Timber-Frame Layout

Systems for labeling the timbers and adjusting the joinery keep the frame plumb and true despite variations in dimensions

by Tedd Benson

The mystique that surrounds the craft of timber framing often clouds a full understanding of the kind of work that goes into cutting, assembling and raising a frame. It's easy to imagine yourself paring off fine shavings with a razor-edged chisel and raising timbers in communal euphoria. There's real satisfaction in pushing a tenon home into its perfectly mated mortise, or in driving the pegs to lock the joint. All these things contribute to the pleasures of framing with timbers.

But precise joinery is only a small part of the process. Many of the frames we build contain well over 200 timbers and 350 connected joints. The frame shown in the photo above was raised in one dramatic day by a crew of five and a crane. But this day was merely the culmination of all the work that preceded it. There were five days of sanding timbers and assembling bents, and before that, many hours of work in the shop.

Careful planning, hard work and strict adherence to labeling, layout and mapping rules made it possible for five workers and a crane to raise this frame in one day. It has 203 individual timbers and 382 joints.

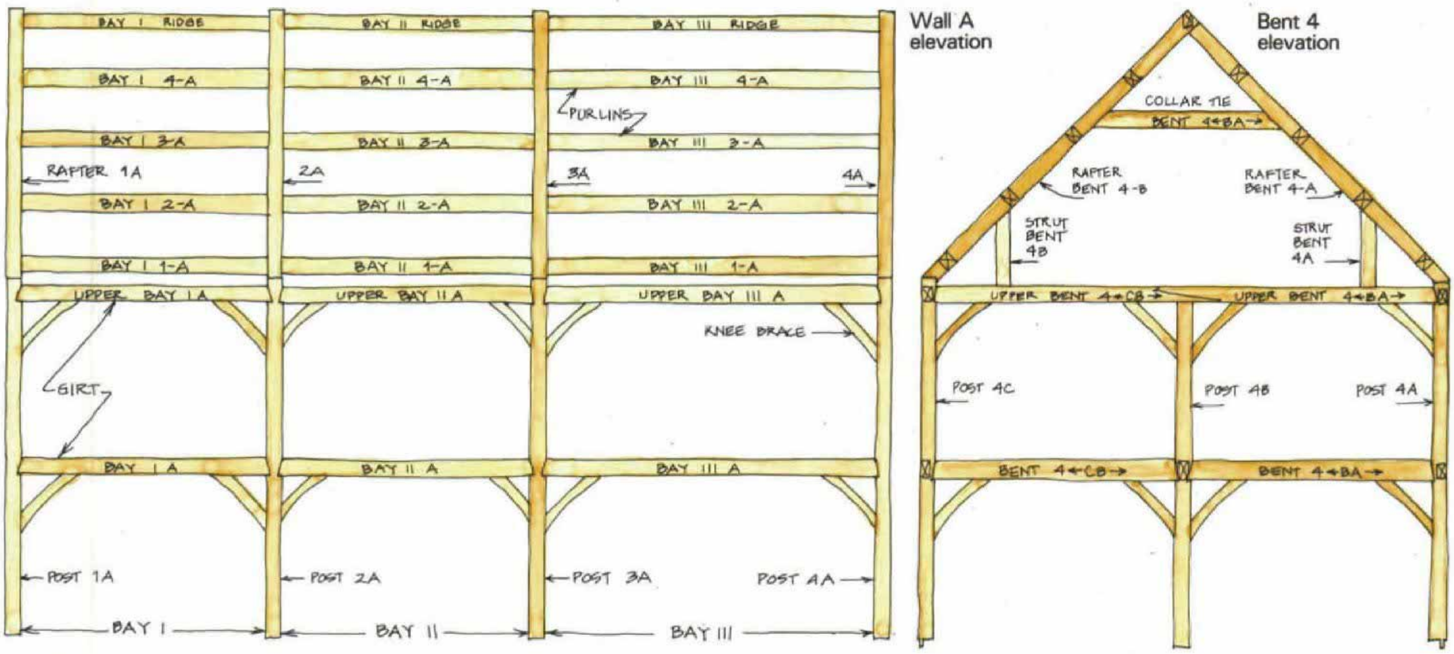
In order to work with speed and efficiency, there can't be any mystery whatsoever about what timber goes where. And all the timbers must fit exactly—a single misaligned joint stops a raising dead in its tracks.

