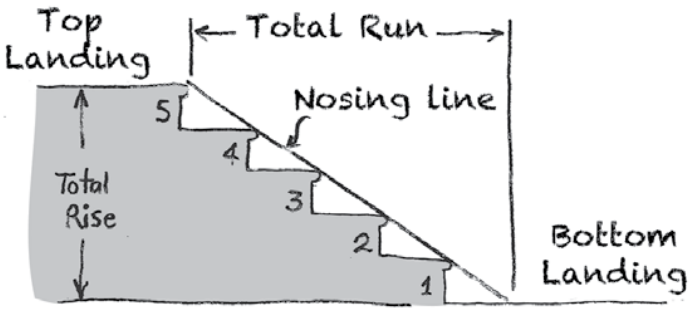
Shop Talk

Stair railings
Step-by-step

In this article, you'll learn how to layout a handrail using simple tools and techniques to get accurate measurements. You'll see how to properly space pickets with no arithmetic or electronic device.

By John Barron
Photography by Mark Kochan



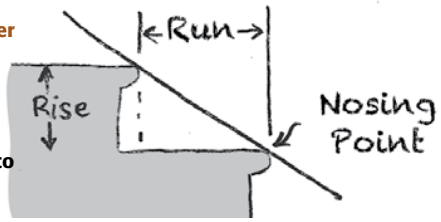


Figure 1 shows four treads with their corresponding riser below numbered 1–4. Number 5 represents the riser from the uppermost tread to the top landing.

Editor's note: This article is adapted from ABANA's Hammer's Blow *magazine, www.abana.org. Thank you Mark Aspery. Also, author John Barron has presented stair railing workshops for the California Blacksmith Association. He will next demonstrate his techniques at the CBA Spring conference, April 4–6, 2013 at Placerville, CA.*

Writer's note: My thanks to Peter Clark for making the mock set of stairs and to Mark Kochan for the photography. The stairs were specially constructed to be straight on one side and curved on the other, allowing both straight and curved stair-rail layout to be demonstrated at California Blacksmith Association workshops.

To the uninitiated, the design and construction of stairways and their railings can be intimidating.

Stairways require a handrail and often a guardrail. The handrail is placed at a specific height above the stairs and landings to provide a fixture to hold onto while going up and down the stairway.

If a high enough wall exists at the edge of the stairs, a handrail will simply be a bar of suitable size that runs the length of the stairs, parallel to the "nosing line," and levels off at the landing above and below.

The nosing line is a line that attempts to connect all the projecting edges, or noses of a set of stair treads. A guardrail is required if the edge of the stairway has an open drop-off to prevent someone falling over the edge. The guardrail needs to be a certain height above the nosing line and landings.

The Universal Building Code (UBC) currently in use in Northern California where I live specifies that the handrail be located 34–38 inches above the nosing line and landings, and that the guardrail be at least 36 inches above them. Design or site conditions influence the specific height, or the customer may have a preference. Earlier in my career, I preferred the feel of a lower rail, but now a higher one seems more comfortable.

If the top of the guardrail is of suitable size material (between 1¼–2 inches wide in cross-section), it can double as the handrail as long as it is at least 36 inches high and no more than 38 inches high (consult your local building department for their requirements).

To understand the construction of stair railings we must first understand the stairway, defined as having two or more risers that cause a change in elevation. A stairway of four steps or treads actually has five risers. Figure 1 shows four treads with their corresponding riser below numbered 1–4. Number 5 represents the riser from the uppermost tread to the top landing.

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The current UBC specifies a minimum rise of 4 inches with a maximum rise of 7 inches and a minimum run of 11 inches. Whatever the actual rise and run is, there can be no more than ⅜-inch difference between the largest and smallest of each.

For example: If the four treads in our example have a rise of 6¾ inches each and the rise to the landing is 6¼ inches, the stairway does not conform to the UBC (check with your local building department).

Someone walking up these stairs will often notice the difference as they step up onto the top landing. The sensation is similar to unexpectedly stepping off a curb.

Likewise, if the first tread's run is 11 inches, all other runs must be at least 11 inches (11 inches being the minimum allowed) but no more than 11⅜ inches. On any stairway, your feet adapt to the pattern of rise and run quickly, but even subtle differences can cause a misstep.

In a properly built stairway, the distance from nosing point to nosing point measured along the nosing line will be the same. Each of these nosing points will be part of a straight line. But that is rarely the case when we show up to measure a railing for it on site (figure 2).

Ideally, we build railings in our shop with all our tools at hand, having no worries of gashing a site's walls, cracking stonework, burning up floors, or having a nervous homeowner looking over our shoulder (at least until the installation). However, a precise replica of the stairway is nice to have to eliminate questions about proper fit.

I use a simple, low-tech method to measure stairways that I learned 30 years ago working in a union steel fabrication shop in Oakland, CA. I continue to use this "tried-and-true" method with great success, regardless of the "correctness" or complexity of the stairway.

Often I measure simple railings without a tape measure or ruler, or even without recording any numbers. A few simple tools and techniques can actually create a mold of the stairs with confidence that upon our return to the shop, we can reproduce a duplicate of those stairs.

