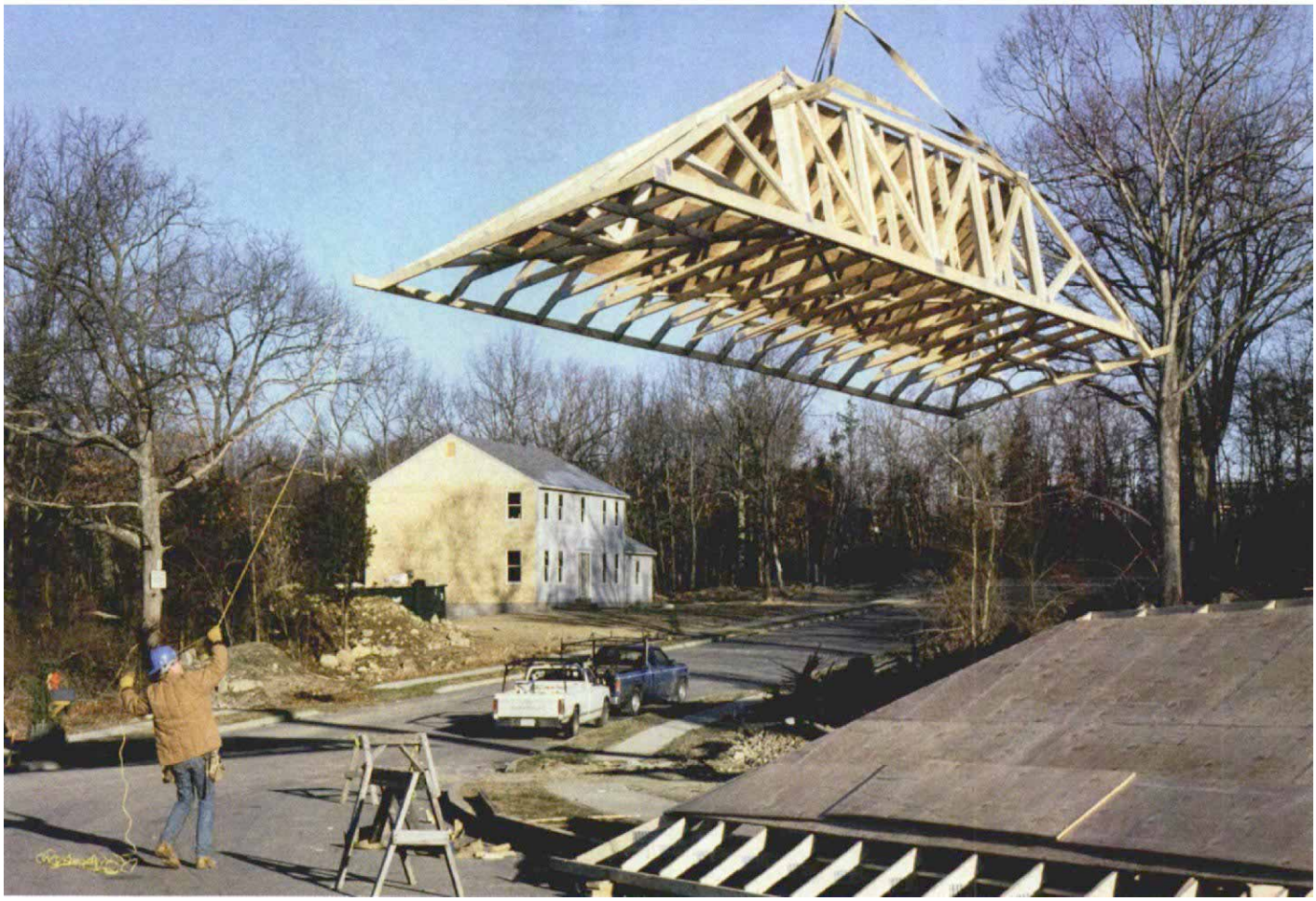


The hip goes up in one piece. Like a giant box kite on a string, an entire hip section is lifted to its home atop a two-story house.

