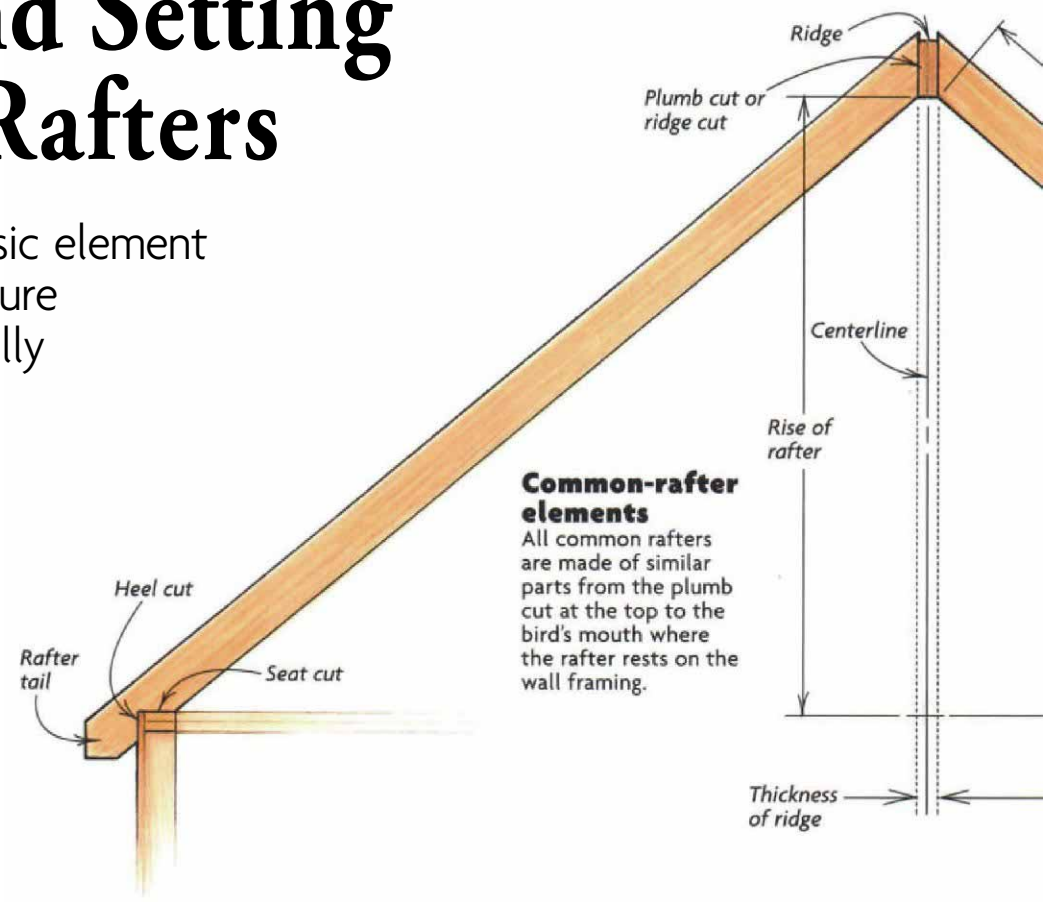
Cutting and Setting Common Rafters

Rafters are the most basic element to a gable roof, so measure and lay them out carefully to make your roof look like it grew there

BY JOHN SPIER



Common-rafter elements
All common rafters are made of similar parts from the plumb cut at the top to the bird's mouth where the rafter rests on the wall framing.

If building a staircase is the test of a master carpenter, then building a simple gable roof must be the test of an apprentice. The gable roof is the foundation, so to speak, for almost every roof a carpenter will learn to build, from sheds to gambrels. Just about every gable roof begins with common rafters, those simple framing members that stretch from plate to ridge. There are many ways to approach cutting and installing common rafters; here's the one I use most often.

Start with straight, plumb walls

Every good roof starts with good wall framing. The bearing walls that carry the rafters and the roof need to be straight, square, plumb and parallel to each other. If they're not, fix them now, or the roof framing will never be right.

I start by checking the distance between the plates at the ends of each roof section, both at the floor and at the top plate (photo right). With the wall corners braced plumb, all four measurements should be the same. If the floor is square to begin with and the walls are either sheathed or braced so that they can't rack diagonally, the top plates should also be square to each other. I check for square by measuring the diagonals, which should also be the same or at least within a ¼-in. tolerance.

