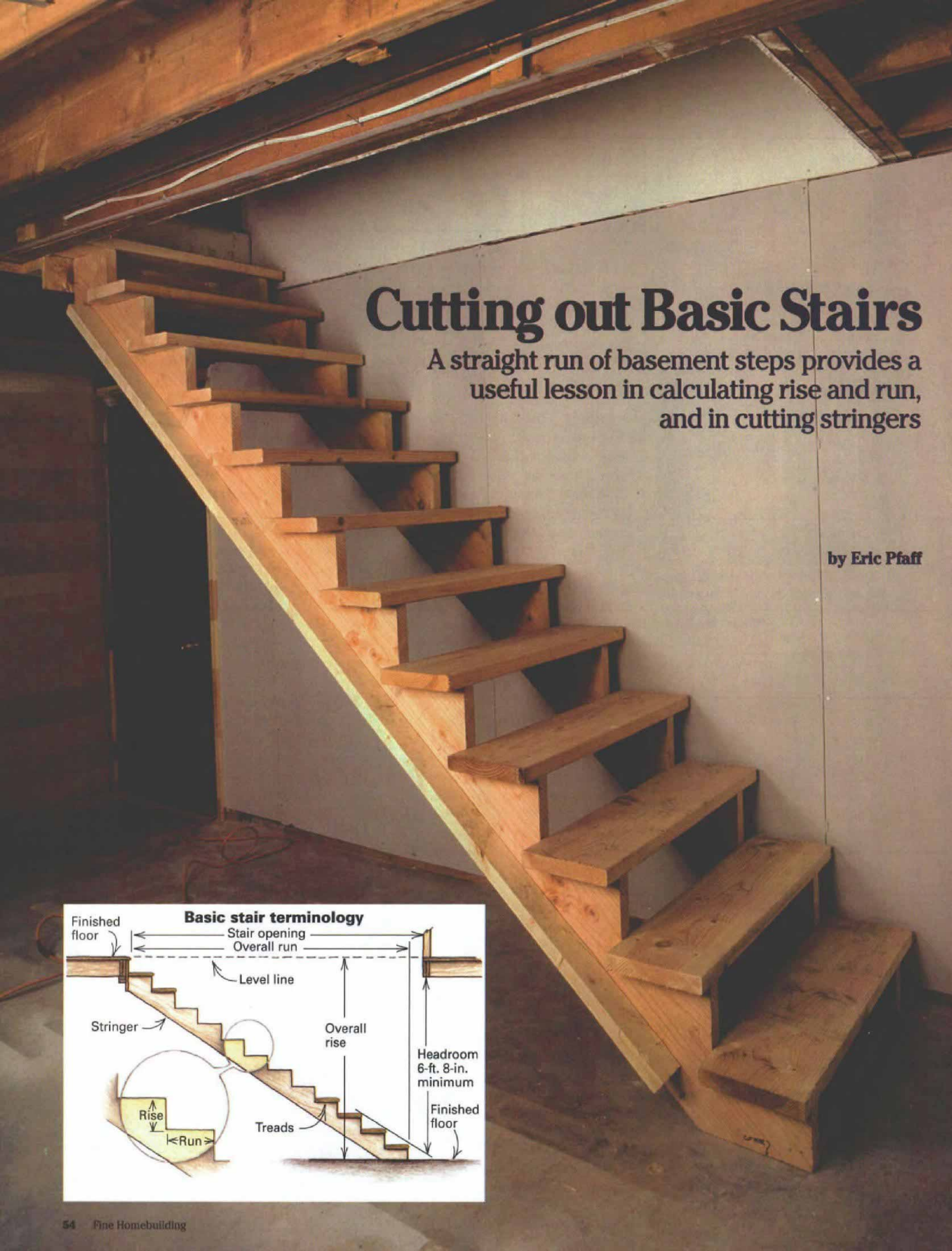
Cutting out Basic Stairs

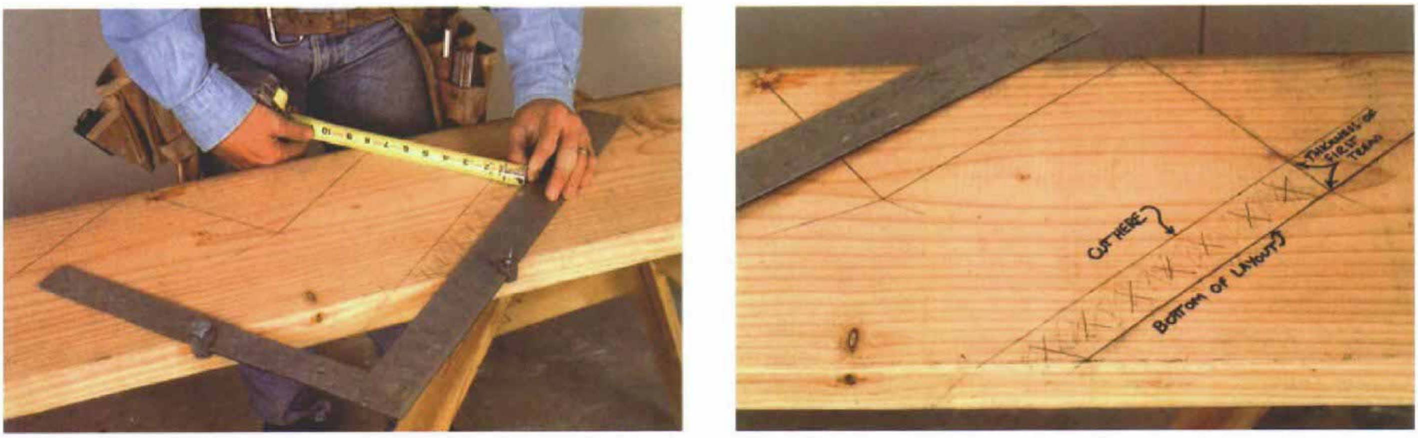
A straight run of basement steps provides a useful lesson in calculating rise and run, and in cutting stringers

by Eric Pfaff



Measuring the overall rise. A 2x4 extends a 4-ft. level over to where the staircase will land. Measuring the rise at this point minimizes the chance of error from a basement floor that might not be level.

Stair gauges streamline layout. Small clips called stair gauges are attached to the framing square at rise and run measurements to keep the orientation of the framing square the same for each step layout.



Subtract the thickness of a tread. For the bottom rise to be the correct height, the thickness of one tread must be subtracted from the bottom of the stringer. Moving the square to the other side of the stringer makes it easier to complete the lines.

I started out as a laborer on a framing crew ten years ago. After a few months I began feeling cocky about my framing skills and one day decided that I was going to impress the boss. I asked him if I could cut a simple set of basement stairs while he was on lunch break. He told me to go for it, though he wasn't going to pay me extra for working through lunch. Anxious to prove myself, I agreed to his terms.

I worked frantically, first figuring the rise and run, then cutting the stringers as fast as I could. I was just nailing the last of the treads when the boss came back from lunch. He seemed surprised that I had gotten the steps done, but the real surprise came when he smacked his forehead on the stairwell header. In my haste I had miscalculated the headroom over the stairs and never got a raise while working with that crew.

Measure the height of the stairs where they land on the floor—I've cut over 100 sets of steps since I gave my boss that concussion, and I now realize that the first and most important step in stair building is accurately calculating the rise, or the height of each step, and the run, or the width of each step. (For more stair terminology, see drawing, facing page.) I begin by finding the overall rise, or the distance between the two floors that the stairs will connect.

In a perfect world all floors would be flat and level, and measuring the rise would mean simply running a tape from the floor above to the floor below. However, I've seen floors—especially in basements—that slope a couple of inches from one wall to the other.

The way around this problem is measuring the overall rise as close as possible to where the stairs will land on the floor. I make this measurement by taping my 4-ft. level to a straight 2x4 that is at least as long as the framed opening for the stair (photo top left). Keeping the 2x4 level, I measure up to it near to where I figure the stairs will land. In the stair featured here, the overall rise is 99½ in.

Figuring rise and run

Many codebooks and safety officials insist that all stairs have a 7-in. rise and an 11-in. run. However, the formulas below are also routinely used to determine rise and run.