Building Hip and Valley Roofs With Trusses

Keep the numbered trusses in order, and entire hip sections can be assembled on the ground and lifted as single units

by Rick Arnold and Mike Guertin

A few years and many roofs ago, a builder approached us about framing a two-story colonial-style house. He said that he wanted to try a truss system for the hip roof. We had used trusses for a lot of gable roofs, but we had never seen a hip done that way. When the trusses for the job were delivered, we just stood back and scratched our heads. It looked as if bunches of unrelated pieces had been strapped together in no particular order. The engineering plan looked like a map of some unfamiliar suburb.

Too smug to admit that we needed help, we muddled our way through, lifting each weird-looking truss up to the roof by hand and then moving each piece three or four times until we found the right spot to nail it. That roof is still in good shape after two hurricanes, and whenever we drive by the house, we chuckle at how much time and effort it took to put that roof together.

Our methods for assembling hip-and-valley truss systems have evolved a great deal since that first puzzled attempt. The biggest advance in our technique came when we described the process to our crane operator. He suggested assembling some of the trusses on the ground and lifting whole hip sections onto the house in one shot (photo above). It worked like a charm. Now we even sheathe the assemblies before they go up.

Building hip systems on the ground is quicker and safer—Before anything is assembled, we prep the hip-and-valley trusses much as

we do standard trusses (*FHB* #99, pp. 50-55). We line them up in a stack on the ground and mark layout lines for the sheathing and strapping and for alignment on the walls. If necessary, we also restack the trusses that will be lifted individually by the crane to be sure they're in the proper order. We lay out the wall plates according to the truss plan (sidebar p. 79) and write the number and designation for each truss at its layout point.

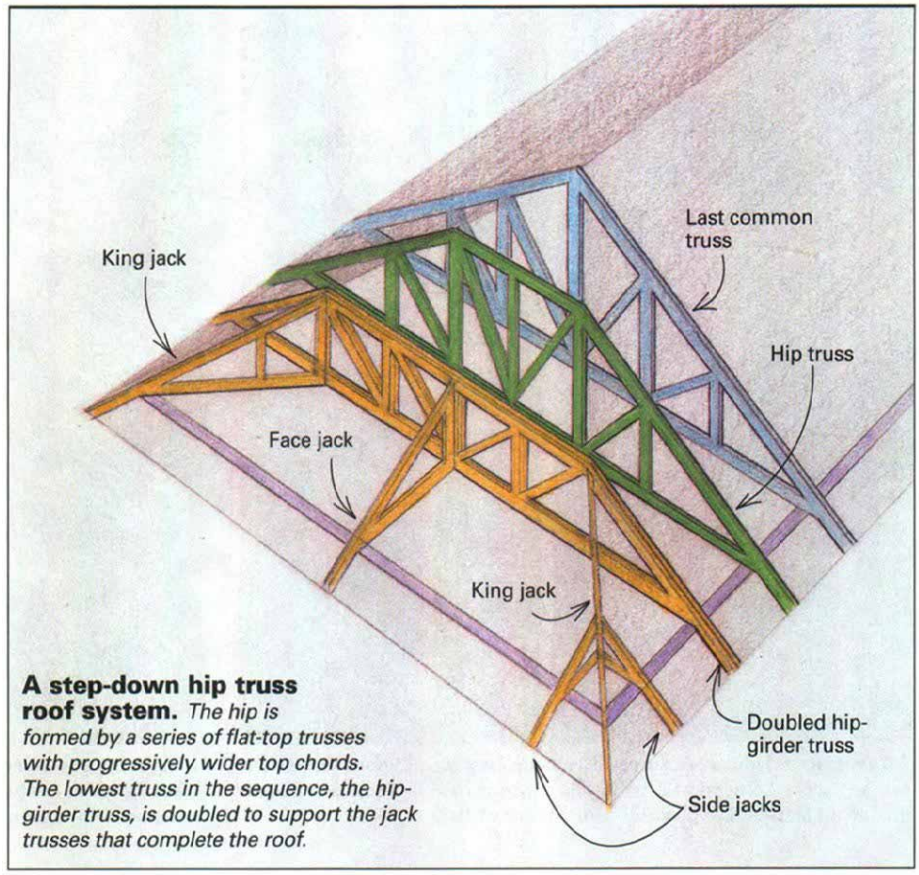
When framing hip roofs with trusses, we most often use a step-down hip truss system (top drawing). Trusses in this system have the same span as common trusses, but they're flat on top (for more information on types of trusses, see *FHB* #89, p. 41). The flat parts of the hip trusses become progressively wider and lower as the trusses step away from the last common truss to begin forming the hip. The lowest and widest hip truss, the hip-girder truss, supports a series of monotrusses, called jack trusses, that complete the roof. The hip-girder truss usually has a heavier bottom chord than the other hip trusses to accommodate the extra weight of the jack trusses and the metal hangers that hold the jacks. Generally, two girder trusses are nailed together and work in tandem for each hip system.

