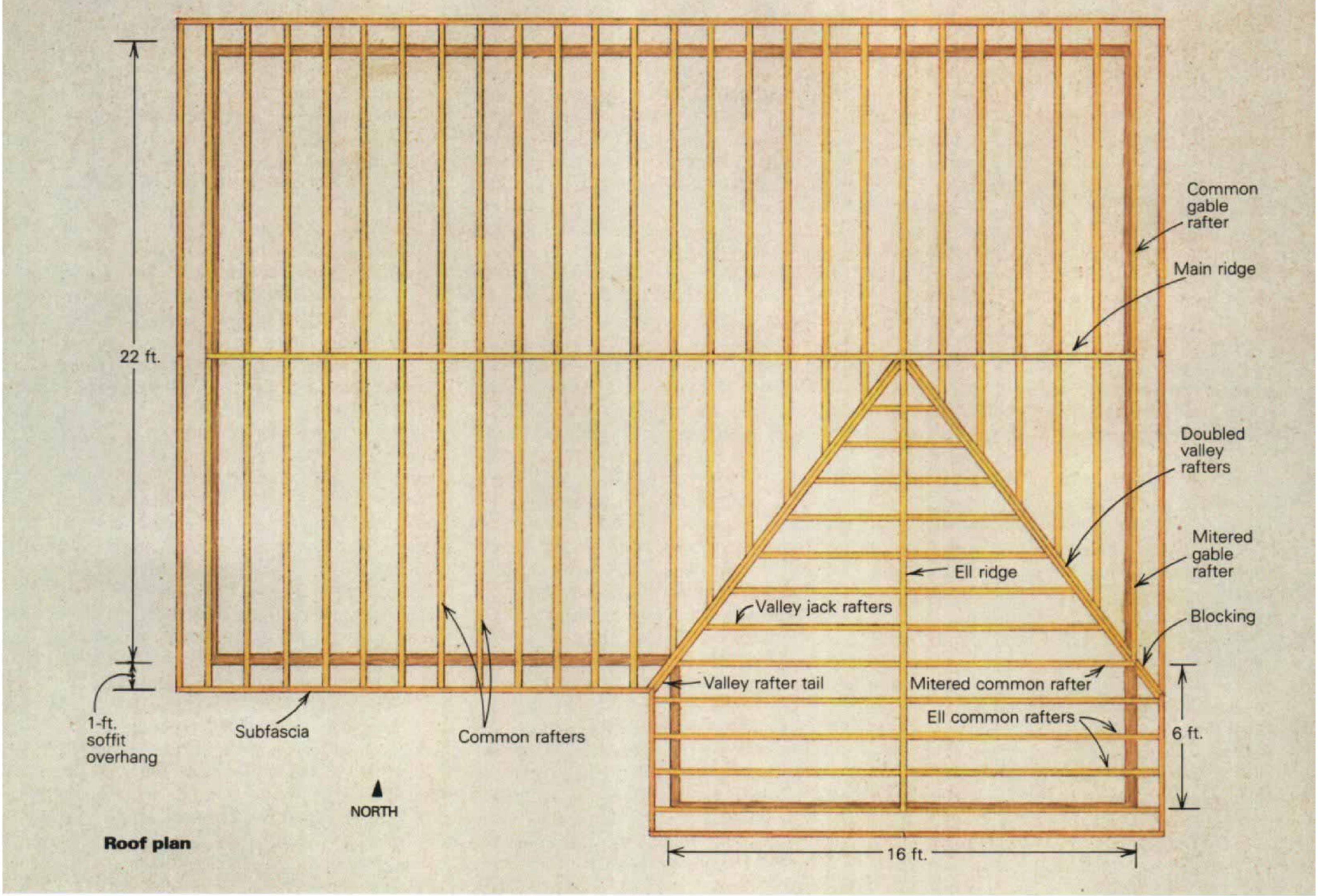



# Valley Framing for Unequally Pitched Roofs

## An empirical method that works

by George Nash

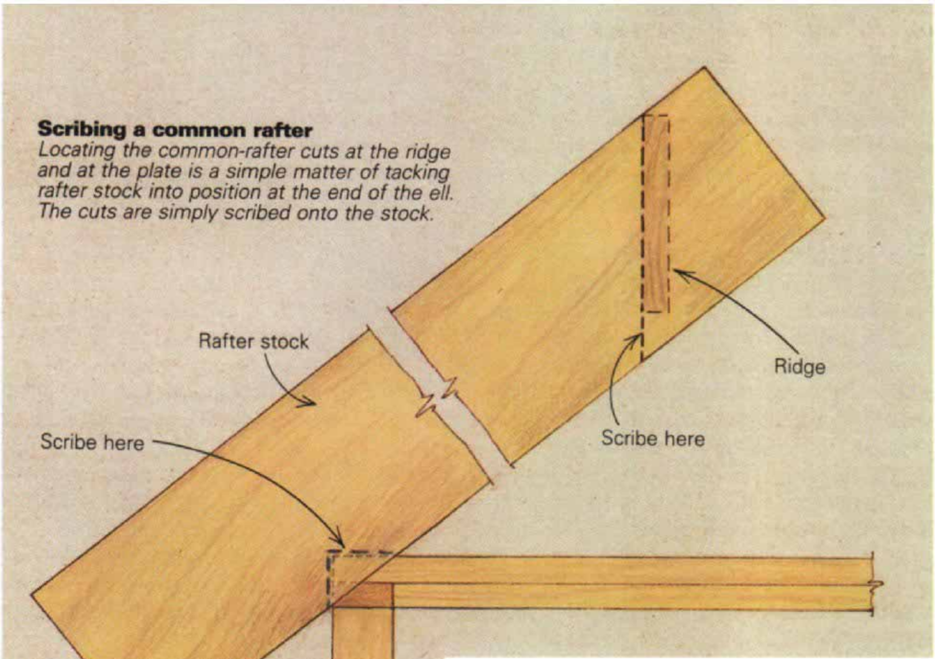
The intersection of two roofs with unequal pitches involves geometrical relationships not readily visualized or easily understood. Graphic projections like the method detailed by Scott McBride in "Roof Framing Revisited" (*FHB* #28, pp. 31-37) can be intimidating to anyone without substantial framing experience. As for me, I want to frame the roof, not tinker with models, pens, paper and a calculator. In fact, I'm convinced that "fear of ciphering" is so common that few framers have anything more than a vague notion of somehow using "strings and levels" to lay out complex roofs. This sometimes translates into blundering through, trial-by-error or fudge-and-fix techniques, with hopes that the client doesn't show up until the roof sheathing has hidden the mistakes.

That's how it went for me until a summer when everything I built had a weird roof. I needed a framing method that was fast, accurate, relatively simple and, most of all, nonmathematical. I've forgotten all the trigonometry I never learned in high school, so I'm hopelessly doomed to be a string-and-level man. In the article that follows, I'll describe that method for you and apply it to a house I built that's fairly typical of unequally pitched roof framing.

