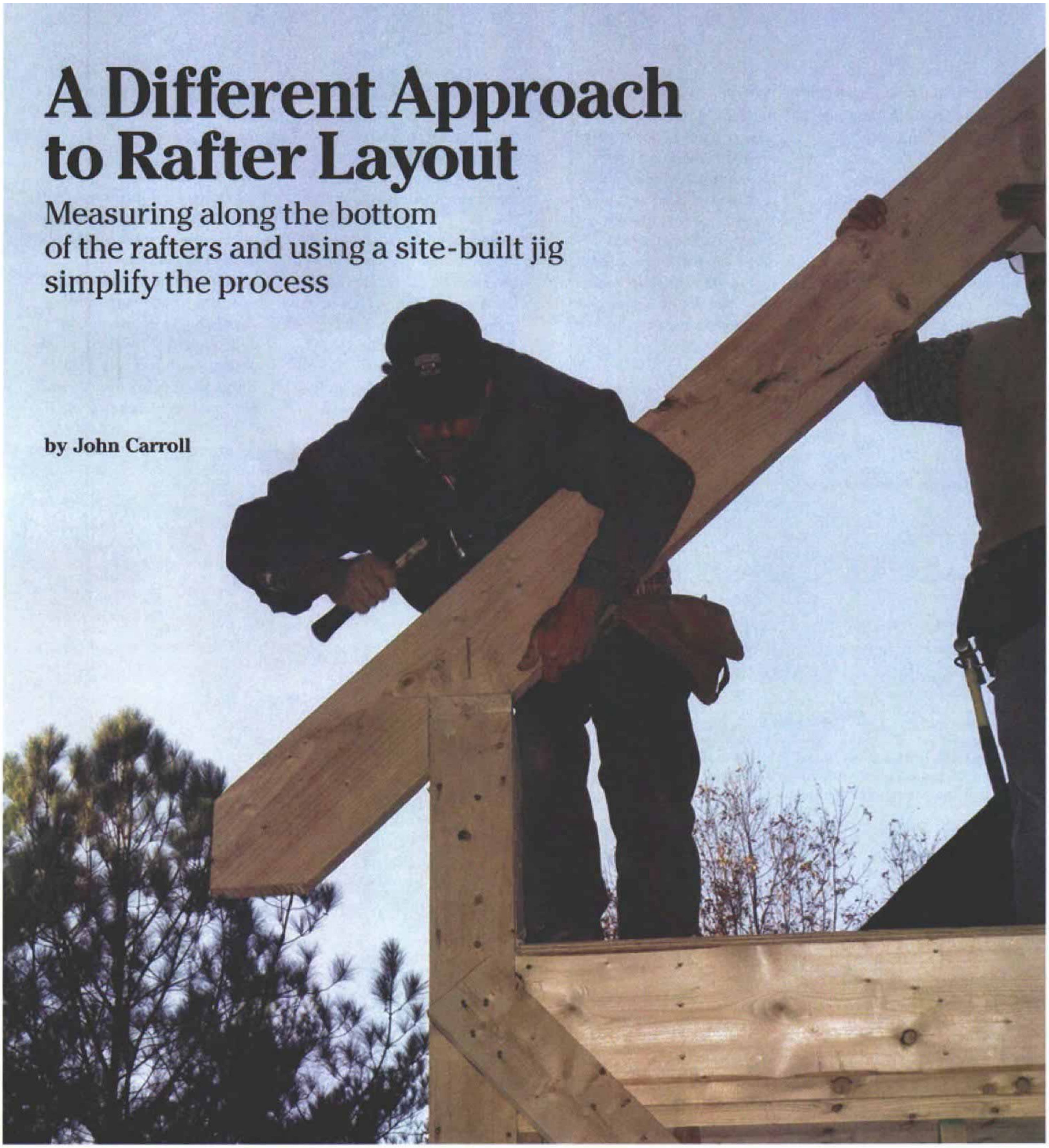
A Different Approach to Rafter Layout

Measuring along the bottom of the rafters and using a site-built jig simplify the process

by John Carroll



Earlier this year, I helped my friend Steve build a 12-ft. by 16-ft. addition to his house. A few days before we got to the roof frame, I arrived at his place with a rafter jig that I'd made on a previous job. I'm a real believer in the efficiency of this jig, so I told Steve that it would enable me to lay out the rafters for his addition in 10 minutes.