After the wall plates are laid out, we lay out a hip-girder truss while it is still lying flat on top of the pile. We begin our layout by locating the exact vertical center of the truss, top chord to bottom (bottom drawing). First we locate the middle of the top flat chord of the truss. Then from the ends of the flat chord, we measure equal distances diagonally to the bottom chord. Halfway between our diagonal marks is the midpoint of the bottom chord. The line between the midpoints is the vertical centerline.

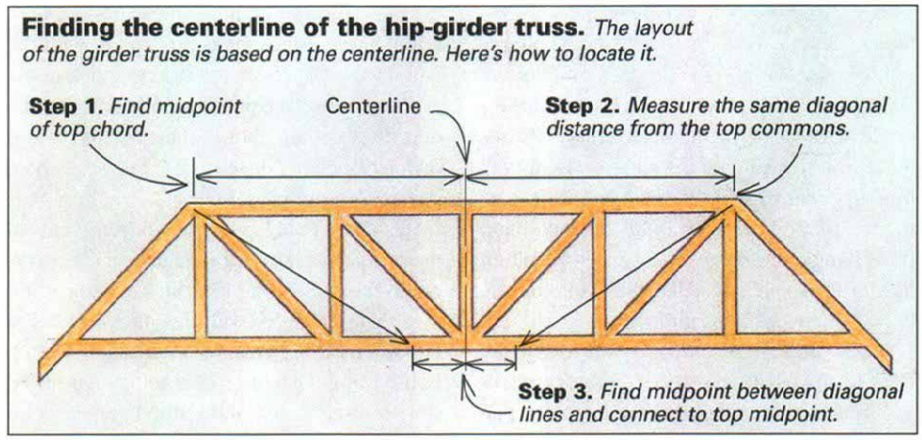
From this centerline we can locate the position of the outermost jack trusses on both the top and bottom chords as indicated on our truss plans. A jack truss is a monotruss with a single top chord. There are three different types of jack trusses in a hip system: face jacks that are attached to the face of the hip-girder truss and that run perpendicular to it; king jacks that run diagonally from the girder truss and form the outside corners of the roof; and side jacks that are attached to both sides of king jack trusses.

The layout for the rest of the face jacks is taken from the wall-plate alignment mark on the girder truss. However, the center jack truss is always at the exact center of the girder, regardless of the spacing. We tack metal hangers for the face jack trusses onto the bottom chord of the girder truss with just a couple of nails in each hanger. They will be nailed in permanently with spikes after the second girder truss is mated to the first.

Jack trusses are nailed to a pair of hip-girder trusses—Next we move the prepared hip-girder truss to a relatively flat area of the job



A step-down hip truss roof system. *The hip is formed by a series of flat-top trusses with progressively wider top chords. The lowest truss in the sequence, the hip-girder truss, is doubled to support the jack trusses that complete the roof.*



A jack truss holds the girder truss upright. The center face jack truss is tacked to the girder truss to keep it vertical while the rest of the face jacks are installed.

Straightening the girder trusses. A temporary brace keeps the girder trusses straight while they are being nailed together.