Purists, or those more mathematically adept than I, may find my methods inelegant, or



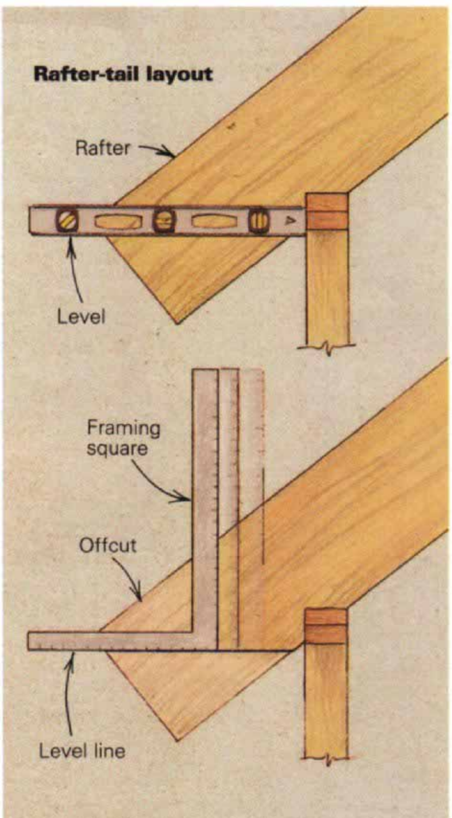
Drawings, except where noted: Christopher Clapp



**Scribing a common rafter**

*Locating the common-rafter cuts at the ridge and at the plate is a simple matter of tacking rafter stock into position at the end of the ell. The cuts are simply scribed onto the stock.*

*The template rafter tail runs long. It will later be cut in place (drawing below).*




**Rafter-tail layout**

*Determining the length and cutting pattern for a common rafter tail on the ell can be done without calculation. Snap a level line on the wall, corresponding to the common rafter level cut on the main roof. Then use a spirit level to transfer this line to the common rafter tail. Slide a framing square along this line until it measures a given distance along the vertical leg; this will be the plumb cut.*

perhaps less precise than the computational approaches. I'll tell you this, though: the tolerances are well within the width of a pencil line, the mechanics are easily understood and the method works for me.