His look suggested that I had already fallen off one too many roofs. "Come on, John," he said. "Ten minutes?" I bet him a six pack of imported beer, winner's choice, that I could do it.

Like most builders, I have a long and painful history of underestimating the time different jobs require. In this case, however, I was so certain that I agreed to all Steve's conditions. In the allotted time, I would measure the span of the addition; calculate the exact height that the ridge should be set; measure and mark the plumb cut and the bird's mouth on the first rafter; and lay out the tail of the rafter to shape the eaves.

When the moment of reckoning arrived, we set a watch, and I went to work. Eight minutes later, I was done and in the process secured the easiest six bottles of Bass Ale in my life. With this layout in hand, we framed the roof in 5½ hours.

Why should it take an hour to do a ten-minute job?—That evening, as we enjoyed my beer, Steve's wife asked him how long he would have taken to do the same layout. "An hour," he said, "at least." Steve is a seasoned carpenter who now earns a living as a designer and construction manager. So why does a ten-minute job require 60, or possibly 90, minutes of his time? The answer is that Steve, like many builders, is confused by the process.

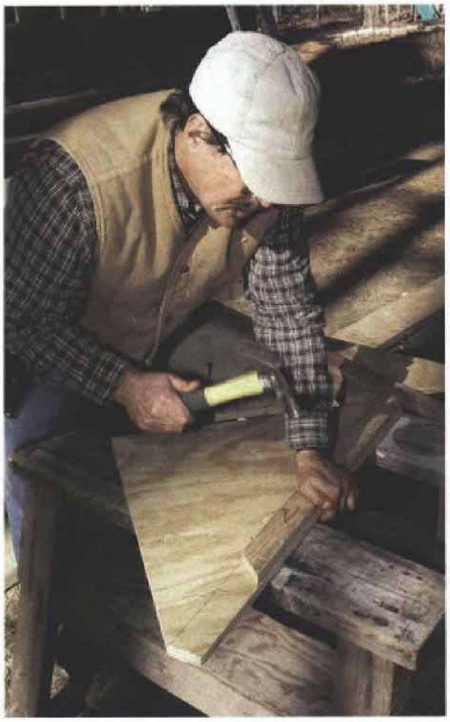
The first framing crew I worked with simply scaled the elevation of the ridge from the blueprint and then installed the ridge at that height. Once the ridge was set, they held the rafter board so that it ran past both the ridge and the top plate of the wall, then scribed the top and bottom cuts. Then they used this first rafter as a pattern for the rest. This technique worked. And because it's so simple and graphic, I'm convinced that it still is a widespread practice.

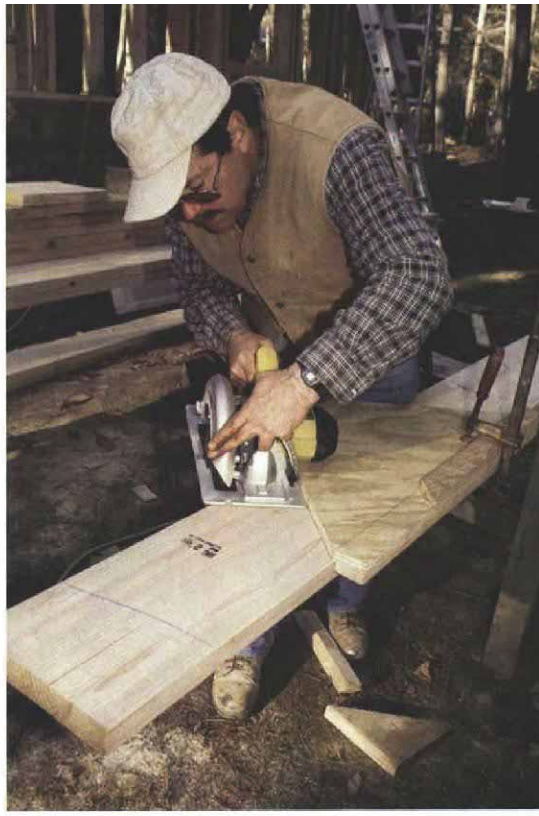
There are several reasons why I retired this method decades ago. To begin with, I haven't always had a drawing with an elevation of the roof system, which means that I couldn't always scale the height of the ridge. Second, it's just about impossible to scale the ridge with any degree of precision. Because of this fact, these roofs usually end up merely close to the desired pitch. Third, this method typically leaves the layout and cutting of the rafter tail for later, after the rafters are installed.