Drawings: Chuck Lockhart

A furring-strip spacer keeps the tails in place. Before the system can be squared, the tails of the face jack trusses are spaced according to the layout and held in position with a piece of 1x3.

Diagonal measurements square the system. Measurements are taken between the two outermost jack trusses, and the tails of the trusses are moved in unison until the measurements are equal.

site and prop it upright on blocks. The center face jack truss is set into its hanger and tacked to the girder truss at the top to hold them both upright (photo left, p. 77). The tails of all of the jack trusses need to be supported, so we make a continuous block out of long lengths of 2x material. The blocking for the jacks is raised until the hip-girder truss is sitting fairly plumb, and the rest of the face jacks are then slipped into their hangers and tacked at the top. When they're all in place, we nail them off through the chords and webs of the girder truss.

Now we tack the second hip-girder truss to the first with just a few nails so that the girder trusses can be straightened before they are joined permanently. We run a Stringline on the top and bottom chords of the girder trusses to get them straight. If need be, we temporarily brace the bottom chord against the ground to keep it straight (photo right, p. 77). The tails of the face jacks are kept at the correct spacing with furring strips, marked to match the jack-truss layout and tacked on top of the bottom chords (photo left). When the girder trusses are straight and the face jack trusses are spaced properly, we nail the two girder trusses together through all of the chords and webs, and we nail off the hangers for the face jacks.

We are now ready to square the assembly. First we recheck our strings on the girder trusses and then measure diagonally between the top chords of the two outermost face jack trusses (photo right). The tail ends of the face jacks are moved in unison until our measurements are equal and the face jacks are square with the girder truss. We check our strings one last time and nail a furring strip diagonally onto the underside of the top chords of the face jacks and on top of their bottom chords to keep the whole system square and uniform.

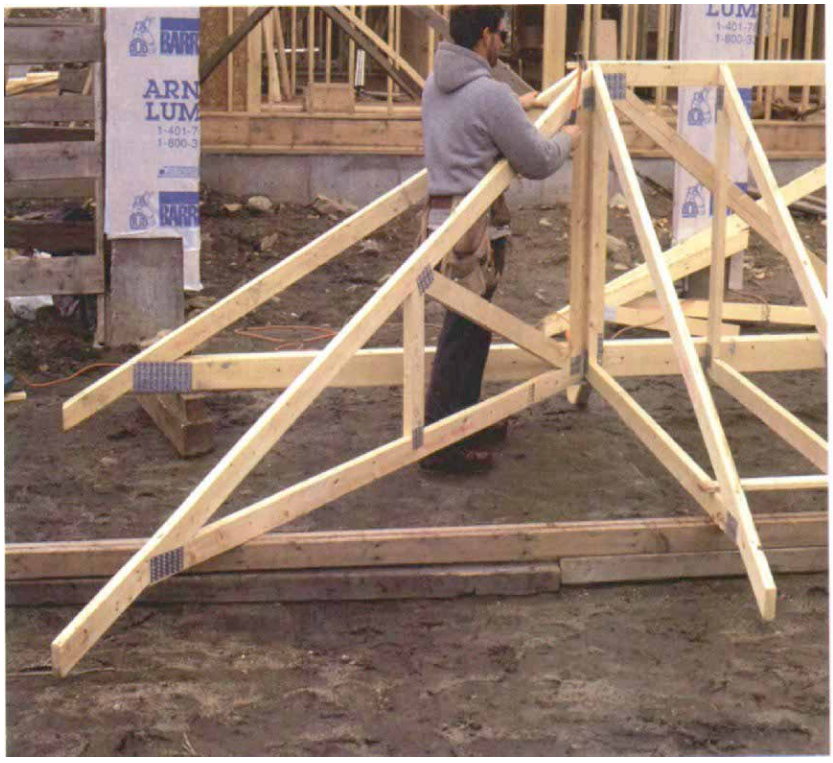
A 2x4 subfascia is now nailed to the tails of the face jack trusses and extended far enough to catch the tails of the king jack trusses when they're installed. We will straighten the subfascias after the hip systems are installed on the house walls. If the hip roof is going on a single-story house, we ordinarily stop here. Because the staging is simpler for a single-story house and because materials can be passed to the roof directly from the ground, it's quicker for us to complete the assembly in place.