Figure 2

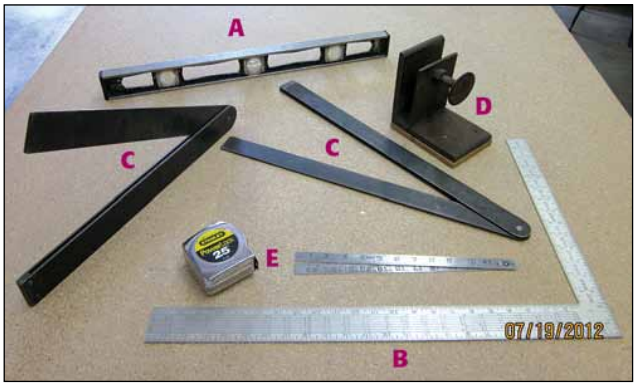

Figure 3A–3E

Figure 4

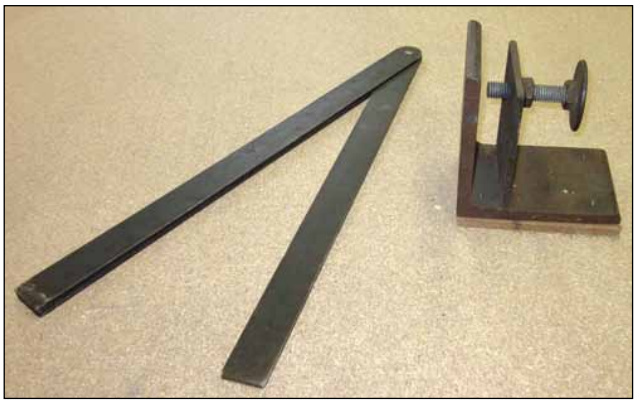

Figure 5

Tools required

■ **Level** of at least 24 inches (figure 3A). This tool accurately helps you to draw plumb lines and check all existing walls, posts, and columns for plumb, and to level floors and landings. Plumb, level, and square will be the same in your shop and anywhere you go, but you must verify on site that they are what they appear to be. Take nothing for granted.

■ **Framing square** (figure 3B). Get a large carpenter's type, 24 x 16 inches to accurately to check angles and corners that appear to be square. Again, take nothing for granted.

■ **Large bevel square** (figure 3C). This is similar in size to the framing square and used to accurately record all the above angles and corners you thought were square and others as necessary. I have several of these that I have made and use regularly.

■ **Measuring board holder** (figure 3D). This is used to hold the measuring boards on edge on the stairway securely to draw lines onto them (figure 4, 5)

■ **Tape measure, rule** (figure 3E). to take measurements on site.

■ **Measuring boards** accurately record plumb lines and tread top locations and angles. I use ⅜-inch particleboard, ripped to 12-inches x 8-foot strips. It needs to be thin, but stiff enough to stay straight when stood on edge. You can increase the 12 inches, but I would not recommend using less than that. Pencil lines on the particleboard can be erased, sanded off, or painted over thereby allowing them to be used repeatedly.

■ **Pencil and paper** to record measurements and notations. I always do a simple sketch to give an overview of

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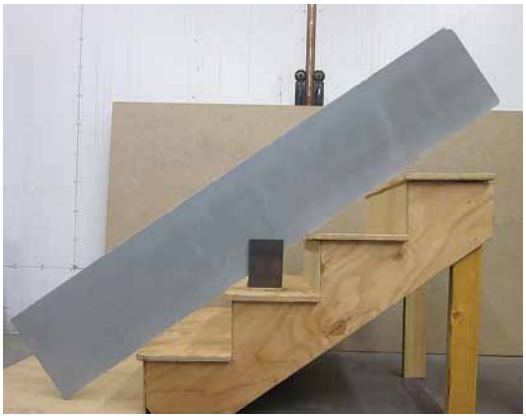

Figure 6

Figure 7

the entire stairway, which will include any measurements not on the same plane as the boards.

■ **Camera.** Although high tech for me, it can be a useful tool.

The most critical part of our "mold" is the nosing line and how it relates to plumb. The top of the handrail (and/or guardrail) must be parallel to the nosing line and placed the proper distance above it. The proper distance is a minimum of 36 inches for guardrail and a minimum of 34 inches to a maximum of 38 inches for handrail, and needs to be consistent at all points along the nosing line.

All vertical elements will be parallel to these plumb lines. In general, all lines of the railing, whether "actual" or "visual," will parallel the nosing line or plumb line. Horizontal is simply square to plumb. Actual lines are elements such as pickets or balusters. Visual lines are elements such as repeating scroll patterns, which are all spaced the same distance below the top rail. In this way, each element of those patterns is "visually" parallel to the nosing line and top rail.

How to measure

To begin measuring the stairway, lay the measuring board on edge along the nosing line as close as convenient to where the railing will be installed and clamp it in place with the board holder (figure 6).

The board probably will not touch each nosing point. Don't worry; posi-

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tion it where it touches the most. If the stair will have a rail on both sides, measure one side then move your board to the other side to check for any differences.

Make sure the bottom corner rests on the bottom landing and that the top corner of the board extends beyond the top landing.

Clamp or screw boards together for longer runs or cut or break them for short stairs. Be sure to mark the boards with an indexing system to assure an accurate realignment later.

Figure 8

Stand your level up against the nosing of each tread and draw a plumb line to the nosing point (figure 7).

Then use the level as a straight edge on top of each tread and the top landing. Draw a line along the bottom of the straight edge.