My technique is also different from the traditional approach espoused in most carpentry textbooks, which I've always found to be obscure and confusing. In rafter-length manuals and in booklets that come with rafter squares, dimensions are generally given in feet, inches and fractions of inches. I use inches only and convert to decimals for my calculations. To convert a fraction to a decimal, divide the numerator (the top number) by the denominator (the bottom number). To convert a decimal to sixteenths, multiply the decimal by 16 and round to the nearest whole number.

Another difference in my approach is the measuring line I use. As the drawing at right shows, the measuring line I employ runs along the bottom edge of the rafter. In contrast, most rafter-length manuals use a theoretical measuring line that runs from the top outside corner of the bearing wall to a point above the center of the ridge. A final thing that I do differently is use a site-built jig instead of a square to lay out the cuts on the rafter (top photos).

There are lots of ways to lay out rafters, and if you already have a method that works well, your way might be faster than mine. But if you've al-





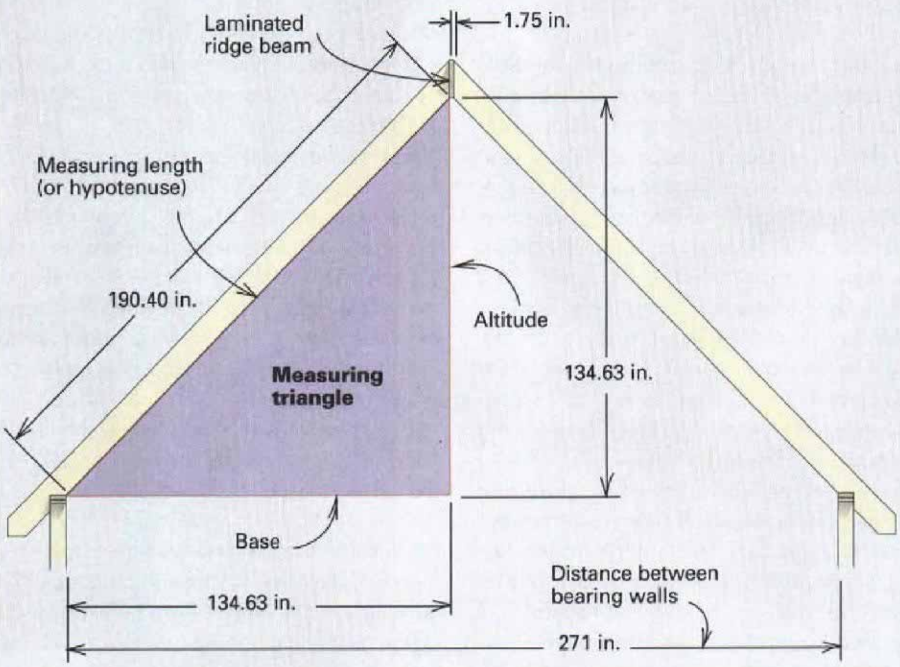
Rafter jig doubles as a cutting guide. Scaled to the 12-in-12 roof pitch, and with a 1x3 fence nailed to both sides of one edge, this plywood jig is used to lay out plumb and level cuts on the rafters. Notice that the fence is cut short to make room for the circular saw to pass by when the jig is used as a cutting guide. The jig will be used later to lay out plywood for the gable-end sheathing.

Use the measuring triangle to find the rafter length.

***1.** Find the base of the measuring triangle (the run of the roof).* Measure between bearing walls and subtract width of ridge, then divide by 2. (271-1.75 = 269.25; 269.25÷2 = 134.63).