1. The rise times the run should equal approximately 75 in.

2. Two times the rise plus one run should equal 25 in.

3. Rise plus run should be 17 in.-18 in.

Check local codes before cutting your stairs—Before I explain my calculations, let me say a brief word about stairs and the codebook. Code requirements for stairs seem to change with every new codebook and can vary greatly from state to state, sometimes even from town to town. For instance, some codes require a 7-in. maximum rise; others allow an 8-in. rise. So check with your local building inspector to make sure that any stairs you build meet the local code. For the project featured here, I was replacing an existing set of basement stairs. My

Drawing facing page: Christopher Clapp

First cuts are made with a circular saw. Overcutting the lines will weaken the stringer, so the initial cuts with a circular saw should never extend beyond the layout lines.

Finishing the cut. A jigsaw is used to complete the cuts in each corner, cutting the wood that the circular saw can't get. A handsaw will also work instead of a jigsaw.

The first stringer becomes a template. Once the first stringer has been cut and tested in place, it can be traced for the layout of the second stringer. The crown of the stringer stock must be facing the same direction as the points on the template.

floor heights were fixed, as was the rough opening in the floor, so I had to work within the constraints of the existing framing. Consequently, these stairs are steeper than most codes allow. But the current BOCA code, for instance, under section 817.6, grants an exception to the tread and riser size requirements for "any stairway replacing an existing stairway within a space where, because of existing construction, the pitch or slope cannot be reduced."

Generally, I think a $7\frac{1}{2}$-in. rise with a 10-in. run produces a safe, comfortable stair, so as a starting point, I divided my overall rise by 7.5, which gave me 13.266 rises. You can't have a partial step, so I divided the total rise by the nearest whole number, in this case 13. The result is 7.653, or very close to $7\frac{11}{16}$ in. for each individual rise.

Now that I know how many steps I'll have, I can figure out the depth, or run, of each tread. The header that will support the staircase at the top of the stairs will act as the first riser, so the stringers actually end up with 12 risers and 12 treads. (In every stair, you'll have one less tread than the number of risers.) For maximum headroom I'd like the bottom step to land directly below the other end of the framed opening, which is 108 in. long. So I divide 108 in. by 12, the number of treads, and end up with a tread depth of 9 in. As mentioned previously, code requirements for stairs may vary, as well as the formulas for calculating safe and comfortable stairs (sidebar, p. 55). My local building officials tell me that the rise plus the run of a stairway should be 17 in. to 18 in. At $16\frac{11}{16}$ in., this staircase is a bit steeper than I'd like. Again, I'm restricted by the existing framing, but I'd rather have a slightly steep stair than compromise the headroom clearance. For this project, the inspector agreed with me.

Stair gauges help with the stringer layout— A stringer, or carriage, is the diagonal framing member that holds the treads (and the risers, if they're used). I like to use straight, kiln-dried Douglas fir 2x12s for stringers whenever possible. I start by setting a 2x12 on sawhorses with the crown, if any, facing toward me. A framing square is the best tool for laying out the sawtooth pattern of treads and risers on the stringer. But I also use stair gauges, which screw onto the framing square and increase the speed and accuracy of the layout (photo top right, p. 55). Available at most hardware stores, these little beauties are small hexagonal blocks of aluminum or brass with a slot cut in them so that they slip over a framing square. Thumb screws or knurled nuts hold them in place on the square. I put one gauge at the rise number on the short side of the square (the tongue) and the other at the run on the long side of the square (the blade). The gauges register against the edge of the 2x12 and keep the square orientation on the stringer consistent for every step.

The thickness of a tread is subtracted from the bottom of the stringer— As I move down the stringer and lay out the steps, I line up the edge of my rise with the run line from the step above. I repeat the process all the way down the stringer until I have the right number of rises, in this case 12.

After I've drawn the last rise on the bottom of the stringer, I square it back using my framing square (photo bottom left, p. 55). If the stringers were cut and installed and the treads put on at this point, the bottom step would be higher than the rest of the steps by the thickness of the tread. I solve this problem by subtracting that thickness from the bottom of the stringer, which lowers the stringer assembly. That way, when the stair treads are installed, all of the rises will be the same.