**First things first**—In the project drawings I was given, the L-shape of the Stoecklein house appeared to include a conventional valley, but it didn't. According to the drawings, the ridge was at the same height for both roofs, but the rafter span of the main roof was 22 ft. while the ell span was only 16 ft. The main roof was framed at a 7-in-12 pitch. In order for a smaller span to terminate at the same eave height, the pitch of the ell had to be steeper.

The first rule for framing uncommon rafters is to lay out and install all the rafters that ain't (in other words, do the common rafters first). I'll assume you know how to use a framing square to do this; if not check *FHB* #10, pp. 56-61. After cutting and installing all the rafters on the main roof, I was ready to tackle the ell (drawing facing page).

**Installing the ridge**—As for framing the roof of the ell, the idea is to work from the top down, which means getting the ridge into place and *then* installing the rafters. The first step was to measure and mark the midpoint of the ell top plate and center a plumbed and braced 2x4 post over it. This would support the outboard end of the ell ridge until the ell's common rafters were installed. The post was cut to the same length as the distance between the top plate and the underside of the main ridge. Working from pipe scaffolding, I transferred the centerline of the ell onto the main ridge to locate the intersection of the ell ridge. (I always use rented pipe scaffolding for roof framing. With two sections and enough staging plank, all but the longest roofs can be framed with minimal movement.)

Figuring the length of the ell ridge was easy. It had to run the full length of the ell, plus half of the full width of the main building, minus one-half the thickness of the main roofs ridgeboard. In this case, that meant 6 ft. (the ell) plus 11 ft. (half the main roof) minus ¾ in. (half the ridge). So the ell ridge would be 16 ft. 11¼ in. long. After cutting the ell ridge to length and marking out the rafter spacing on it (better now than when it's up in the air), I nailed it into place at the main ridge and atop the ell centerpost. I double-checked to make sure that the end of the ell ridge ended plumb over the gable wall. A temporary diagonal brace run down to the deck held everything in place.

**Ell common rafters**—Once the ridges and main-roof common rafters were in place, the layout for the ell common rafters was simple: I pinned rafter stock against the end of the ridgeboard and the corner of the wall plate and scribed for the plumb cut and bird's mouth (top drawing, left). No, it's not elegant, but it works perfectly. The position and depth of the bird's mouth followed from the rule that the seat cut should begin at the inside edge of the top plate. The length of the rafter tail will determine how far away from the wall the fascia will be, so the rafter tails on the ell had to be laid out to allow the ell fascia to flow continuously into the main fascia. Rather than including this step in the initial layout, I simply made the plumb cut at the ridge and the bird's-mouth cuts, leaving ample tail stock to be trimmed later. I cut two rafters and tacked them to the ridge to test the fit.

With the two test rafters in place, it was easy to lay out the cuts on their tails. First I leveled across from the bottom edge of a main-roof common rafter tail to the wall itself, as if laying out a horizontal soffit lookout, and then measured the distance from this mark to the top of the wall plate. Returning to the ell, I measured down the wall this same amount and snapped a level line across the wall. Then it was short work with a level and a pencil to extend this line across the bottom of the extending rafter tails; this would be the level cut (bottom drawing, left). To get the plumb cut, I moved a framing square horizontally across this line until it measured a vertical line equal in length to the plumb cut of the main-roof rafters.

It's important to note that if you want the intersecting ridges to be of the same height and the fascias on both parts of the house to line up, the width of the ell soffit will be less than that of the main soffit. If the ell were wider than the main roof, the reverse would be true. If you'd rather have the soffits be equal in width and at the same elevation all around the house, then one of the ridges must be lowered or raised accordingly. Usually these sorts of details are worked out in the design phase. On this job, the difference in soffit width amounted to slightly less than 3 in., which really isn't noticeable.

Although the method I just described will establish the tail cut for either horizontal or pitched soffits, I'd recommend using a horizontal soffit unless the design is beyond your control or changes are not allowed. Horizontal soffit boards and vents are much easier to fit and nail than pitched ones.

About this time I'll usually support the intersecting ridges with a temporary post. Otherwise the ridges could sag as the valleys and their jack rafters are added, and the plumb cuts and lengths of the jack rafters would become increasingly inaccurate. I always check the ridges for straightness, or line them to a string, before laying out the valley rafters.

**Finding the valley length**—A valley rafter has a lot of cuts and angles to line up, and you'll have a lot of lumber to throw away if one calculation turns out wrong. Fortunately, there's a way to isolate each component and reduce the chances for confusion and error.