***2.** Find the altitude of the measuring triangle (ridge height).* Divide the base of the measuring triangle by 12 and multiply the result by the rise of the roof pitch. For a 12-in-12 pitch, the base and the altitude are the same. (134.63 in.÷12 = 11.22; 11.22x12 = 134.63). (Editor's note: To present a set of consistent figures, we rounded to 134.63.)

***3.** Find the hypotenuse (rafter length).* Divide the base of the triangle by 12 and multiply the result by the hypotenuse of the roof pitch, which is listed as length of common rafter on the rafter square (photo p. 94). (134.63 in.÷12 = 11.22; 11.22x16.97 = 190.40).



Setting the ridge. Temporary posts are set up to hold the ridge at the right height. The posts are braced 2x4s with a 2x4 scrap nailed to the top that rises 10 in. above the top of the post. The ridge is set on top of the post and nailed to the scrap of wood.

ways been vexed by roof framing, I think you'll find my way easier to understand than most.

Run and roof pitch determine the measuring triangle—Framing a roof can be a little intimidating. Not only are you leaving behind the simple and familiar rectangle of the building, but you're starting a job where there is a disconcerting lack of tangible surfaces to measure from and mark on. Most of this job is done in midair. So where do you start?

There are only two things you need to lay out a gable roof. One is a choice of pitch, and the other is a measurement. Usually the choice of pitch was made before the foundation was poured. The measurement is the distance between the bearing walls (drawing p. 93).

After taking this measurement, deducting the thickness of the ridge and dividing the remainder in half, you have the key dimension for laying out the rafters. This dimension could be called the "run" of the rafter; but because it is slightly different from what is called the run in traditional rafter layout, I'll use a different term. I'll call it the base of the *measuring triangle*. The measuring triangle is a concept that I use to calculate both the correct height of the ridge and the proper distance between the top and bottom cuts of the rafter, which I call the *measuring length*.

Working with this measuring triangle takes a little getting used to. The biggest problem is that when you start the roof layout, only one-third of the measuring triangle exists. As we've just seen, you find the base of the measuring triangle by measuring existing conditions. Then you create the altitude and the hypotenuse (same as the measuring length) by using that base and some simple arithmetic.

To see how this works, let's look at the steps I followed to frame the roof of a 12-ft. by 24-ft. addition I recently finished.

Build the rafter jig first—While the rest of the crew finished nailing down the second-floor decking, I began fabricating a rafter jig based on the pitch of the roof (photo left, p. 93). The desired pitch was 12-in-12 (the roof rises 12 in. vertically for every 12 in. of run horizontally). The basic design of this jig was simple, and the cost was reasonable: three scraps of wood and ten minutes of time.

The first step in making this jig was finding a scrap of plywood about 30 in. wide, preferably with a factory-cut corner. Next, I measured and marked 24 in. out and 24 in. up from the corner to form a triangle. After connecting these marks with a straight line, I made a second line, parallel to and about 2½ in. above the first—the 1x3 fence goes between the lines—then cut the triangular-shaped piece along this second line. To finish the jig, I attached a 1x3 fence on both sides of the plywood between these two lines. I cut the fence short so that it didn't run all the way to the top on one side. That allowed me also to use the plywood as a cutting jig running my circular saw along one edge without the motor hitting the fence and offsetting the cut (photo right, p. 93).

Here I should pause and note an important principle. The jig was based on a 12-in-12 pitch, but because I wanted a larger jig, I simply multiplied both the rise and run figures by the same number—two—to get the 24-in. measurement. This way, I enlarged the jig without changing the pitch. This principle holds true for all triangles. Multiply all three sides by the same number to enlarge any triangle without changing its proportions, its shape or its angles.

