing as the point of reference. Then I shot the elevation of each one with the builder's level. I soon discovered that I was in for considerable digging. The required scraping simultaneously cleared the path for the lower two-thirds of the stairway and contributed fill to expand Ron's parking area.

Once I was convinced that the calculated pier elevations were correct, I poured the concrete piers and oriented wet post anchors in them to accept the stringers.

**Solving the stringers**—When the concrete set up, I began to work on the stringers. I worked from top to bottom so I could compensate for accumulated errors by adjusting the finished level of the concrete slab at the base of the stair (the accumulated error amounted to less than ⅛ in). The usual framing square and stair-gauge fixtures were useless for the layout of these stairs because of the different slopes of the stringers and because nearly every tread was a different shape. Instead, I laid out the stringers in place.

I started out by making plumb and level cuts on the ends of the upper pair of stringers, figuring the cuts by taking the rise and


**Stair layout**

*The meandering stair connects the entry-level deck to the slab in front of the mechanic's shop below. Most of the stair layout was calculated on paper. For his drawing, Matteson first rendered the existing deck, landing, shop slab and boulders to scale, and sketched in the rough outline of the stair. Then he drew a line to represent the theoretical line of travel. He walked an architect's scale along the line and measured a total run of 20 ft., or 12 in. per tread. By making a tick mark every foot (to scale) along the line of travel, he could then use the marks as pivot points for the treads, drawing and erasing the nosings until the treads followed the curvature of the stair gracefully. Matteson then sketched in the five pairs of stringers required to skirt the obstacles, drew in the piers to support them and labeled his drawing with the tread elevations. Pier elevations were derived from the tread elevations. On-site layout was then scaled off the drawing, and the elevations of the piers were shot with a builder's level.*

run of each stringer off my drawing. After notching the bottoms slightly to clear the piers, I propped the stringers against a 4x6 header fixed to the landing and clamped them to the post anchors at the bottom. Next, I marked the inside of the stringers 10¾4 in. down from the deck surface (the rise plus one tread thickness) and used my 2-ft. level to scribe a horizontal line through each mark. Going back to my drawing, I scaled off the run for the first tread at both stringer locations (the run differed on opposite ends of the tread) and marked their lengths on the horizontal lines. I used my rafter square to scribe a 6¾4-in. long plumb line down from each mark, then drew another pair of horizontal lines, repeating the process until I reached the end of the stringer.

In order for the risers to lay snug against the stringers, I needed to bevel most of the plumb cuts. To figure these bevels, I simply extended my plumb lines up to the tops of the stringers, layed my 4-ft. level across the tops and aligned the edge of the level with a pair of plumb lines. Then I scribed a line across the tops of both stringers. That gave me the angles to which I adjusted my saw for each cut. I undamped the stringers and cut along the lines with a worm-drive saw, finishing the cuts with a handsaw.

Next, I replaced the stringers, drilled pilot holes in them and screwed them to the deck posts and to the post anchors with #8 zinc-plated bugle-head drywall screws, greased with a dab of beeswax from a toilet gasket. I had special-ordered 2,000 of these screws for the deck from Mid-Valley Distributors (3886 E. Jensen Ave., Fresno, Calif. 93725). They worked so well that I decided to use them for the stairs, too.

I approached the rest of the stringers the same way as the first pair, except that the subsequent stringers each required a beveled plumb cut at the top end where they met the preceding stringers. To lay out the cuts for a pair of stringers, I notched the stringers to fit the piers and laid them in place, snugging the top ends up alongside the upper stringers. Then I used my 2-ft. level to draw plumb lines at the joint locations and used a saw protractor to figure out the proper bevels, transferring the bevels onto the stock. Once the stringers were marked, I took them down and put my worm-drive saw to work.

The required bevels for the top cuts were all greater than 45°, so I couldn't cut them in a single pass. Instead, I made the plumb cut with the saw set at 90°. Then I set the saw to 90° minus the bevel angle and made the finish cut by resting the base of the saw on the end grain exposed from the first cut. This was a little awkward, but it worked. Next time, maybe I'll clamp a block to the stock for added base support.

The varying width of the treads had two unavoidable consequences. Sometimes the treads dropped faster than the stringers, leaving less meat in the stringers than I liked. To stiffen up these skinny stringers, I thickened them with a pair of 2x6s fastened with construction adhesive and screws. On some of the outside stringers, I encountered the opposite problem—the stringers descended faster than the treads, leaving a triangular void between the riser, tread and stringer (photo facing page, right). I addressed that problem by gluing and screwing vertical 2x6 blocks to the stringer to provide extra support for the front corner of the treads.