Next I stretch a line (usually yellow mason's string; photo top right, facing page) inside the top plates of each wall. I use blocks at each end to space the string away from the wall. A third block makes a quick gauge to check the straightness of the wall (photo bottom right, facing page). The walls then are held plumb and straight with 2x braces every 8 ft. or so. If interior walls have top plates that lap over outside walls, I put diagonal braces on them.

Simple math and a calculator

There are many ways to lay out common rafters, but I stick to the simplest approach using math, geometry and a calculator (top photo, facing page). I also work from the bottom edge of the rafter rather than working from the theoretical line traditionally used when calculating rafters. With my approach, the length I find is between two definite measurable points: the bottom corner of the ridge cut and the beginning of the seat cut. To find the length of the bottom edge of the rafter, I start with the desired roof pitch and the inside plate-to-plate measurement.

From that measurement, I subtract the thickness of the ridge and divide that number in half to give me the run dimension for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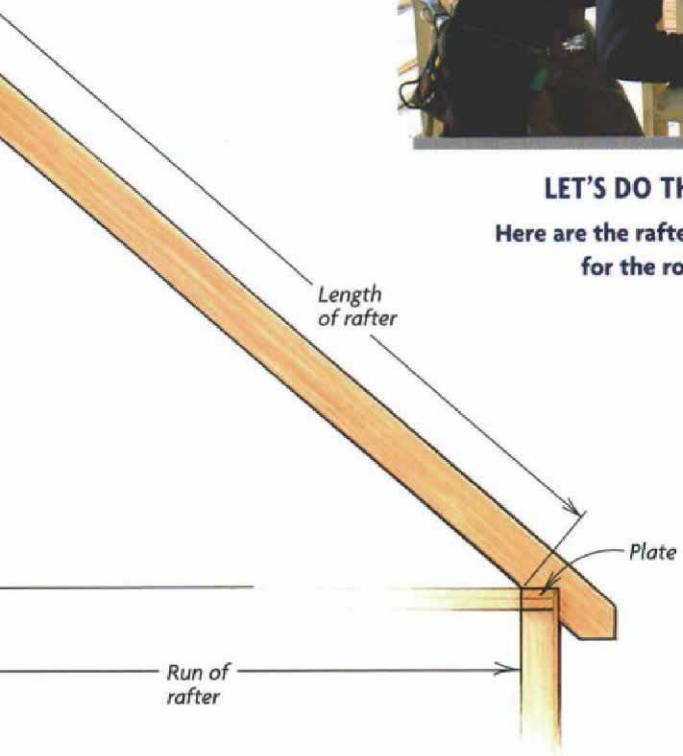
Drawing: Dan Thornton

LET'S DO THE NUMBERS

Here are the rafter calculations for the roof featured in this article.



Find run of rafter

277⅝ in. (plate to plate)
− 3½ in. (double LVL ridge)
274⅛ in.
÷ 2
137 1/16 in. (run of rafter)

Find rise of rafter

Set up a proportion, cross-multiply, and divide

$$\frac{X}{137\frac{1}{16}\text{ in.}} = \frac{10}{12}\ \text{(roof pitch)}$$

$12 \times X = 10 \times 137\frac{1}{16}$ in.

$X = (10 \times 137\frac{1}{16}\text{ in.}) \div 12$

$X = 114\frac{1}{4}$ in. (rise of rafter)

Find length of rafter

$(137\frac{1}{16}\text{ in.})^2 + (114\frac{1}{4}\text{ in.})^2 = 31839.19$

$\sqrt{31839.13} = 178\frac{7}{16}$ in.