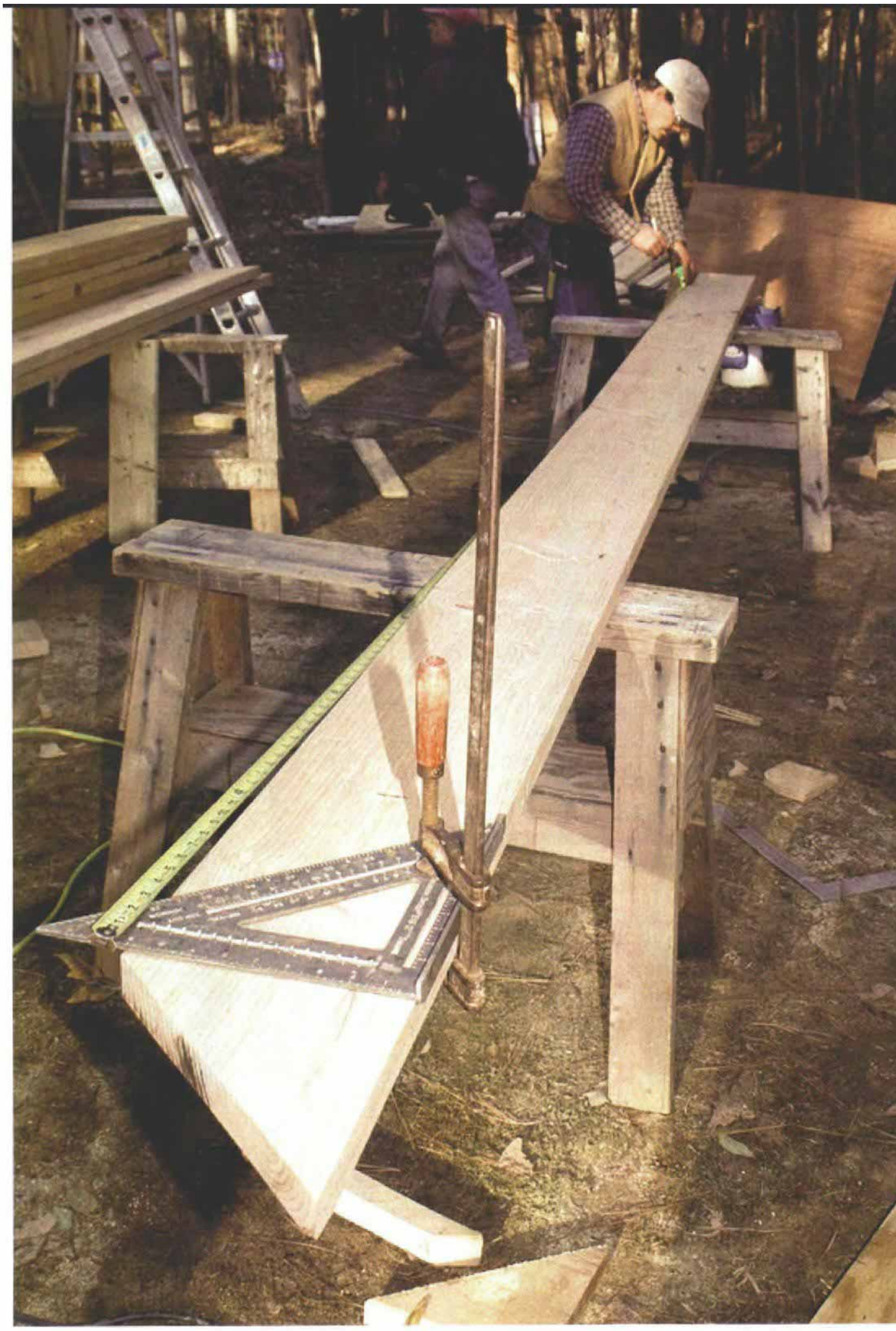
To use this jig, I hold the fence against the top edge of the rafter and scribe along the vertical edge of the plywood jig to mark plumb lines and along the horizontal edge to mark level lines.

There are at least four reasons why I go to the trouble to make this jig. First, I find it easier to visualize the cuts with the jig than with any of the manufactured squares made for this purpose. Second, identical layouts for both the top (ridge) and bottom (eave) cuts can be made in rapid succession. Third, I use the plumb edge as a cutting guide for my circular saw. Finally, I use the jig again when I'm framing and sheathing the gable end, finishing the eaves and rake, and installing siding on the gable. I also save the jig for future projects.