Because I always use a subfascia of 2x stock (for the extra support it gives to the soffit), finding the length of the valley rafter isn't tough. First, I nailed the subfascia to all the common rafters around the house. Where the ell intersected the main building, I extended the subfascias to meet at the inside corner (drawings below). Because I had beveled their top edges to match the corresponding roof pitches, it took some fudging with a trim plane to fit the steeper bevel to the shallower one. Some carpenters skip the bevel and simply drop the fascia slightly instead (either method will provide a nailing surface for the edge of the roof sheathing). Then I nailed the intersecting subfascias together. I stretched a string from the outside corner of this intersection to the intersection of the two ridges, right to the top edge; this represented the center line of the valley rafter's top edge (drawings below). Finding the actual rafter length was simple: I just measured along the string.

**Figuring the plumb cuts**—To find the face angle and the edge angle of the valley-rafter plumb cuts, I used a sliding T-bevel to copy the angle between the string and the ridges. The same angle marked the heel cut of the bird's mouth. It was easy to use a short level and plumb up from the wall plate to the string and then measure the distance to determine not only the heel cut, but the depth to the seat cut of the bird's mouth and the length of the valley from ridge to plate (drawings facing page). The tail cut was simply the same angle repeated where the string crossed the intersecting subfascia. Before making the actual cuts I transferred the angles to a short length of stock and cut a test piece—mistakes on scrap stock are a lot easier to correct.

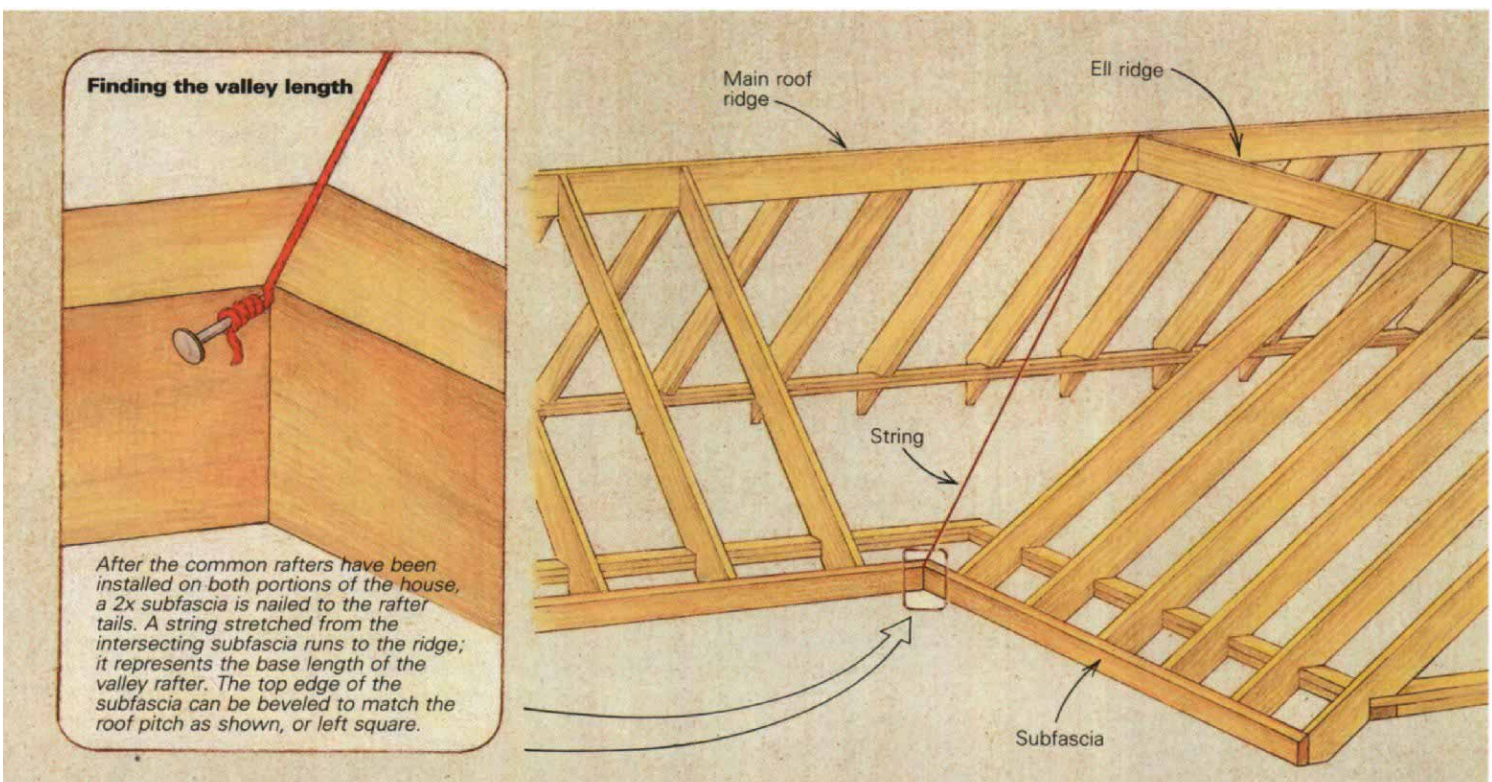
**A doubled valley**—A valley rafter on a roof with *regular* pitches calls for a double cheek cut where the valley rafter intersects the ridges and the subfascia. The top edge of the valley rafter then has to be "dropped" just enough to allow roof sheathing to clear it. But the double cheek cut can be complicated, and dropping the valley leaves very little support for fastening the roof sheathing. That goes against the grain of my framing aesthetic—I like plenty of meat to nail into. That's why I double the valley rafter. And if the top edge of each doubled valley rafter is beveled to match the plane of the adjacent roof, the rafter will provide a much better nailing surface for the sheathing (small drawing, facing page).