Do not look at the bubble! Do not adjust to make it truly horizontal. By keeping the level flat to the tread's surface you can recreate that tread later (figure 8).

Never assume that landings or stair treads are level, especially with exteriors, which will often be intentionally sloped to allow water to run off to prevent slipping hazards.

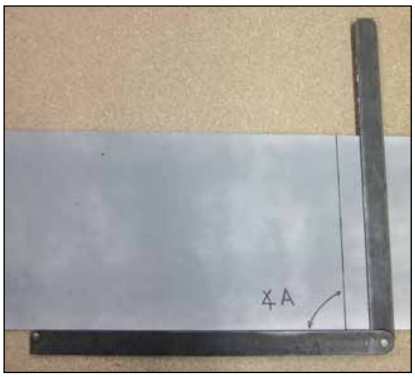

Figure 9, ***above***, and Figure 10, ***left***

The lines drawn using the straight edge will duplicate those variations on the treads and top landing.

For the bottom landing, adjust the large bevel square to lie on the bottom landing and along the bottom nose plumb line. Draw that angle onto another measuring board and label it. I measure and record all angles this way. It is safer for me than using a protractor (figures 9, 10).

If the rail will be attached to an adjacent wall and you have your board set close to that wall, locate any necessary backing, attachment points, or obstructions and mark them directly on your board using plumb lines. Measure up along those lines to locate their tops and bottom.

If there is anything along the outside of the stairway that could affect the installation or influence the design of the rail, mark its location on your board. I don't move the boards until I