Special hangers hold the jack trusses for the hip corners—For multistory houses we finish building the hip section on the ground. The next step is tacking the king jack trusses in place (photo top left, facing page). The king jack truss is built with the top chord at the same pitch as a hip rafter and functions in much the same way. The king jack trusses are installed between the hip-girder truss and the last face jack truss on both ends of the assembly. They fit into a specially designed hanger, provided by the truss manufacturer, that eliminates the need for the 45° angles normally cut on the top end of a hip rafter. We position the king jacks at exactly the same distance from the girder truss and the adjacent face jack truss, and we temporarily hold them in place with a furring-strip brace.

The tails of the hip trusses are usually left long by the manufacturer and cut to length on site. We run a string along the tails of the face jacks to determine where the tails of the king jacks need to be cut. We usually make this cut with a reciprocating saw because the subfascia tends to get in the way of a circular saw.

Next we cut the return angle on the tail of the first king jack. We find this cut by measuring along the bottom chord of the hip-girder truss from the first face jack truss to the end of the overhang. Then we measure that distance from the tail of the face jack to the tail of the king jack and make our cut there. The subfascia is cut to the same length and then nailed to the king-jack tail. On the other end of the assembly, we cut the king-jack tail and subfascia so that the length of the subfascia is the same as the overall length of the girder truss. The returning subfascias can now be nailed on. If possible, we extend the returning subfascias back beyond the girder trusses to tie into the other step-down hip trusses when they are installed.

The side jack trusses are attached directly to the king jacks (photo top right, facing page). A side jack truss is a simple monotruss with just a top and a bottom chord joined together with



The king jack truss forms the corner. The top chord of the king jack is cut to the pitch of a hip rafter and functions similarly. It is held in place with a special hanger, and the tail is positioned equidistant from the girder truss and the outermost face jack.

Side jacks fill in the framing beside the king jack. Side jack trusses consisting of just a top and bottom chord are nailed to the king jack and the subfascia.

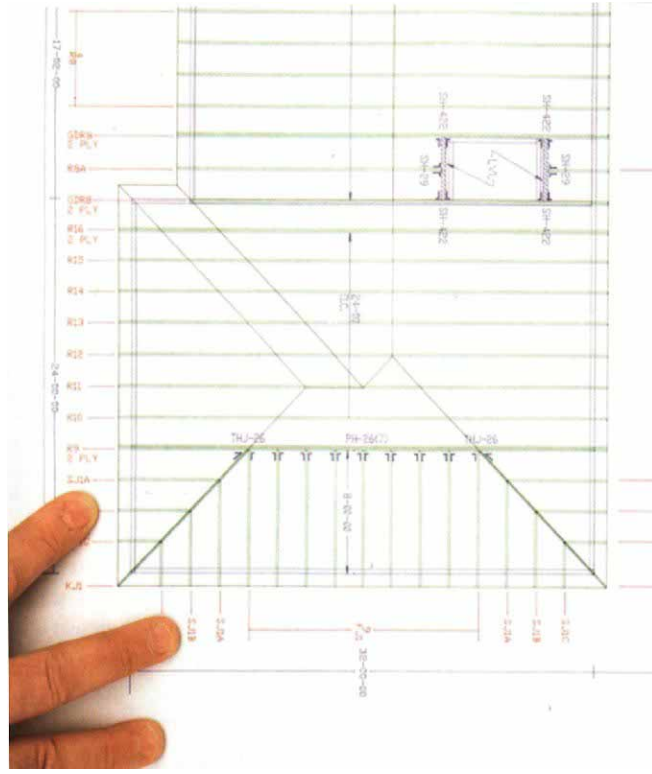
Truss fabricators engineer the roof for you

Truss systems can be designed for almost any complicated roof design (photo right). Although the cost for the truss package may be more than the cost for conventional framing materials, the labor savings are phenomenal. As an added benefit, the interior bearing walls necessary for conventionally framed roofs can be eliminated, which allows greater design flexibility. Some of the truss packages we have ordered even include complicated details such as vaulted ceilings and roofs with hips and valleys of different pitches, roofs that would have been a real challenge to frame conventionally.