Of course, two trial pieces with single cheek cuts already made are needed, one for each half of the doubled valley. To find the angle of the top bevels, I lined up each of my trial pieces with the valley rafter center-line string and held it at the intersection of the two ridges. Then I scribed it where the stock projected above the ridge. This is called backing the valley. Because the resulting angle will be scribed across the face of the compound angle (the ridge plumb cut) and not the square edge of the rafter stock itself, it can't very easily be duplicated with a T-bevel. Instead, I used trial and error—when the cut of the table saw matches the scribe line, I've got the right angle. After the top bevels were cut, I installed the paired rafters and spiked them together.

By the way, the same benefits of doubling the valley rafter apply when it must support a finished ceiling. In that case, a 2x4 ripped to the required width and bevel will furr out the underside of the double rafter for solid nailing, and the finished intersection of the different ceiling planes will be more accurate (small drawing, facing page).

While I left a tail on the doubled southwest valley rafters, letting them intersect the fascia, I dispensed with tails on the southeast valley rafters where the ell shared a common wall with the main-roof gable. Instead, I cut a 45° miter in the plate end of the main roofs gable rafter and did the same thing with the intersecting common rafter of the ell. This way they'd fit against each other at the outside of the wall plate and automatically give the correct height for the center-line string. In lieu of the valley rafter tail, the soffit was fastened to a lookout, and blocking above carried the edge of the roof deck.

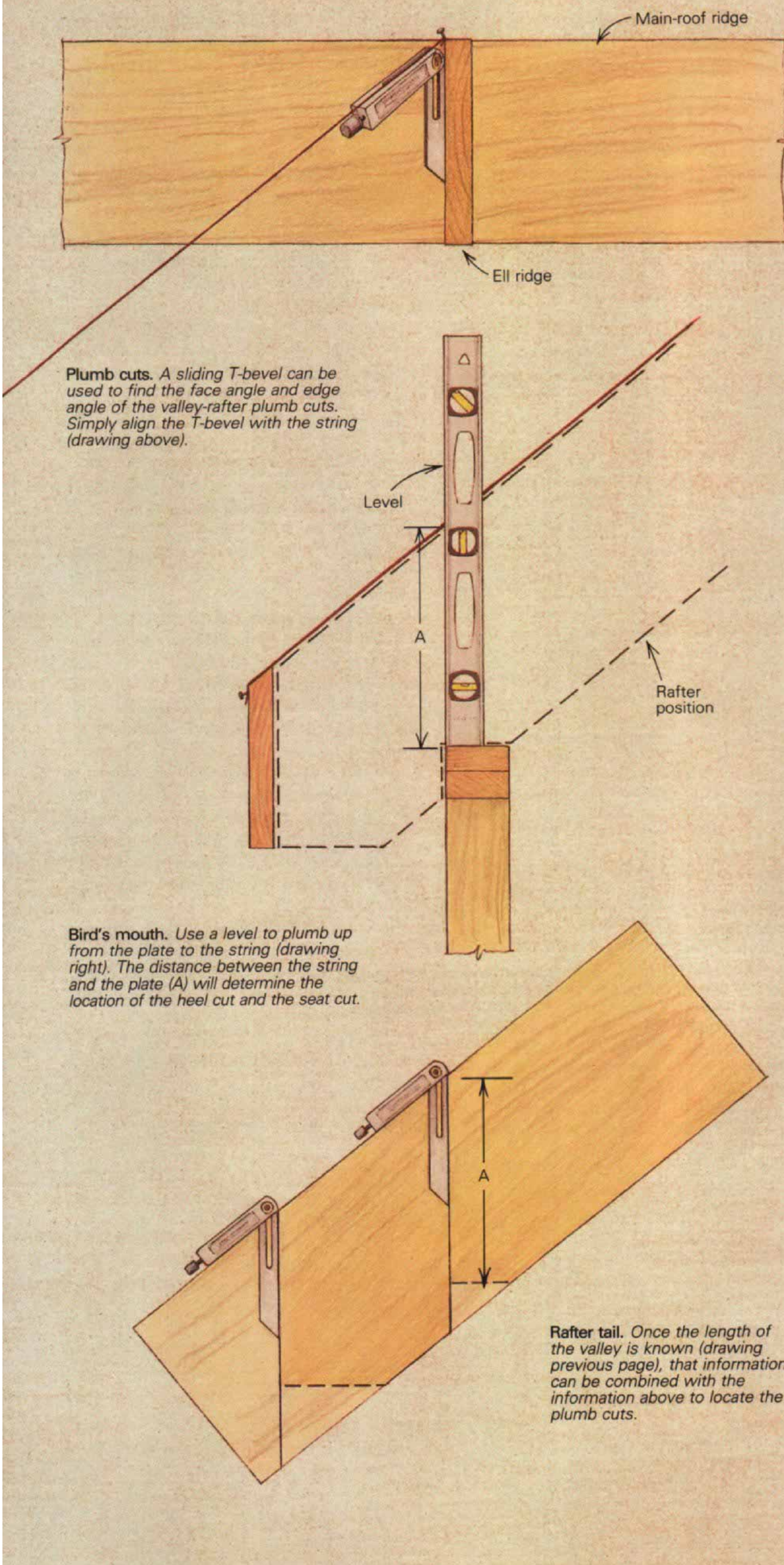
By the way, I left the center-line strings in place until all the valley jack rafters were finished. Even a doubled valley rafter will shift with the push and shove of the jack rafters and the weight of the carpenters as they clamber