Step one: Determining the base of the measuring triangle—The base of the measuring triangle is the key dimension for roof layout. In my system, the base of the triangle extends from the inside edge of the bearing wall to a point directly below the face of the ridge. In this addition, the distance between the bearing walls was 271 in. So to get the base of the measuring triangle, I subtracted the thickness of the ridge from 271 in. and divided the remainder by 2. Because the ridge was 1¾-in. thick laminated beam, the base of the measuring triangle turned out to be 134.63 in. (271-1.75 = 269.25; 269.25÷2 = 134.63).

Step two: Determining the altitude of the measuring triangle—With the base of the measuring triangle in hand, it was easy to determine both the altitude and the hypotenuse. The altitude of this measuring triangle was, in fact, too easy to be useful as an example. Because we wanted to build a roof with a 12-in-12 pitch, the altitude had to be the same number as the base, or 134.63 in.

Let's pretend for a moment that I wanted a slightly steeper roof, one that had a 14-in-12 pitch. In a 14-in-12 roof, there are 14 in. of altitude for every 12 in. of base. To get the altitude of the measuring triangle, then, I would find out how many 12-in. increments there are in the base, then multiply that number by 14. In other words, divide 134.63 by 12, then multiply the result by 14. Here's what the math would look like: 134.63 in.÷12 = 11.22; 11.22 x 14 = 157.08 in. Wouldn't it be nice if finding the hypotenuse of the measuring triangle was so simple? It is.



A clamped square serves as an extra pair of hands. It's easy to measure along the bottom of the rafter if you clamp a square to the bottom of the plumb cut and run your tape from there.

Step three: Determining the hypotenuse of the measuring triangle—Now let's return to our 12-in-12 roof. The base and the altitude of the measuring triangle are both 134.63 in. But what's the hypotenuse? One way to solve the problem of finding the hypotenuse is to use the Pythagorean theorem: $A^2 + B^2 = C^2$ (where A and B are the legs of the triangle and C is the hypotenuse).

There are other ways to solve this problem—with a construction calculator, with rafter manuals, with trigonometry—but I usually use the principle mentioned in step one. According to this principle, you can expand a triangle without changing the angles by multiplying all three sides by the same number.

For over a century, carpenters have used the rafter tables stamped on rafter squares. The common table shows the basic proportions of triangles for 17 different pitches (bottom photo).

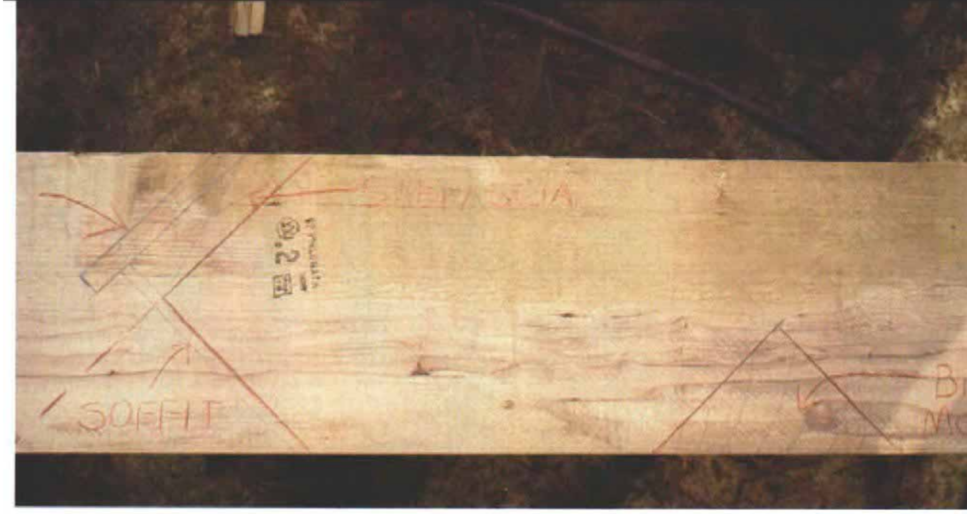
The base of all these triangles is 12; the altitude is represented by the number in the inch scale above the table. And the hypotenuse is the entry in the table. Under the number 12, for example, the entry is 16.97. This is the hypotenuse of a right triangle with a base and an altitude of 12.