We've found that the best way to explore the possibilities is to go over the house plans with the engineer for the truss fabricator. At that meeting we often make arrangements for minor structural changes in the house to accommodate the roof trasses. Sometimes by moving a couple of bearing points or inserting a carrying beam, we can change a roof from conventional framing to a truss system. The benefits we gam by using trusses have always outweighed any changes we need to make.

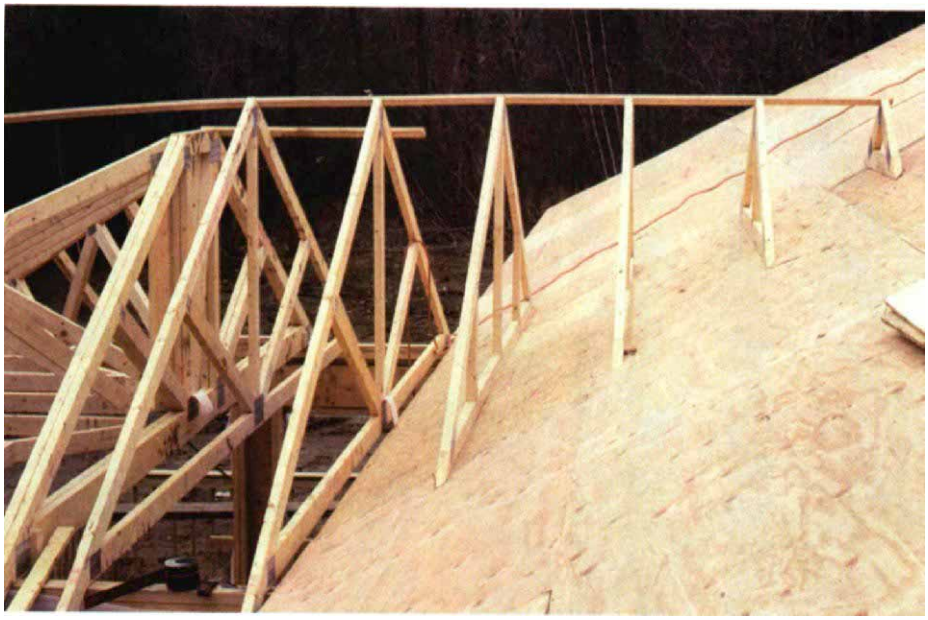
After the meeting our fabricator usually gets back to us within a few days with a rendering of the truss plan and a price. We are occasionally astonished when a truss system ends up costing less than the lumber for a conventionally framed roof because trusses are made of less expensive, smaller dimension lumber.

We study the truss plan before the trusses arrive. If we're having trouble understanding a plan view of the system, the truss fabricator will provide an isometric drawing, usually at no extra cost. An isometric drawing shows the roof in 3-D and helps clarify the more difficult details.—*R. A. and M. G.*



The map of a complicated roof system. Engineered-truss plans like this one, which is for the roof pictured on p. 81, are provided by the truss manufacturer. The plan identifies each type of truss and its exact location. This roof features a dozen different types of trusses.

Truss plan: Courtesy of Trussco Inc., Davisville, R. I.



A valley kit is nailed directly to the sheathing. A series of progressively smaller trusses, called a valley kit, forms the valleys between two intersecting roofs.

truss plates at the splice point. We locate the attaching points for side jacks by pulling 24-in. centers off adjacent girders and face jack trusses. The subfascias are laid out the same way.