Figure 11

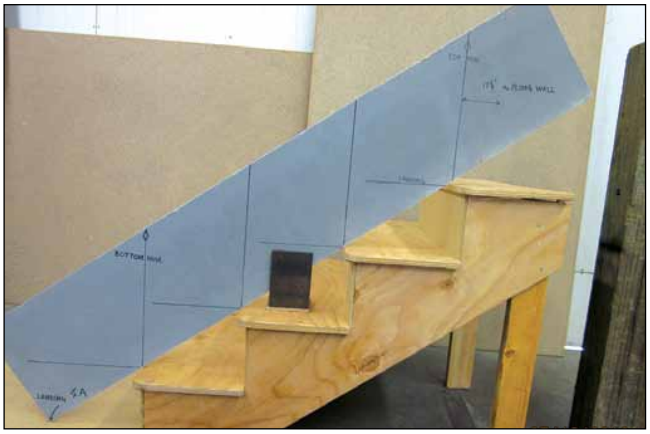

Figure 12

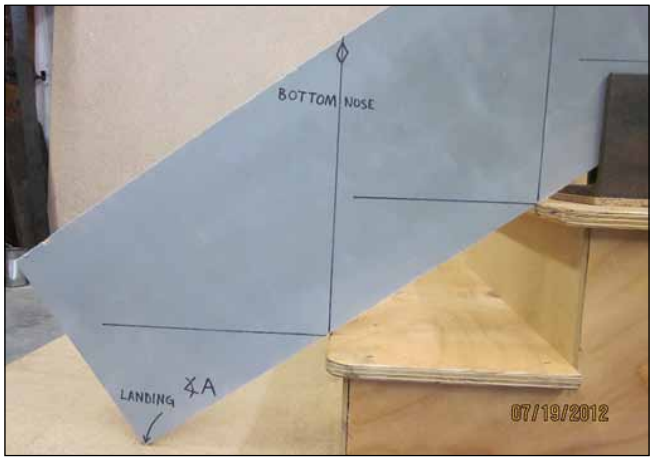

Figure 13

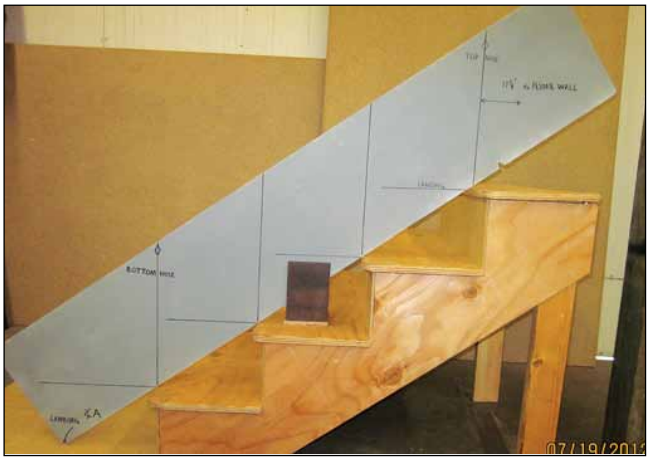

Figure 14

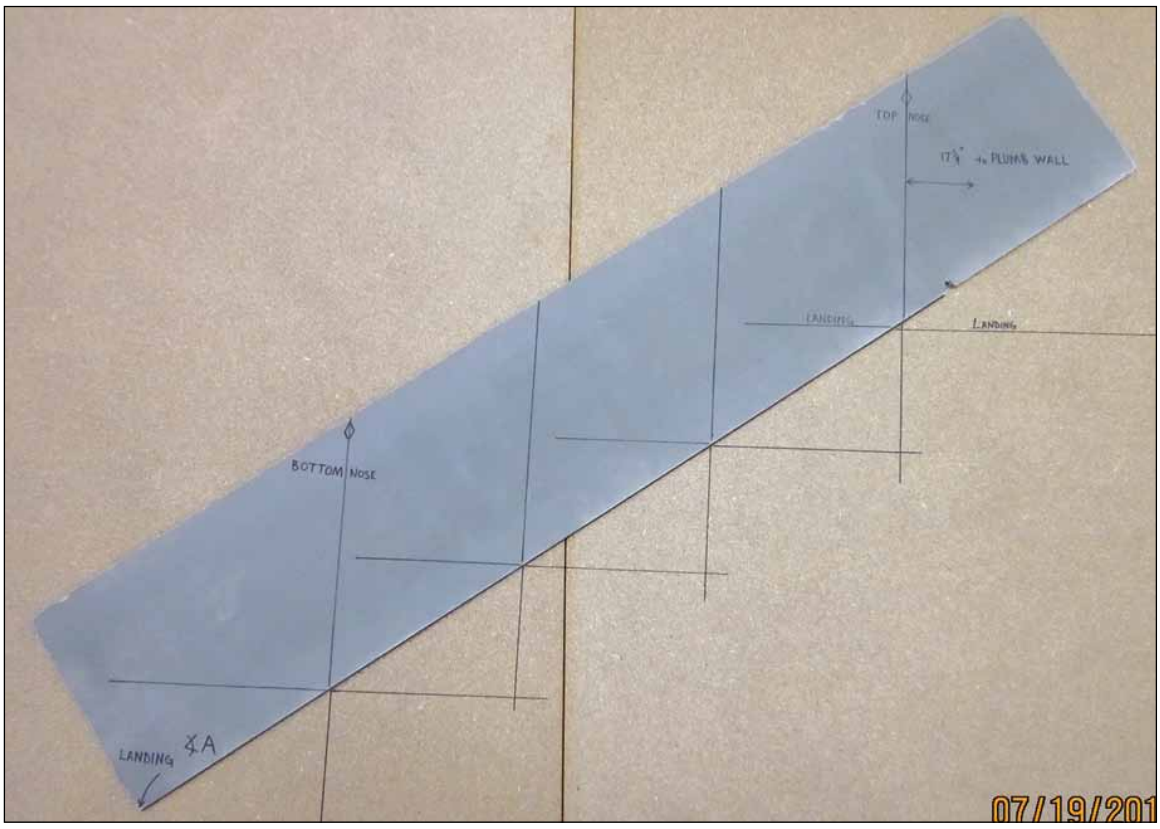

Figure 15

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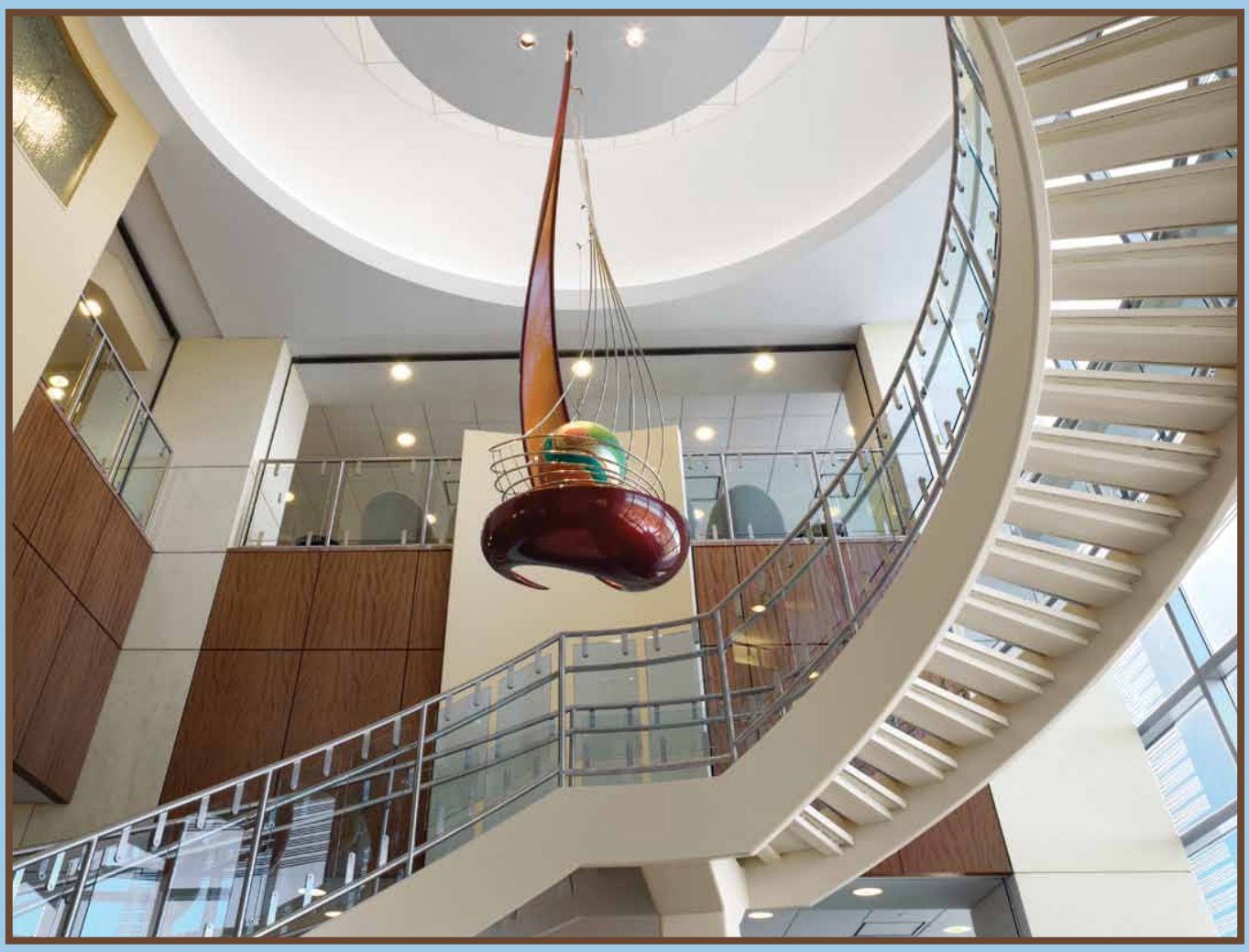