After cutting all the stringers to receive the treads, I screwed them to the post anchors and to each other, occasionally checking my progress down the slope with the builder's level.

**Treads and risers**—Starting again at the top of the stairs, I began to install the treads and risers. Each tread butts up against the riser above it and laps the riser below it.

Most of the treads were composed of three pieces: a 4x8 nosing piece, a 4x6 center piece (usually with an angle cut along the rear to fit against the riser) and a small wedge to fill out any remaining space along the back. I cut the nosing piece of the top tread to length first, ripped a 45° chamfer under its front edge so it wouldn't look too chunky, and smoothed out the chamfer with a power plane. Then I set the piece on the stringers so that the bottom of the chamfer would be flush with the front of the riser to be installed later below it, creating a 1¾-in. nosing.

With the nosing piece positioned on the stringer, the next step was to fit the middle piece (drawing facing page). To figure out the taper on the middle piece, I first held my tape measure perpendicular to the rear edge of the nosing piece and marked the point along that edge where it measured exactly 6 in. to the riser. That point would locate the beginning of the taper on the middle piece. Next, I measured the perpendicular distance between the nosing piece and the riser at its narrowest point. I transferred these measurements to the blank for the middle piece and cut the taper with the worm-drive saw. This method gave me a cutting line more easily, quickly and accurately than measuring the angles could have, and I repeated it for the wedge piece.

When the three pieces of the tread fit tightly in place, I reached underneath and scribed a pencil line along the outside edges of the stringers. Then I removed the pieces and eased their top edges with a block plane. I turned the pieces upside down and screwed a pair of 1½-in. by 1½-in. cleats to the two front tread pieces. The cleats were positioned along the pencil lines, and would later be screwed to the stringers horizontally to anchor the treads. I used redwood shims between the cleats and the tread pieces to account for the varying stock thickness.

Next I stood the partly assembled tread on its nose and further connected the two front pieces with three ½-in. by 6-in. lag bolts, counterbored into the back edge of the middle piece deep enough so that the entire threaded portion of the bolt would grip the nosing piece. For all this hole-shooting, I rigged up a few drills: a Milwaukee Hole Hawg with an Irwin expansion bit (set at 1½ in.) for the counter boring and a ½-in. Milwaukee "Magnum" drill for the lag-bolt shanks and pilot holes, plus I had my dad's antique clunker for drilling all the pilot holes for the drywall screws. The Hole Hawg is frighteningly powerful; a few weeks earlier it snapped the 9⁄16-in. shank of a self-feed auger in mid-hole with hardly a twitch. The Magnum drill is nice and sturdy. The only problem is that the handle is mostly switch, and it's hard to grip without turning it on. Once the holes were drilled for the lag bolts, I drove the bolts halfway home with an impact wrench. The last few turns went faster with a ratchet wrench, which also allowed me to feel when the bolts were snug.

I attached the wedge piece with drywall screws, which my cordless driver/drill sent burrowing into the redwood as far as I needed to counter sink them. That's another indispensable tool, especially if you have an extra battery charged up and ready to go.

Once the pieces were connected, I drove a few more screws into each through the bottom rail, flipped the tread over and used a round-over bit in my Sears Craftsman router to smooth the top front and side edges. During use, this router sucks bits up into the collet unless I really bear down with the collet wrench while changing bits—hard enough to bend the tooth on the shaft lock. To switch the bits after such punishment, the whole collet must be removed and the bit forced out with a nail set. Maybe I should just be happy the bit doesn't creep *down* during use.

To install the finished tread, I once again needed to use shims, this time between the tread and the stringers. When I was satisfied that the tread was at the proper height and solidly level, I glued the shims in place with construction adhesive and screwed the cleats into the stringers. Is reached back under the tread and screwed the header above to it through the predrilled holes in the header.

When the tread was secured, I cut a riser to fit underneath it. I cut the riser to length, freshened up the face with the power plane and predrilled several holes along the bottom edge, which would later allow me to screw the riser to the back of the tread below it. Then I pried the riser tight against the tread with a flat bar and screwed it to the stringers with the drywall screws, low enough so the screws would be hidden by the tread below. I made and installed the rest of the treads and risers the same way (right photo, facing page).