Usually the manufacturer cuts the side jack trusses to the proper length but without the 45° angles on the ends of the chords. We cut these angles on site. For each hip system, there are four of each size side jack truss, two with right-hand 45° cuts and two with left. Having one person organize and cut the side jacks minimizes the chances of cutting them wrong. Once the side jacks are cut with the proper angle, they can be positioned and nailed to the king jack truss and the subfascia.

We sheathe the trusses by snapping lines across all of the jack trusses and filling in as many sheets as we can. We don't sheathe return facets of the hips until the system is in place on the house so that our sheathing will tie back into the other trusses. Lower sheets are tacked in place temporarily so that we can lift them out of the way when we nail trusses to top plates.

Assembled hip sections are lifted level— When we lift the hip sections, we run heavy-duty straps through the top corners of the hip-girder trusses where the king jack trusses are attached for the strongest lifting points (photo p. 76). We attach an adjustable strap around the tails of the three middle face jack trusses to balance the load. The crane operator lifts the assembly just a little so that we can adjust the middle strap and get the assembly as level as possible before it's lifted into place. The more level the assembly is, the easier it is to position on the walls.

When the assembled hip system is airborne, a crew member stationed on the ground keeps it steady with a tag line until it is within reach of the crew on the staging. First we land the assembly at the layout marks on the plates for the hip-girder trusses. Then we have the crane tug the whole assembly toward the front or back until the lines on the bottom chord of the girders align with the inside edge of the walls. When the system is properly positioned, we release the straps and nail the trusses to the top plates of the end wall and along one side. The process is repeated for the opposite hip assembly.

The step-down hip trusses are now lifted into position one at time. We tack on short pieces of furring just below each of the flat sections to connect one truss to the next at the correct spacing. The process is repeated until we set the first full-height common truss. Then we pause the crane and tack a long piece of furring onto the flat tops of the trusses, measuring and spacing them properly as we go.

The common trusses are sent up two at a time and locked in place temporarily with Truslock truss spacers (Truslock Inc., 2176 Old Calvert Road, Calvert City, Ky. 42029; 800-334-9689; see *FHB* #93, p. 98). The layout for the last common truss is usually irregular to accommodate the step-down hip or valley system. We space that truss with a piece of furring marked to reflect the difference in the layout. The step-down hip trusses for the other end of the house can now be sent up one at a time and braced with furring as we did with the first end.

Building valleys out of trusses is a snap— There are two basic ways of framing valleys with trusses. The one we encounter most frequently, and the easiest to frame, is the intersection of two simple roofs. We begin by setting all of the trusses for the main roof. If there are no interior bearing walls to support the trusses of the main roof where the two roofs meet, we hang the ends of the unsupported trusses on hangers nailed to a girder truss, which is part of the other intersecting roof.

Once the main roof has been sheathed, we set the trusses for the intersecting roof as far as the main roof. The valleys are created with a valley kit, which is a set of progressively smaller common trusses nailed directly onto the sheathing (photo left). We usually rip the pitch angle of the intersecting roof onto the bottom chord of each truss in the valley kit. Although cutting trusses is not a practice that is generally accepted, our truss manufacturer has assured us that ripping valley-kit trusses for this type of application is permissible.

If a valley is so close to a hip that a girder truss can't be used to hold the main roof trusses, a second method using special step-down valley trusses may be the answer (photos and drawing, facing page). These valley trusses are similar to common roof trusses except that the top chord is interrupted by a flat extension. The length of the flat extension is the same for every step-down valley truss and reflects the distance between the hip and valley lines. However, the height of the flat extension increases with each successive truss, creating both the valley and the hip as they go. Again, because each truss in the series is different, we take extra care to stack the trusses in the order that they will be lifted by the crane. Following the truss plan to the letter helps a great deal.

All of the hip and valley lines are reinforced with blocking—After all of the trusses are set and the crane leaves, we complete the truss installation with a few extra details. First, we beef up the hips and valleys with 2x blocks cut with compound angles. These reinforcing blocks are not specified on the engineer's plan, but nailed between the step-down trusses at the hip and valley lines, they're helpful as spacers for the trusses and as nailers for the sheathing.