**Finding the valley length**

*After the common rafters have been installed on both portions of the house, a 2x subfascia is nailed to the rafter tails. A string stretched from the intersecting subfascia runs to the ridge; it represents the base length of the valley rafter. The top edge of the subfascia can be beveled to match the roof pitch as shown, or left square.*

**Finding the valley-rafter cuts**




**Plumb cuts.** *A sliding T-bevel can be used to find the face angle and edge angle of the valley-rafter plumb cuts. Simply align the T-bevel with the string (drawing above).*

**Bird's mouth.** *Use a level to plumb up from the plate to the string (drawing right). The distance between the string and the plate (A) will determine the location of the heel cut and the seat cut.*

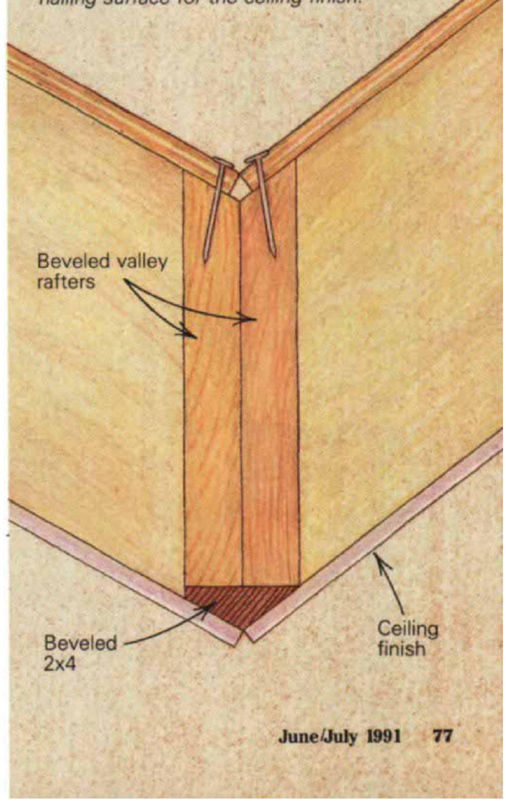
**Rafter tail.** *Once the length of the valley is known (drawing previous page), that information can be combined with the information above to locate the plumb cuts.*