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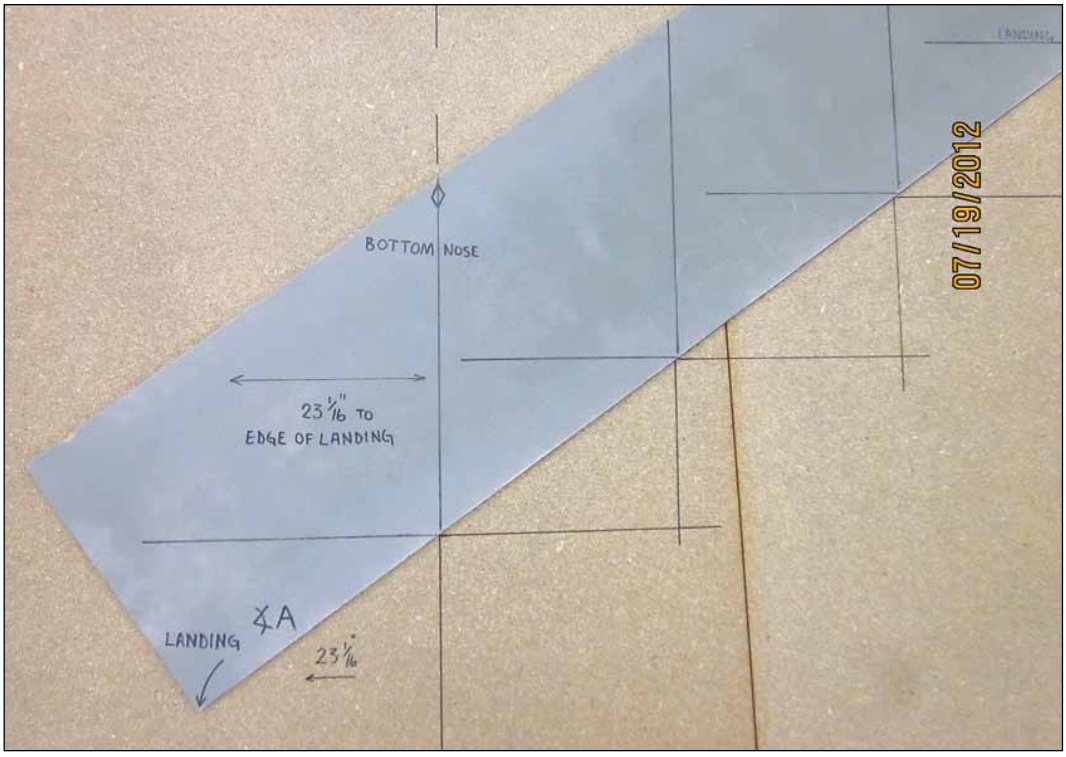
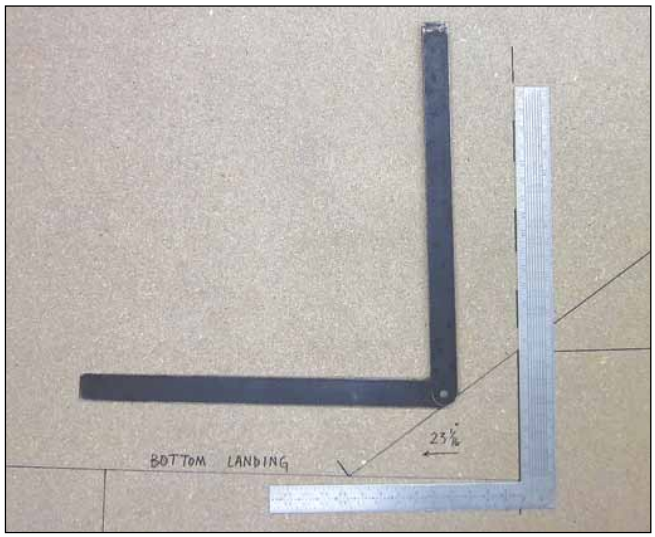
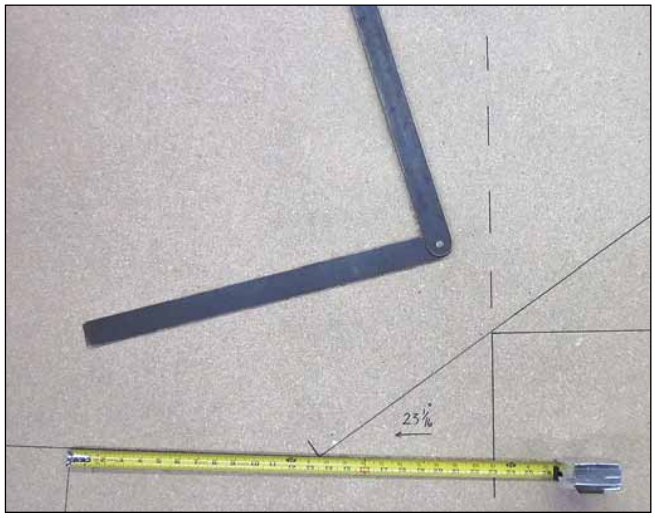
have completed all other measurements, such as lengths of landings or the locations of corners. Mark as much as possible directly onto the board.