As with a simple truss roof, we nail the trusses only along one side of the house during the raising. After the crane leaves, we restraighten the walls in case they've been knocked out of line while the trusses were set. When the walls are straight, we nail off the other end of the trusses. The rest of the subfascias can now be installed and shimmed straight. After our lunch break, we finish sheathing the roof. □

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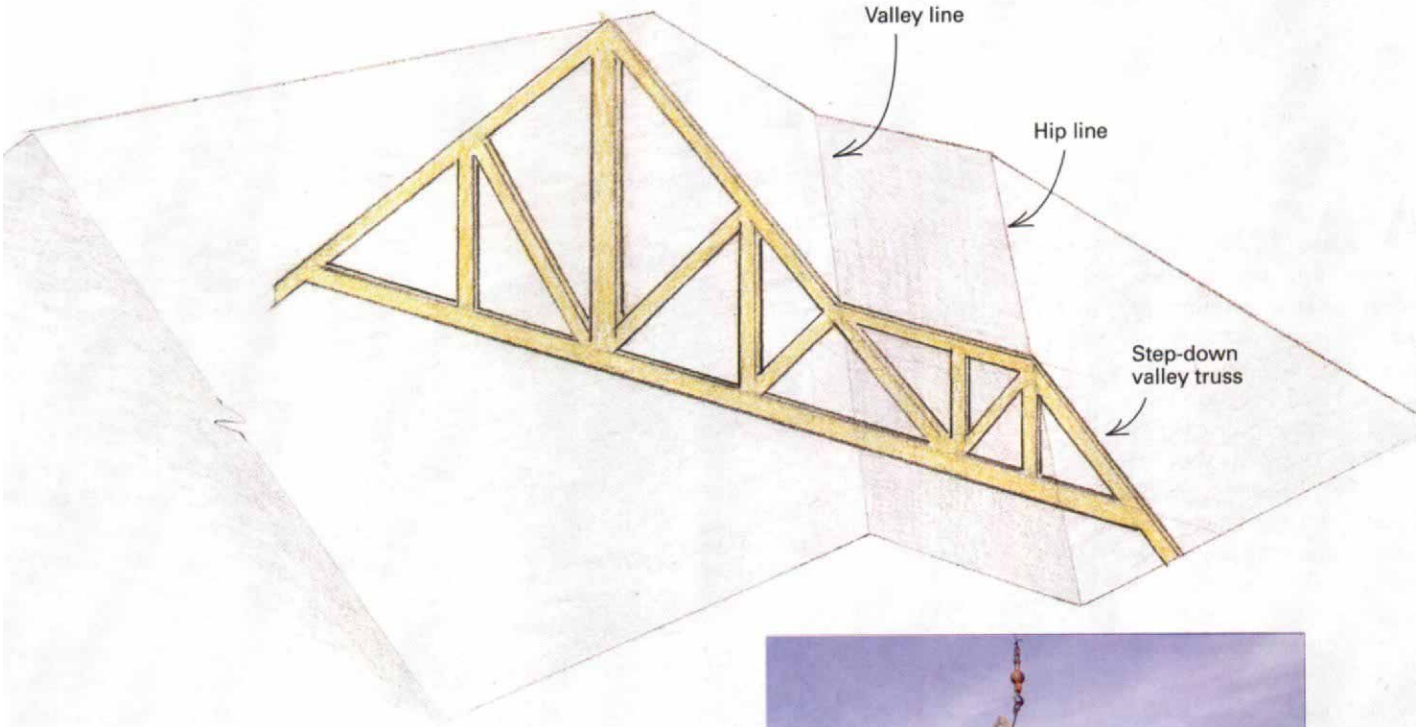
Photo this page: Mike Guertin

Hips and valleys next to each other require special trusses. *When a hip and a valley are too close together to be framed with conventional trusses, as in the drawing below, special step-down valley trusses have to be used.*



Step-down valley trusses create the roof plane. When step-down valley trusses (photo right) are installed, the flat portion of the top chord gets higher with each successive truss (photo below), forming the roof plane between the hip and the valley.