As a word of caution, the overall rise of the stair should be calculated from the finished floor above to the finished floor below. If you didn't compensate in your original measurement, adding finished flooring after stairs are built will result in a top or a bottom step different from the rest, which creates a dangerous stair.

Because my treads will be made out of 2x10s, I measure up $1\frac{1}{2}$ in. from the bottom of the stringer. I always label my lines to avoid confusion when cutting (photo bottom right, p. 55).

Overcutting can weaken the stringer— After laying out the stringer, it's time for me to cut the rises and the runs. I make my initial cuts with a circular saw, making careful, steady cuts for all of the rise and run lines along the length of the stringer (photo top left). I take care not to overcut the lines, which would substantially weaken the stringer. Instead, I finish my rise and run cuts with a jigsaw (photo top right).

After the stringer is cut, I set it in place temporarily to make sure that it fits and that it's level. I figure out exactly where the stringer will rest against the header of the stair opening by measuring down from the floor the distance of the

Both stringers are tested together. Before the stringers can be installed, both are set up and leveled individually. A 4-ft. level then tests them in relation to one another.

Strongbacks stiffen the stringers. Strongbacks, or 2x4 stiffeners, are nailed to the sides of the stringers to keep them from flexing.

Treads are attached with screws. Screwing the treads to the stringers is the best way to keep the staircase from squeaking. Predrilling the holes prevents the screws from snapping while they're being driven.

rise plus the thickness of the tread ($7^{11}/_{16} + 1\frac{1}{2} = 9^{3}/_{16}$ in.). I make a level line across the header at this measurement and tack my stringer in place so that the top of the stringer is even with this line. For this stairway I had to extend the header down with a 2x4 and plywood to give me more to attach the stringer to.

Next I test several of the steps with a torpedo level. Once I'm satisfied with the stringer, I take it down and use it as a template to lay out and cut the second stringer (bottom photo, facing page). I make sure that the sawtooth points on the template stringer point in the same direction as the crown of the second 2x12.

The second stringer is cut the same as the first, and then both stringers are tacked in place and checked for level. This time I check the runs on the individual stringers for level and also use my 4-ft. level to make sure they are level with each other (photo top left). If a staircase with 1½-in. thick treads is over 36 in. wide, it's necessary to use three stringers. Again, it's best to check with your local building official if you have any doubts or questions.

Strongbacks take the flex out of the stringers—Before I install the stringers permanently, I add Strongbacks to each one (photo bottom left). Strongbacks are 2x4s nailed at right angles to the stringer and run their entire length. I nail the Strongbacks through the stringers with 16d nails every 8 in. Putting them on the outside of the stringers lets the stringers be closer together, which reduces the span of the treads and makes the stairs feel more stiff. Strongbacks stiffen the stringer by limiting lateral flex.

After the Strongbacks are nailed on, I install the stringers for good. I nail them securely at the top through the plywood header extension from behind and into a 2x4 spacer block between the stringers. At the bottom a length of pressure-treated 2x nailed to the concrete with powder-actuated fasteners serves as a nailer as well as a spacer between the bottom ends of the stringers. Some builders like to notch the bottom of the stringers around the nailer. But with the bottom step already cut 1½ in. narrower for the thickness of the tread, notching out for the nailer leaves a thin and precarious section of diagonal grain that is more likely to split when the treads are attached or to break off if I trip over the stringer before the treads are installed.

The final step is putting on the treads. I cut the treads for this stairway out of 2x10s and attach them to the stringers with 3-in. screws (photo right). Screws are the best way to keep the treads from squeaking, and if there is ever a problem, they can be removed quickly without damaging either the tread or the stringer. I predrill my holes, especially if I'm using bugle-headed construction screws, which can snap as they're going in.

One important item that I'm obviously leaving out is the railing system. Not only are railings an essential part of stair safety, they are also the law. This stairway will be enclosed with a wall on the open side, and handrails will be hung on each wall to make the stairway complete. Stair railings are a topic for another article. □

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