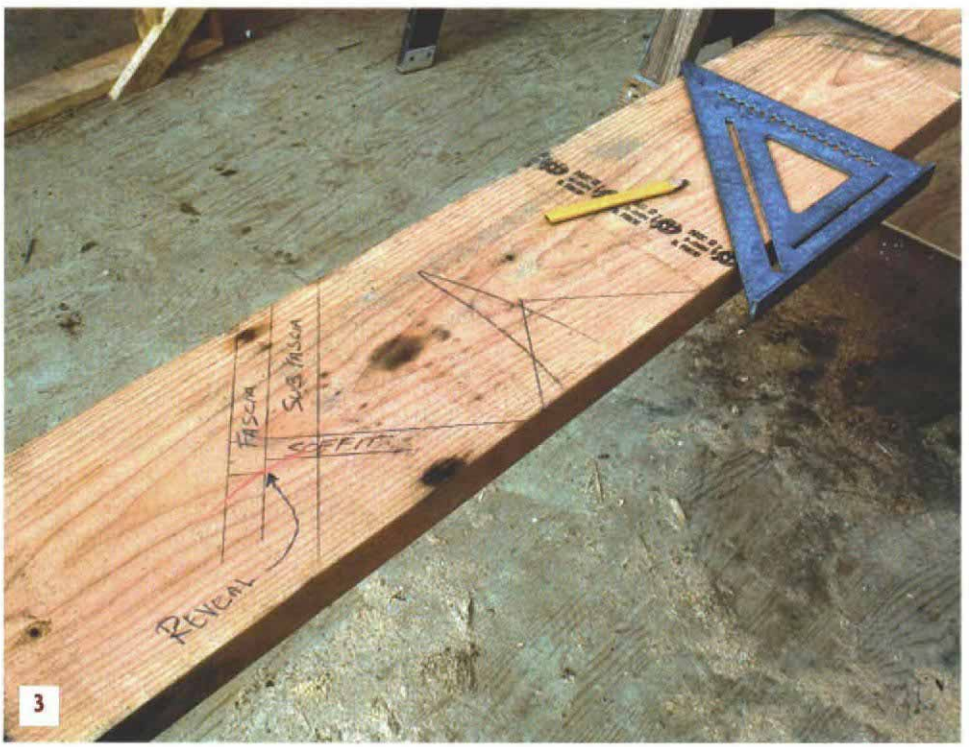
Handy tip: If you have no calculator, pick a big room with square walls. Measure rise along one wall and run along another. Then string a tape between the two points for the length of rafter.

STRAIGHTEN THE WALLS FIRST

Before the rafters can be cut and installed, the walls have to be straight, plumb and square. First, plate-to-plate measurements are taken at both ends of each roof section at the inside of the plates (photo 1). Lines stretched along the walls (photo 2) are gauged straight with a block (photo 3).

THE PATTERN RAFTER: A TEMPLATE FOR THE ROOF

After finding the length of the rafter, a straight piece of rafter stock is selected (photo 1). A rafter square sets the angle for the ridge cut (photo 2), and the length of the rafter is measured down from the short point. The bird's mouth and rafter tail are drawn full scale with all the trim and soffit detail (photo 3) before the pattern is cut to make sure all the details fit properly.



the rafter (calculations, p. 57). Next I set up a simple proportion using the roof pitch to find the rise dimension. Once I've determined the rise and run of the rafter, I use geometry to find the rafter length. Square the rise, square the run, add the two, and take the square root of the sum.

Construction calculators are programmed to do this automatically and have the benefit of calculating in feet and inches, but any calculator with a square-root function will do.

The first rafter is a pattern

Armed with these figures, I'm ready to lay out the first rafter. I select a nice straight piece of rafter stock for a pattern (top photo) and mark the direction of the crown, or the bend along the edge, if any.

Every common rafter has a ridge cut or a plumb cut at one end and a bird's mouth and a tail at the other end where the rafter fits over the wall plate. The roof pitch determines the plumb-cut angle, which I mark using a triangular rafter square (center photo), such as a Speed Square.

Today's framing codes require that the bottom of the rafter's ridge cut must bear fully on the ridge, although the top point of the cut may be left as much as an inch high to facilitate ridge-venting. The length of the plumb cut determines the minimum width of the material needed for the ridge.

Measuring along the bottom edge of the rafter from the short point on the plumb cut, I mark the rafter length on the stock. This mark is where I begin the seat cut for the bird's mouth of the rafter. The angle of the seat cut, or the flat part of the notch, is the complement of the plumb-cut angle. The roof in this project had a 10-in-12 pitch with a plumb cut of 40°. So the seat-cut angle, or complement, is 90° minus 40°, or 50°.

The length of the seat cut is the width of the wall plate plus the thickness of the sheathing. Another plumb cut, called the heel cut, for the outside of the wall completes the bird's mouth.

The rafter tail is the part that carries the roof overhang and trim. I lay out the tail by drawing a full-scale picture of the roof-trim and soffit details on the pattern rafter (bottom photo). Details include the vent, subfascia, blocking, frieze and anything else that affects the framing. When my drawing is complete, I cut out the pattern rafter and mark it as such.