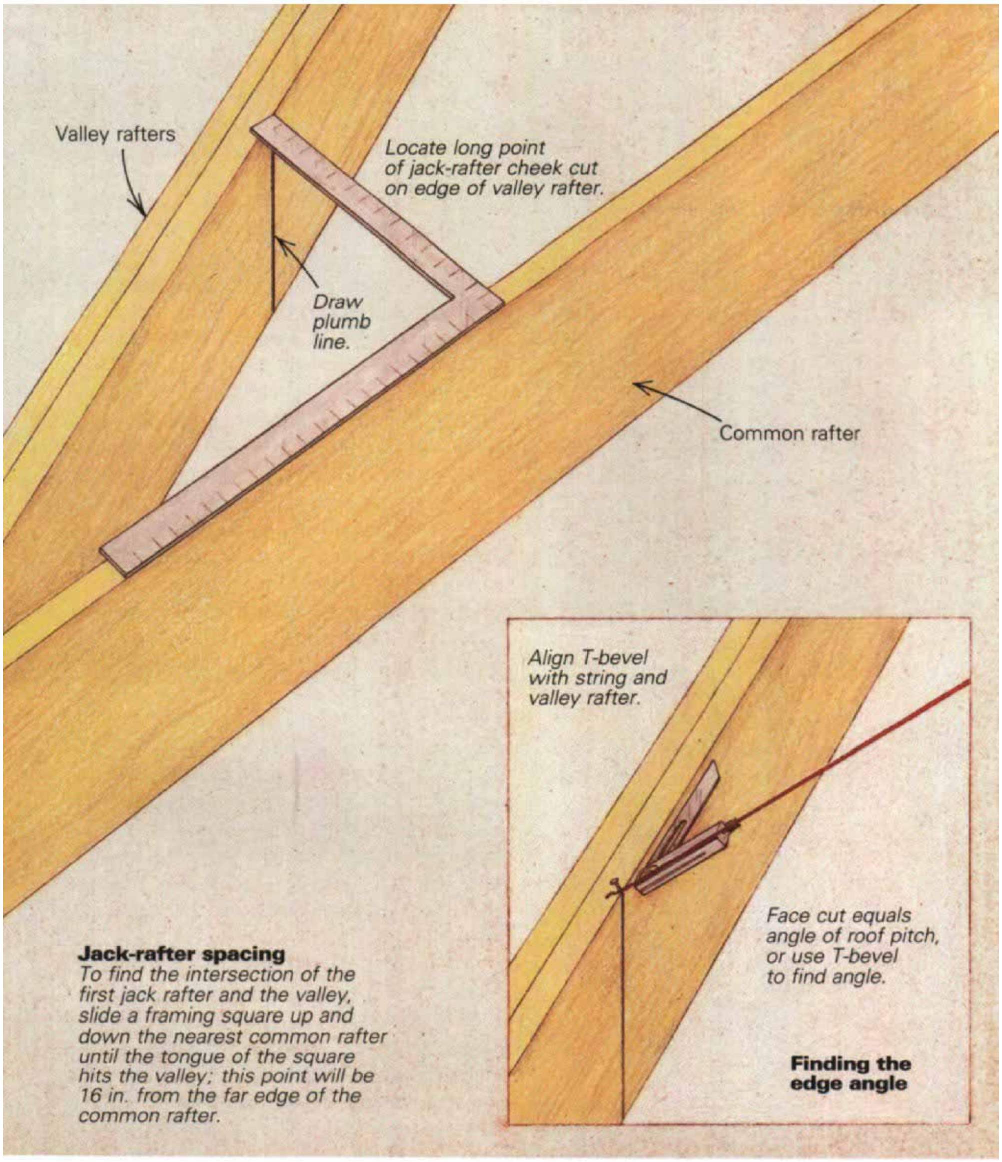
about, especially if the span is long. The string is a convenient guide for constantly checking alignment. Temporary braces may be needed to hold the valley rafter to the line until all the framing is complete.

**The valley jack rafters**—I have found that the tables of common differences for jack and hip rafters on lines 3 and 4 of the framing square don't always lead to perfect cuts. There are just too many 16ths and smidgens in a real framing job for it to correspond exactly with a theoretical frame. And because I was dealing with an odd pitch on this project, I wanted to derive the common difference (the uniform difference in length between each successive jack) by measuring the actual distance between the first two jack rafters, not by consulting a table. It was string and level time, phase II.

The layout lines for the jack rafters were already marked on both ridges. All I had to do was make a corresponding tick mark on the valley rafter at the right place to find the length and face angle of the jack. I knew that the center of the jack would have to be 16 in. away from the center of the nearest common rafter and be parallel to it, so I was able to use my square to pinpoint its intersection with the valley. (You'll have to eyeball the common rafter for straightness and take out any bows by bracing with a temporary board before you try this.) With the long side of the square resting on top of the common rafter and. the short side resting on the valley rafter, I simply slid the square up and down until I located a point on the outside of the valley exactly 16 in. away from the outside of the common rafter (top drawing, next page). This represented the intersection of the valley jack with the valley.

**Section through doubled valley**
*A 2x4 ripped to fit can be nailed to the underside of the doubled valley rafters as nailing surface for the ceiling finish.*






Then I drew a plumb line down the side of the valley rafter using a short level.