I will often use colored pencils to help avoid confusion later. Green lines may represent backing and red lines obstructions. Make all measurements from a plumb line and write that dimension on the board (figures 11–14, page 22).

I also make a simple sketch that is an overview of the entire stair and labeled to match notations on the boards. On this sketch, I record any dimensions that are not on the same plane as the boards. Special attention is given to any anticipated attachment points and required fasteners. Take photographs from various angles, especially of any unusual conditions. These can be invaluable aids to the memory.







Figures 16–18

Doing the layout

To begin your layout, lay your measuring board on the layout table or shop floor. Leave enough room above it to draw the entire rail, not just the steps.

Draw the nosing line along the bottom of your board. Then transfer all the plumb lines and tread tops onto the layout surface with a straight edge. My lines were necessarily thick for the purposes of this article — I'm going from the top of the line (figures 15–16).

Transferring these lines from your measuring board will give you the exact duplicate of the stairway. Use the straight edge to extend the top and bottom nose plumb lines to at least the height of the railing. Use these to measure up to the top of the new rail, as well as any mid- or lower rails. Transfer any remaining lines.

Next, remove the board. Reset the bevel square for the bottom landing (from your board of saved angles) and align it to where the bottom corner of the board rested on the landing and along the bottom nose plumb line and draw in the bottom landing (figures 17–18).

Both landing lines can be extended as necessary and will retain their actual slope. Mark off any remaining dimensions, such as length of landings, locations of corners, or obstacles.

Measure up along the top and bottom plumb lines to locate the rail top. Locate the landing rail heights and draw

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them in. They may simply be drawn square to the plumb lines or may need to parallel the slope of the landing.

If the rail needs to be set parallel to the slope of the landing, set a bevel square to the angle that is made from that of the nosing line and landing line. Then move it to the stair-rail top and the desired landing-rail height.

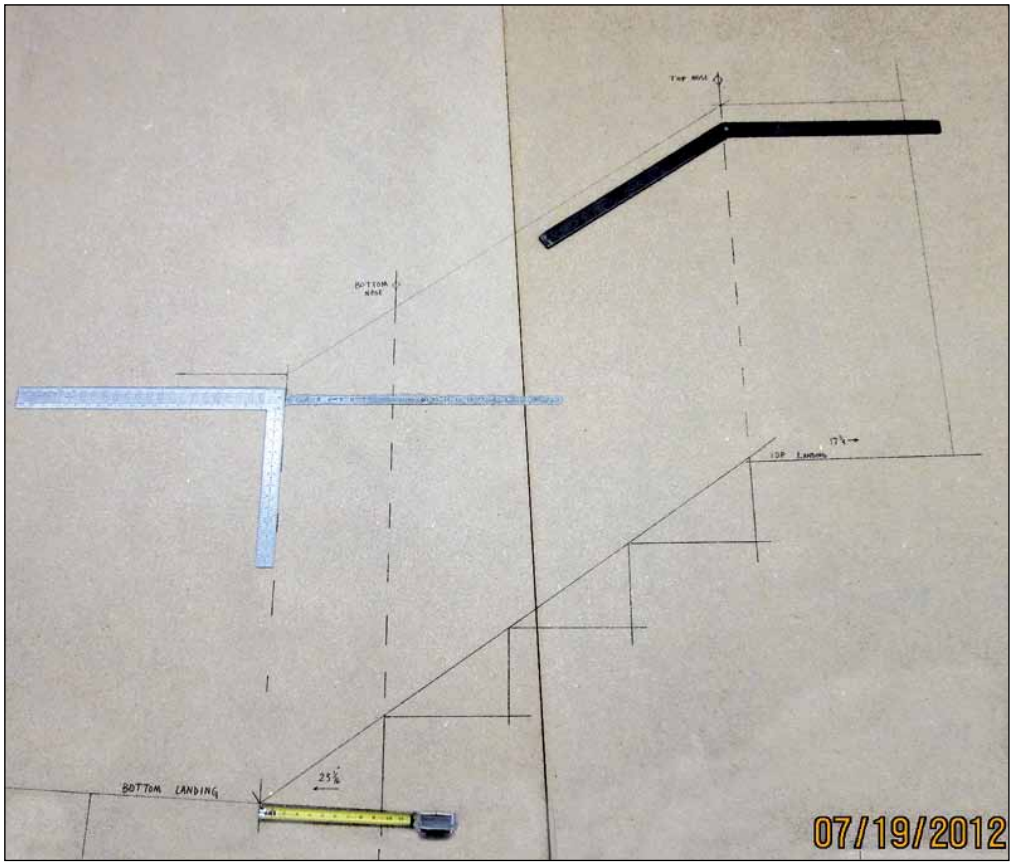
This line will parallel the landing. Do the same for any mid- or lower horizontal rails. I keep a bevel square set to the angle of the nosing line and a plumb line to be used for drawing additional plumb lines necessary (figure 19).