Rafters should align with the studs

A good roof-framing layout starts on the first floor. I always try to line up the studs in the second-floor walls with those on the first

floor and then have the rafters land directly over the studs (photo top left). A unified layout all the way through the house simplifies work for the subs and trim carpenters, provides good nailing for code-required steel connectors and improves the structural integrity of the house.

On the wall plates, I lay out all the common-rafter locations, and also the double and triple common rafters for openings such as skylights, cupolas, chimneys and dormers. I then transfer all these layout marks to the ridge (photo center left), making sure to keep track of which side of the ridge goes where. When the layout is finished, I count the number of rafters I need.

Setting the stage

If the roof has ceiling joists that sit directly on the bearing walls, I can put the joists on now and use them as staging. If not, or if the ridge is too high to reach comfortably, I take the time to set up staging.

I like to be able to walk along each side of the ridge with the tops of the rafters just about head high so that I can nail the rafters comfortably but still duck under them easily. A couple of sections of pipe staging with planks is the easiest approach, but I've also set many ridges on simple staging site-built out of 2x6s and extra rafter stock.

If you're short or if the bearing walls are more than 5 ft. tall, it's also helpful to have staging set up for lifting and nailing the rafters onto the walls, either from the inside or from the outside. We often set up wall brackets outside at a height convenient for installing sheathing, trim and roofing.

Test rafters brace the ridge

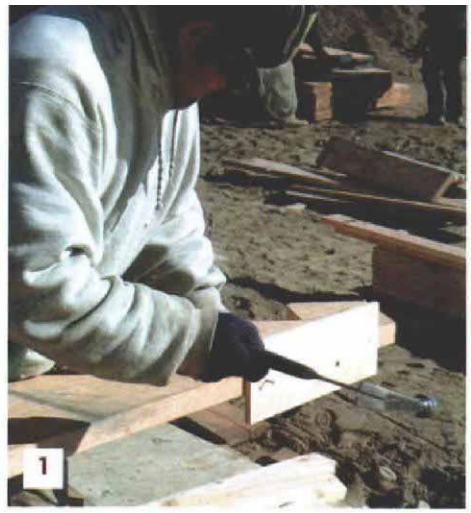
Our ridges used to be a single thickness of 2x lumber, often toenailed together or gusseted

LAYING OUT THE RIDGE AND PLATES

To keep the house framing consistent, rafters should fall directly over the studs and joists (photo 1). Rafter layout is transferred to the ridge (photo 2). The ridge is then set on temporary posts (photo 3), and a test fit of the first two rafters braces the ridge while it's eyeballed for straightness (photo 4).

PRODUCTION RAFTER-CUTTING

After the pattern rafter has been tested, plywood blocks are nailed to each end (photo 1). The blocks register the pattern on the rafter stock while a crew member at each end traces the pattern (photo 2). The ends are then cut at the same time (photo 3), and the finished rafter is set aside.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with scraps of plywood. With today's wind-loading codes and cathedral-ceiling spaces, ridges are more likely to be built-up assemblies of LVLs or other materials engineered to carry some of the roof load.

If posts are incorporated into the gables or interior walls that support the ridge, I build and stand them now, using temporary braces to hold them plumb. If there are no permanent posts in the structure, I cut temporary props to hold the ridge and to keep it from sagging until the roof is sheathed (photo right, p. 59). The post height equals the rise of the rafter plus the height of the walls. I like to have the first couple of rafters cut at this point.

In theory, my pattern rafter is perfect, but before I cut a whole pile of stock, I test-fit a couple of rafters to make sure I haven't made any stupid mistakes. And because I also hate to waste time by moving anything twice, the first two rafters are used to brace the ridge in place (bottom photo, p. 59). If I'm not ready to set the ridge, I test the rafters by inserting a small block of wood the same thickness as the ridge between the ridge cuts.