To use this information to create the larger measuring triangle I needed for this roof, I simply multiplied the altitude and the hypotenuse by 11.22. This, you may recall, was the number I obtained in step two when I divided the base, 134.63 in., by 12. Now multiply the altitude and the hypotenuse of the small triangle by 11.22: 11.22 x 12 gives" us an altitude of 134.63 in.; and 11.22 x 16.97 gives us a hypotenuse of 190.40 in.

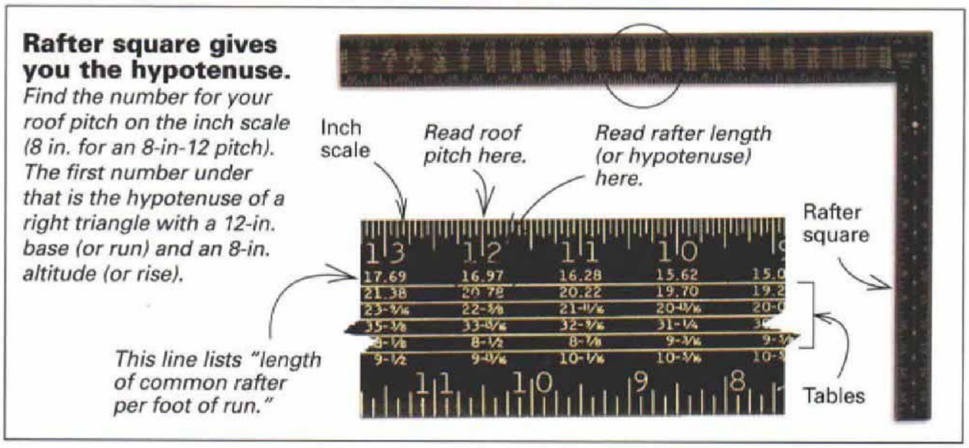
So here is the technique I use for any gable roof. I find the base of the measuring triangle, divide it by 12, and multiply the result by the rise of the pitch to get the altitude of the measuring triangle (which determines the height to the bottom of the ridge). To get the hypotenuse, I divide the base of the triangle by 12 and multiply that by the hypotenuse of the pitch, which is found in the common rafter table.

Say the roof has an 8-in-12 pitch with a base of 134.63. I divide that number by 12 to get 11.22, then multiply that by 8 to get the ridge height of 89.76 in. To get the length of the rafter, I multiply 11.22 by 14.42 (the number found under the 8-in. notation on the rafter table), for a length between ridge and bearing wall of 161.79 in.

The only time I waver from this routine is when a bird's mouth cut the full depth of the wall leaves too little wood to support the eaves. How little is too little depends on the width of the rafter and the depth of the eave overhang, but I generally like to have at least 3 in. of uncut rafter running over the bird's mouth. If I have too little wood, I let the bottom edge of the rafter land on top of the wall rather than aligning with the wall's inside edge. Then I determine how far the rafter will sit out from the inside edge of the bearing wall and use that inside point as the start of my measuring triangle.



Visualizing the bird's mouth and rafter tail. Red lines on this marked-up rafter show where cuts will be made for the bird's mouth, at right, and rafter tail, at left. To determine the correct cut for the tail, the author marked out the subfascia, soffit and fascia board.



Rafter square gives you the hypotenuse. *Find the number for your roof pitch on the inch scale (8 in. for an 8-in-12 pitch). The first number under that is the hypotenuse of a right triangle with a 12-in. base (or run) and an 8-in. altitude (or rise).*

Step four: Setting the ridge—I determined that the altitude of the measuring triangle was 134.63 in. This meant that the correct height to the bottom of the ridge was 134⅝ in. above the top plate of the wall. (Note: I usually hold the ridge board flush to the bottom of the rafter's plumb cut rather than the top.) To set the ridge at this height, we cut two posts, centered them between the bearing walls and braced them plumb. Before we installed the posts, we fastened scraps of wood to them that ran about 10 in. above their tops. Then, when we set the ridge on top of the posts (photo p. 94), we nailed through the scrap into the ridge. We placed one post against the existing house and the other about 10 in. inside the gable end of the addition. This kept it out of the way later when I framed the gable wall.

Getting the ridge perfectly centered is not as important as getting it the right height. If opposing rafters are cut the same length and installed identically, they will center the ridge.