I fastened a string from the top of this mark to the ridge, parallel to the common rafter, and stretched it tightly. Then I aligned the body of the T-bevel with the string and set the blade against the valley rafter; this gave me the angle of the cheek cut. It's important that the blade and the center of the T-bevel handle be in the same plane when lined up to the string; a small twist will give you an incorrect angle. Here again, you'll want to make a trial piece from scrap stock to test the fit before cutting the actual rafter. Because the valley had been doubled up earlier, instead of dropped, the point marked was exact.

To determine the jack-rafter length I simply measured the string from the ridge to the tick mark on the valley rafter. I duplicated the angle of the plumb cut at the ridge on each successive piece using a framing protractor. Making the compound cuts first before laying out the plumb cut at the ridge end ensures a good fit. The string was no longer needed once I found the angles and verified the fit.

After I installed the first jack rafter, it was easy enough to determine the common difference simply by measuring it. All I had to do now was repeat the series of cuts on each remaining jack rafter, reducing the length of each one by the common difference.

To keep the valley rafter in line, the jack rafters are usually nailed home in opposing pairs. But with unequal roof pitches, the cheek cuts are not mirror images and the spacing intervals will not line up across from each other. To avoid throwing subsequent measurements off, I find it easier to work up one side of the valley at a time, marking the position of the next jack rafter by setting the framing square along the edges of the last. I used bracing to keep the jacks from crowding the valley rafter off the center line.

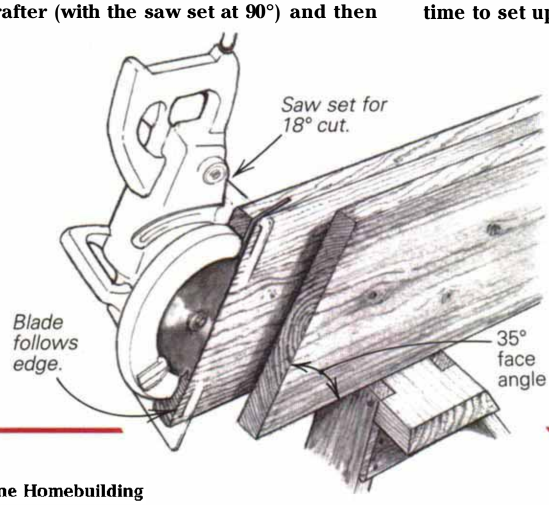
The beauty of this empirical method is that no advance preparation is required before framing can begin. A good rule of thumb is: if you count the jack rafters for one side of the valley as if they were common rafters and add an extra, there won't be much waste. The shorter jacks are usually cut from the leftovers of the longer ones. □

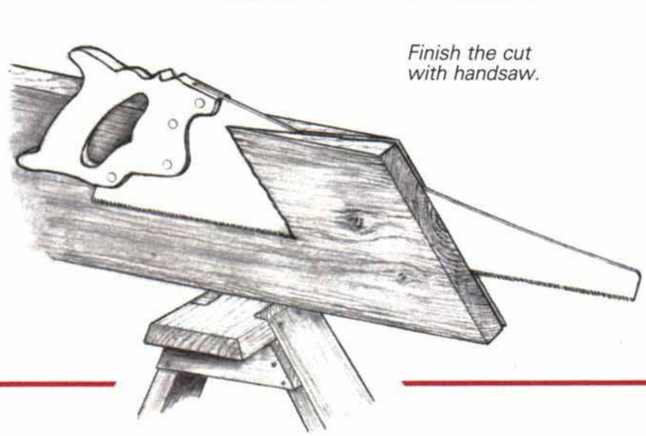
*George Nash lives in Burlington, Vt.*

## *Making cheek cuts*

**The worst thing about jack rafters is making the cheek cut, which is almost always greater than 45°. Sawing through a 2x12 at a compound angle with a handsaw is tedious and tiresome; using a chainsaw is dangerous and usually not very accurate, and I don't have a compound miter saw. Instead, I used applied geometry, some power and a dash of old-fashioned elbow grease.**

**For example, suppose the edge angle figures out to be 72° and the face angle 35°. I first cut the face angle across the face of the rafter (with the saw set at 90°) and then tack the rafter to the sawhorse. Complementary angles must add up to 90°, so the complement of 72° is 18°. If I set the saw at that angle and then hold its base against the edge cut itself (perpendicular to the side of the rafter) I can make a 72° cut. Although a 7¼-in. blade will not cut all the way through the angle, what's left is fairly easy to finish with a handsaw. An 8¼-in. or 12-in. circular saw would be handier. I know of no easier way to make these cuts than on a radial-arm saw, which takes more time to set up.**




Drawing: Bob Goodfellow