Rafter-cutting, tag-team style

When I'm satisfied that my pattern rafter is good, I set up the rafter-cutting operation. First, I nail blocks (usually plywood scraps) on the top edge of the pattern rafter at each end, one directly over the ridge cut and the other over the seat of the bird's mouth (top photo). These blocks ensure that each rafter is uniform so that the ridge and eave stay straight and that differences in rafter width and crown don't affect the finished frame,

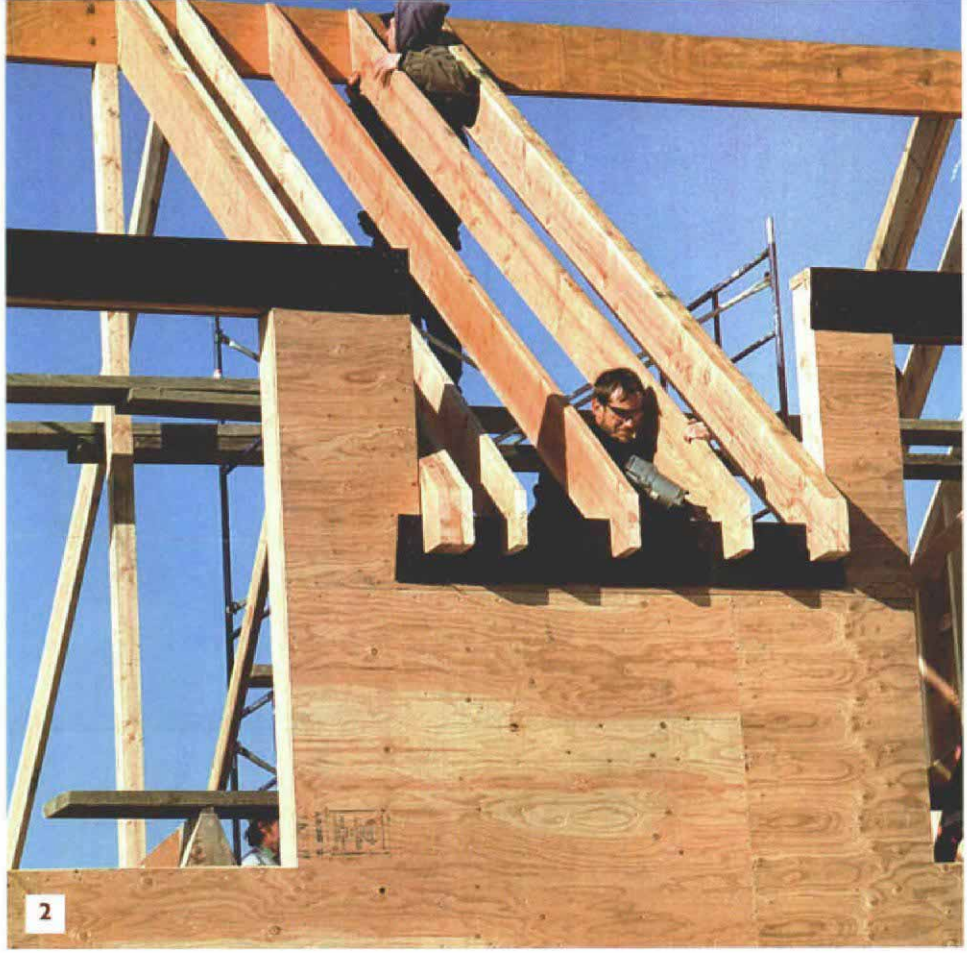
Now I set up an on-site rafter factory. Two of the crew members mark the crown on the stock and then stack it near the cutting station. Any pieces with excessive crown or bow are rejected.

At the cutting station, stock is stacked on sawhorses with the crowns facing the same direction. The pattern rafter is placed on each piece with the crown at the top edge, and the cuts are marked (center photo). Then one crew member makes the plumb cut while the other cuts the bird's mouth and rafter tail (bottom photo). These cuts have to be accurate; sloppy cuts translate into humps or hollows in the roof, which my competitors will gleefully discuss at the coffee shop.

When I'm cutting the bird's mouth, it's generally acceptable to overcut with the circular saw to finish the notch. The exceptions to this rule are when the notch goes more than two-thirds of the way across the rafter and when the tail has to support a wide roof overhang. In these two cases, I cut to the