Step five: Laying out the main part of the rafter—I calculated a measuring length (or hypotenuse) for the rafter of 190.40 in., then used the jig as a cutting guide and made the plumb cut. I measured 190⅜ in. (converted from 190.40 in.) from the heel of the plumb cut and marked along the bottom of the rafter. Rather than have another carpenter hold the end of the tape, I usually clamp a square across the heel of the plumb cut, then pull the tape from the edge of the square (photo p. 95) to determine where the bird's mouth will be.

Once I marked where the bird's mouth would be, I used the jig to mark a level line out from the mark. This would be the heel cut, or the portion of the rafter that sits on top of the bearing wall.

After scribing a level line, I measured in the thickness of the wall, which was 5½ in., and marked. I slid the jig into place and scribed along the plumb edge from the mark to the bottom edge of the rafter. This completed the bird's mouth and, thus, the layout for the main portion of the rafter.

Step six: Laying out the rafter tail—The eaves on the existing house measure 16 in. out from the exterior wall, which meant I would make the eaves on the addition 16 in. wide. To lay out the rafter tail, I started with the finished dimension of 16 in. and then drew in the parts of the structure as I envisioned it (top photo). In this way, I worked my way back to the correct rafter-tail layout.

I began by holding the jig even with the plumb line of the bird's mouth. With the jig in this position, I measured and marked 16 in. in from the corner along the level edge. Then I slid the jig down to this mark and scribed a vertical line. This line represented the outside of the fascia. Next I drew in a 1x6 fascia and a 2x subfascia. I also drew in the ⅜-in. soffit I would use. This showed me where to make the level line on the bottom of the rafter tail.

Marking the bird's mouth and tail. Once the start of the heel cut was determined by measuring from the bottom of the plumb cut, this measuring stick was used to transfer the dimensions of the bird's mouth and rafter tail. The cutting lines were marked using the rafter jig.

Step seven: Preserving the layout–The only dimension for this layout that I had to remember was 190⅜ in., the hypotenuse of the triangle and the measuring length of the rafter. I wrote the number where I could see it as I worked. To preserve the other three critical dimensions–one for the plumb cut of the bird's mouth and the other two for the rafter tail–I used the rafter jig to extend reference points to the bottom edge of the rafter; then I transferred these marks to a strip of wood, or measuring stick (photo above). I was ready to begin cutting the rafters.

Step eight: Marking and cutting the rafters–Some carpenters lay out and cut one rafter, then use it as a pattern for the rest, and I'll often do that on a smaller roof. On this roof, where the rafters were made of 20-ft. long 2x10s and where I was laying them out by myself, this method would have meant a lot of heavy, awkward, unnecessary work. Instead of using a 100-lb. rafter as a template, I used my jig, my tape measure and the measuring stick.

Moving to the end of the 2x12, I clamped the jig in place and made the plumb cut. (The steep pitch of this roof made clamping the jig a good idea. Usually, I just hold it to the rafter's edge the way you would when using a framing square as a cutting guide.) Then I clamped my square across the heel of that cut, pulled a 190⅜-in. measurement from that point and marked along the bottom edge of the board. Next I aligned the first mark on the measuring stick with the 190⅜-in. mark and transferred the other three marks on the measuring stick to the bottom edge of the rafter (photo above).

To finish the layout, I used the jig to mark the level and plumb lines of the bird's mouth and the rafter tail (photo right). For all four of these lines, I kept the jig in the same position and simply slid it up or down the rafter until either the plumb or level edge engaged the reference mark. It was quick and easy. It was fun.

The two cuts that formed the rafter tail were simple, straight cuts that I made with my circular saw. To cut the bird's mouth, I cut as far as I could with my circular saw without overcutting, then finished the cut with my jigsaw. □

John Carroll is a builder in Durham, North Carolina. This article is adapted from his book, Measuring, Marking and Layout: A Guide for Builders, *to be published this fall by The Taunton Press. Photos by Steve Culpepper.*

A rafter jig does the hard work. Once the location of the bird's mouth is determined, the rafter jig is used to mark the level and plumb cuts of the bird's mouth and rafter tail.