Determine where you want or need any posts or attachment points and continue carrying out your design. In this case, I have shown a newel post 23 1/16 inches out from the first riser. I have also allowed 4 inches for a lead into the top-cap rail — in this case a simple scroll (figure 20).

Point "C" in figure 20 is found by projecting the bottom-landing rail (which I have set for a gap of 3/8 inches from the bottom landing) to where it intersects with the bottom stair-rail (which I have set for a 1-inch gap measured perpendicular to the nosing line). This point may not fall directly under the point where the top rail "levels off." The top rail will level off or run parallel to the landing directly above the point where the nosing line touches the bottom landing.

The triangular gap created by the bottom rail and the rise and run of the stairs will be filled according to your local building inspector's satisfaction.

The top rail at the upper landing will level off (or parallel the landing) at the point where it intersects the top nose line, if the stair rail height is the same as the landing rail height. If, for example the stair rail height is 36 inches and the landing rail height is 42 inches, the top rail will need to bend vertically at the top nose line until It intersects the landing rail and levels off.



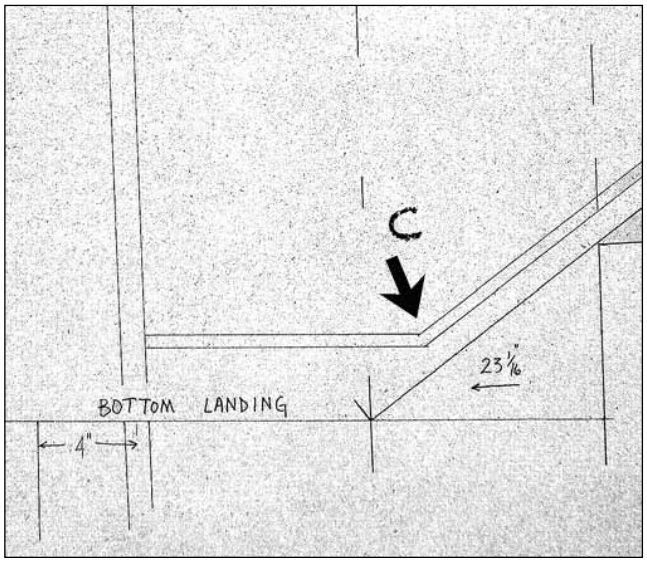


Figure 19, *above*, Figure 20, *left*

Picket spacing

Proper picket spacing can be quickly and accurately determined with the simple use of dividers. (A mathematical approach to picket spacing is shown in the last issue of *Hammer's Blow* (Vol. 20, #3). A little math can save a lot of trial and error with the dividers.

Think of the sides of the top and bottom newel posts as pickets already in place. You want to space all the other pickets equally between these two posts. Note: Since the location of the midrail in this example is determined by the centerline of a tread, I will have to repeat this process for each section of railing between the two posts and the post and wall because they are not equal lengths.

At both ends of your top and bottom newel posts, mark half the thickness of your pickets away from the inside edges of the opening. It doesn't matter how thick your newel posts actually are in reality, for now, treat them as another ½-inch thick picket.

I am proposing to use ½-inch square pickets, so my mark will be

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¼ inch in from the inside edge of the newel post.

Measuring between these two new lines will give you the distance, center to center, of those two "pickets."

Figure 21

Three methods

1 If the top and bottom rails are horizontal, divide the picket gap measurement by four (round up to the nearest whole number). This will be the minimum number of pickets required.

You can adjust his number for even or odd number of pickets by adding one more picket to the total.

Then use this number to divide into that original length plus the picket thickness to get center-to-center distance of pickets. You may end up with a number similar to 3.62 inches, which for me can be a bit unwieldy to be accurately transferred along the entire length of both the top and bottom rails.

2 The method I prefer is to set the dividers to 4 inches plus the thickness of one, whole picket — in this case ½-inch-thick pickets.

Beginning at the inside line of one or other of the newel posts, walk the dividers along the bottom bar until you reach the other inside line.

You need to end up exactly at the center mark of the inside line.

Your first try will tell you how much you need to shorten your dividers. You cannot open them wider because you are already at the maximum allowable space under the UBC.

Keep in mind that the total distance you need to shorten the gap of the dividers is divided by the number of spaces.

Shorten up the dividers and try again, repeating this process until you

can start and finish on the two center marks of the newel posts.

Now mark the centers of your pickets. Move to your top bar and repeat. If the sides are supposed to be parallel, this will confirm your layout. If you know one side is out of plumb, be sure you start your picket spacing from the plumb side (figure 21)!

3 If your top and bottom bars are not horizontal (as in this case), after marking the centers at the outsides of your opening, lay a framing square along one vertical edge above your bottom bar so that it's horizontal leg intersects the bottom bar at the 4-inch mark on the square.