THE RAFTERS GO IN

It's easiest to set rafters with three crew members (photo 1), one at the ridge, one at the plate and another passing up the rafters. The plate end is nailed in first while the ridge end is held up slightly (photo 2). When the rafters are in, steel connecting plates are installed (photo 3), followed by the ceiling joists (photo 4).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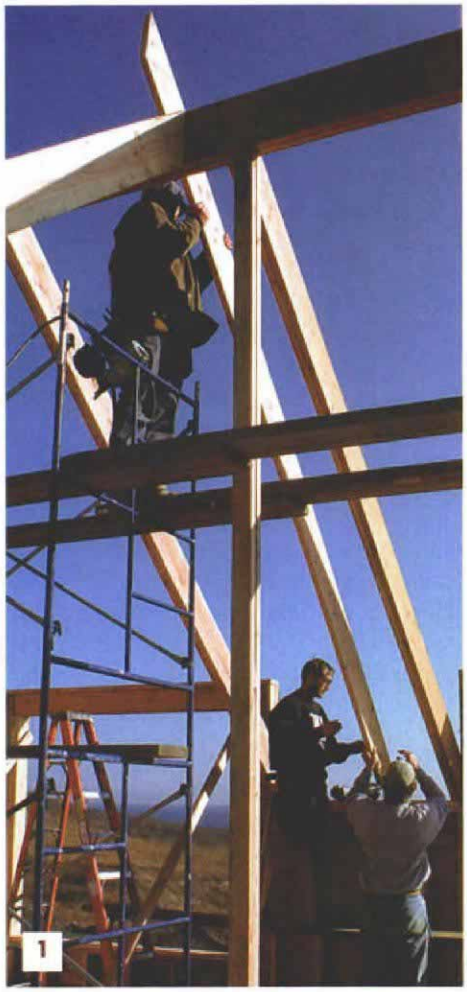
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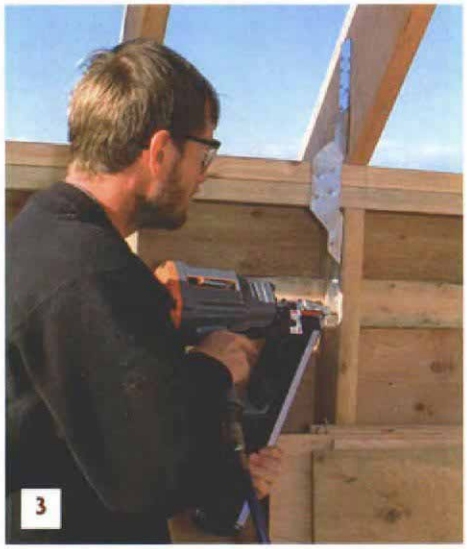
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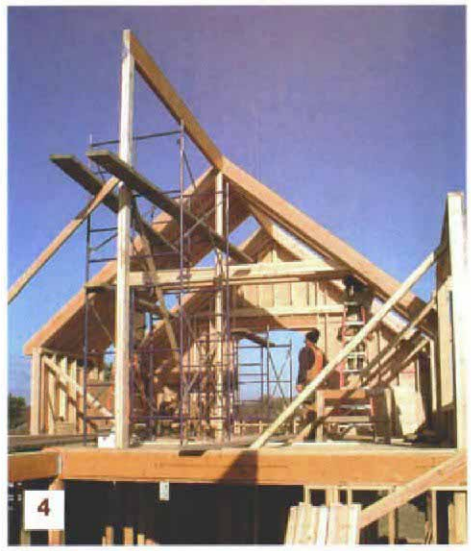
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corner with a circular saw and finish with a sharp handsaw.

Nail the bird's mouth first

Setting rafters is best done as a team with one person at the ridge, another at the eave and a third lifting the rafters into position (photo left). I like to set an opposing pair of rafters every 6 ft. to 8 ft. to hold the ridge straight at intermittent points. Then I check the ridge for straightness, by eye or with a Stringline.

It's best to nail the lower end of each rafter first while the person at the ridge holds the rafter slightly high (photo top right). Nailing the ridge first tends to push the bird's mouth outward. After the ridge is stabilized and straight, I fill in the remaining commons, alternating from side to side every few rafters. Once the rafters are in place, I cast a critical eye along the ridge and eaves. Now is the last easy chance to fix or replace any rafters that are not in line or in plane with the rest.

Final framing details

When all the common rafters are in place, I install the metal rafter ties (photo bottom center), and I put in as many of the cathedral-ceiling joists as possible (photo bottom right). I then turn my attention to the rest of the roof-framing details such as chimney and skylight openings and dormers. Getting the common rafters right goes a long way toward getting the rest of the roof right, and many of the same concepts and methods apply to other parts of the roof as well. □

John Spier and his wife, Kerri, own Spier Construction, a home-building company on Block Island, RI. Photos by Roe A. Osborn.