Any time it was necessary to fit a riser or tread to a rock (left photo, facing page), I transferred the profile of the rock onto it with a contour gauge and gingerly trimmed the ends with a reciprocating saw and a sharp chisel. A contour gauge is made of two metal plates with about 150 tempered-steel wires sandwiched in between. When the gauge is pushed up against an object, the wires slide between the plates until they all touch the



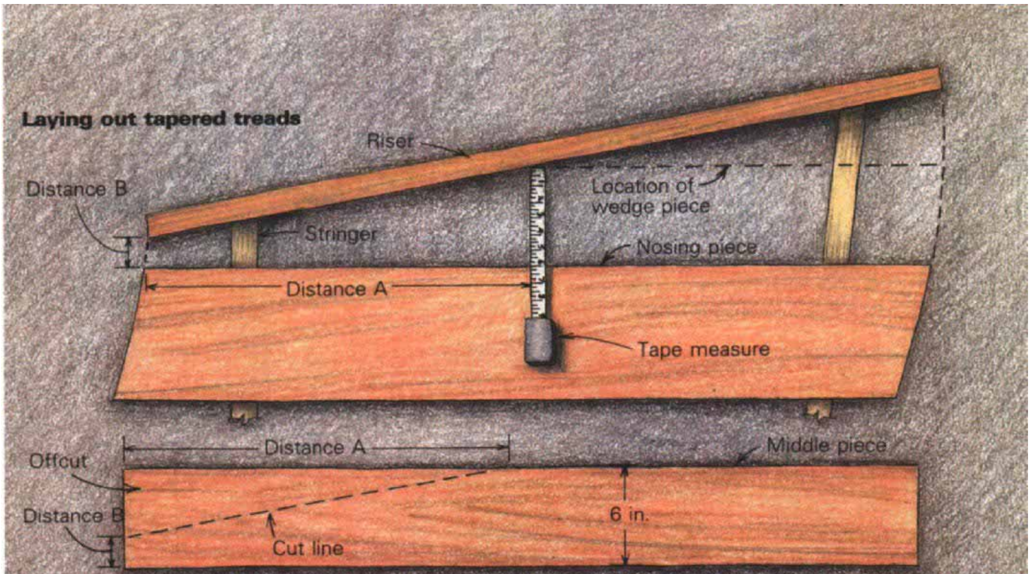
Drawings: Christopher Clapp

object. The contour of the object can then be scribed off the gauge.

Making and installing each tread and riser pair took about two hours. After about a week, I reached the bottom stair and poured a small concrete pad at the base of the stairway.

**Finishing touches**—Once the stairs were finished, a coat of clear wood finish was brushed on (The Flood Co., P. O. Box 399, Hudson, Ohio 44236-0399). Ron built a nice, tight rock retaining wall against the edge of the stairs to keep dirt and critters from getting under them, and Liz landscaped very nicely around the deck and stairs. I got married and moved away to complete school. Those stairs were an enjoyable challenge and great practice for building an even nicer set of front steps for the Skeltons when I move back to the area. □

*Thor Matteson is a civil-engineering student at California Polytechnic State University in San Luis Obispo, California. Photos by the author.*




*Most of the treads were composed of three pieces: a nosing piece, a tapered center piece and a wedge piece to fill out the back. Once a nosing piece was cut and positioned on the stringer, the author held his tape measure perpendicular to the rear edge of the piece and marked the point where it measured exactly 6 in. to the riser. Then he measured from the end of the piece to the mark (distance A) and measured the gap between the nosing piece and the riser at the narrow end (distance B). He transferred these measurements to the blank for the middle piece, connected the points with a diagonal line and cut the taper with a worm-drive saw. The technique worked for the small wedge piece, too.*

**The stair snakes around three boulders en route to the shop, requiring some careful fitting of treads and risers (photo above). The author used a contour gauge to transfer the profile of the stone to the tread and riser stock, then trimmed the stock with a reciprocating saw and a chisel. The stringers are made of 2x12 rough-sawn redwood (photo right), lapped at the joints and secured to wet post anchors and to each other with 3-in. zinc-plated drywall screws. The anchors are made to accommodate 4x stock, so redwood blocks were used to fill out the bottom anchors. Triangular voids in the left-hand stringer were remedied by screwing vertical 2x6 blocks to the stringers to lend extra support to the treads. The risers are screwed to the stringers with drywall screws, low enough so the screws are hidden behind the abutting treads, and they're also screwed to the backs of the treads. Chamfers on the treads prevent the stairs from looking too boxy. A concrete pad will later be poured at the bottom.**