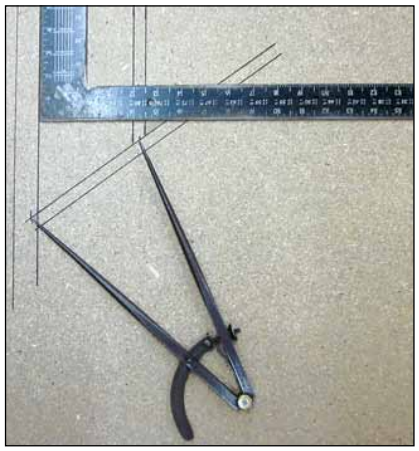

Figure 22

Move over half the picket thickness and make a mark on the bottom bar. Set your dividers along the bottom bar to these center marks and proceed as above (figure 22).

Measured along the pitch, your dividers will be set considerably wider than measured horizontally. If your top and bottom level off before reaching the other end, you need to extend their lines along the pitch until they reach the other ends and do all your spacing along those lines.

Landing rails (commercial and residential) need to be 42 inches now — while rails on the stairs can stay at 36–38 inches. This is not required in all places— but most states and localities have brought this into code (figure 23).

With this method of field measuring and layout, even the novice architectural metalworker can design and build stair rails with the confidence of an accurate fit-up with minimal on-site complications — and sleep like a baby the night before the installation.

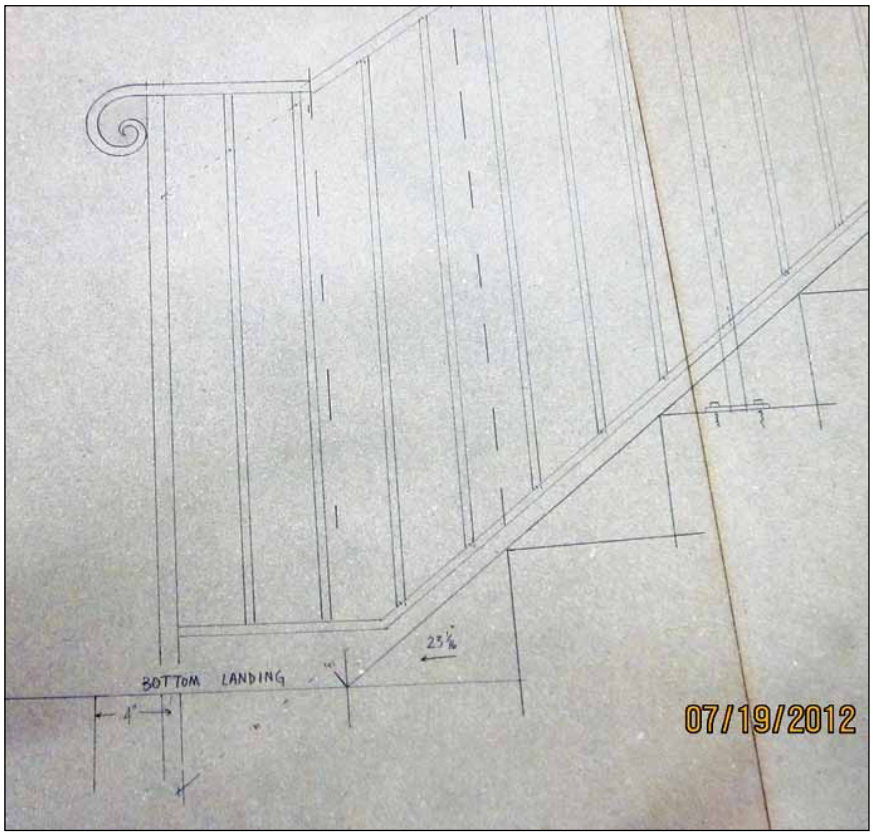

Figure 23

For your information

About the author

John Barron began work with metals in the mid-1970s when he was hired into a Union Iron Fabrication shop in Oakland, CA, without any previous experience. He mentored with two outstanding craftsmen to learn the trade.

In 1989, he moved to Northern California and joined the California Blacksmith Association where he learned that ornamental ironwork was much more than forging scrolls.

By 1991, Barron had his own blacksmith/fabrication business and eventually built a one-man shop in Georgetown, CA, specializing in architectural ironwork.

His work is found throughout the Sierras, from Truckee to San Francisco, including private and public art commissions

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About the photographer

Mark Paul Kochan, a commercial illustrator who is handy with a camera, writes for the California Blacksmith Association (CBA) and is a regular contributor to The Artist Blacksmith Association of North America. He also is a CBA instructor and teaches blacksmithing for the State of California, at the State Park at Sutters Mill.

Kochan began his blacksmithing career about five years ago when he was an apprentice at the Marshall Gold Discovery State Historic Park at Sutter's Mill. As a volunteer docent and interpreter in the blacksmith shop, he learned the basics of 1850–1900 period blacksmithing. Kochan also trained with The CBA over several years and developed friendships with experienced smiths such as John Barron, John McLellen, and Mark Aspery.

His turning point in ironwork came with a chance meeting with artist, iron worker Albert Paley in 2003 at a gallery in which the artist was exhibiting.

Kochan earned a degree at Casa Loma Institute as a UCLA student in the late 1970s doing high-end casting and finishing in the crown and bridge department.

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