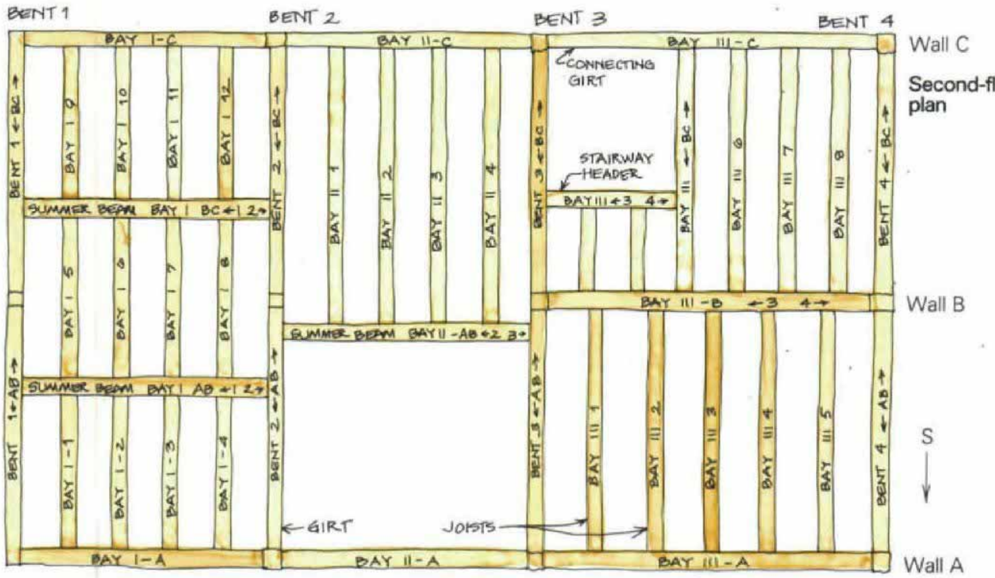
We lay out, cut, and finally truck a completed frame to the site without test-fitting the joints. We're able to do this only because every frame evolves with a great deal of planning, some applied geometry, and an organized approach to layout and cutting.

With an organized system and good preparation, a beginner can get through a difficult project. Without them, even a master joiner couldn't possibly succeed.

We apply three systems to the timbers and joints. *Labeling* is a system for identifying each member so we know where it fits within the overall frame. *Layout* is a method for locating and marking each joint so that all timbers will align correctly. *Mapping* is a system of accounting for variation in timber dimension and adjusting the length of adjoining timbers accordingly, so the completed frame will be true to its planned measurements.

To demonstrate how these planning principles work, I'll use the frame shown above as





Timber list and cutting sequence

Posts	12
Lower bent girts	8
Upper bent girts	8
Lower connecting girts	6
Upper connecting girts	6
Summer beams	8
Rafters	8
Collar ties	4
Struts	8
Purlins	24
Ridge beams	3
Joists and headers	52
Knee braces	56

Labeling a timber frame
Bents are numbered from west to east, posts and walls are lettered from south to north, and bays (the areas between bents) are designated with Roman numerals.

an example. These systems apply to every frame we construct, but we have to modify them somewhat to meet the specific demands of each new frame.

Labeling—After we finish the blueprints for a house, we draft a complete set of shop plans for the frame. This set of working drawings typically includes elevations for each bent and wall, a plan view of each floor to show joist and beam locations, and large-scale sections or blow-ups of any unusual joinery details. At this stage, all joinery decisions have been made, and every timber has been sized in dimension to support its respective load.

Labeling begins when the plans are drawn. A consistent identification system allows us to distinguish between the many timbers in any frame that look alike but may not be dimensionally identical.

Unless your label tells you the exact location and orientation of every piece in the frame, you'll be plagued by constant remeasuring, and you run the risk of putting timbers where they don't belong. Here's how our labeling system works:

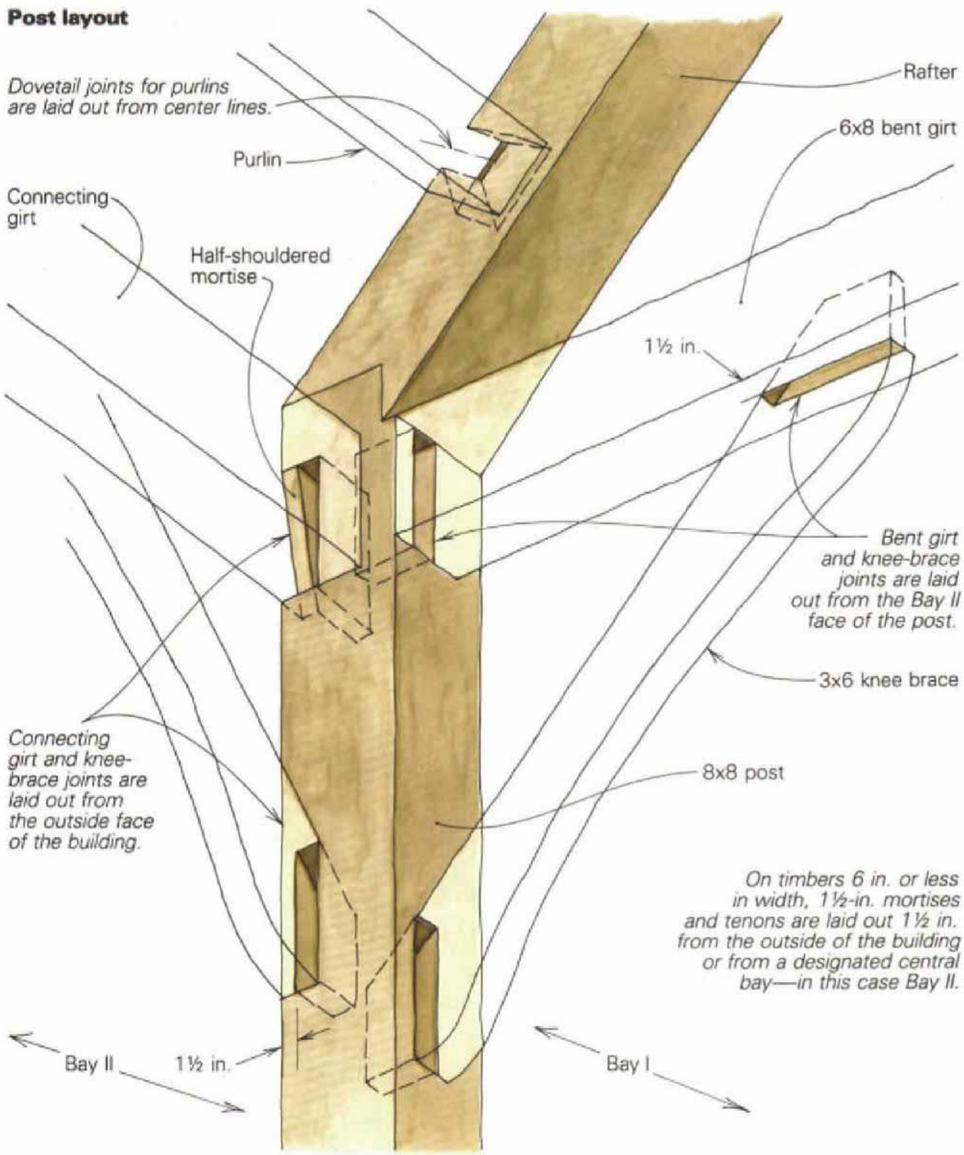
We draw plan views of the frame with south at the bottom of the page. Moving from west to east and from south to north, we number the bents, letter the posts, and assign Roman numerals to the bays (the spaces between the bents). For example, bay I is between bent 1 and bent 2; bay II is between bent 2 and bent 3; and so on. The posts in the southernmost row are A posts, the posts in the next row are B posts; those on the north side of the house are C posts and could be D or E posts on a very large frame. Posts also carry the number of the bent in which they stand. The southwest post will be 1A, for instance, and the post on the northeast corner will be 4C. The drawings above show how the various parts of the frame are labeled.

Bent girts are the horizontal timbers that join posts together to form a bent. Since the bent for a two-story frame will have more than one girt, a label like upper bent 1 ⇐B A⇒ would identify an upper girt that joins posts IB and 1A. The arrows match the ends of the girt to the posts they will join.

Connecting girts, which we sometimes call bent connectors, are bay timbers that span between posts. They join one bent to another, and carry the braces that keep the frame rigid in the direction of the wall. They're labeled according to the bay and wall they fit in. For example, I-B would indicate a girt that falls in the first bay, in the A wall.

Summer beams, purlins and floor joists all fall within bays of the frame. Summer beams are connected to adjacent bent girts and hold the floor joists. They're labeled according to the bay they're in and by the posts and bents they fall between, for example, summer beam I AB ⇐1 2⇒ (bay I, between A and B posts and between bents 1 and 2).

Purlins are horizontal timbers that connect adjacent rafters, and are among the pieces that often appear identical but aren't, as a result of variations in rafter dimensions. A purlin would get a label like purlin III 4-A (bay III, A wall, fourth purlin up from the eave). Floor



joists have a bay Roman numeral, and are also numbered as they fall from west to east or from south to north, as shown in the drawing.

It's important that all labels appear on the shop plans and on individual timbers. We use a lumber crayon and mark on a side of the timber that will later be covered—on the outside, for instance, or on the top. If it's an interior post and all sides of the timber will be exposed, the label can appear on any face. We sand or scrape it off later. Pieces should also be labeled on their ends, so they can be identified in a pile.

Layout—There are only about 10 different types of joints that we use in most of our designs, and all but three of these are simply mortises or tenons with added variables such as housings, shoulders, angles and tenon depths. Therefore, our layout rules are based on the relationship between the mortise and tenon. By standardizing their respective locations within each joint, layout work is simplified. Joints can be cut one at a time, with one framer taking up where another has left off without worrying about misalignments. The specifics may vary, and so may the exact dimensions used by other timber-frame crews, but these are the rules we apply to any frame:

1. All mortises and tenons that join timbers 6 in. or less in width are laid out 1½ in. from the outside of the building, or, in the case of an interior bent, 1½ in. from a designated bay. In the frame shown in this article, the pieces that would be governed by this rule are the knee braces, bent girts, collar ties, struts and connecting girts.

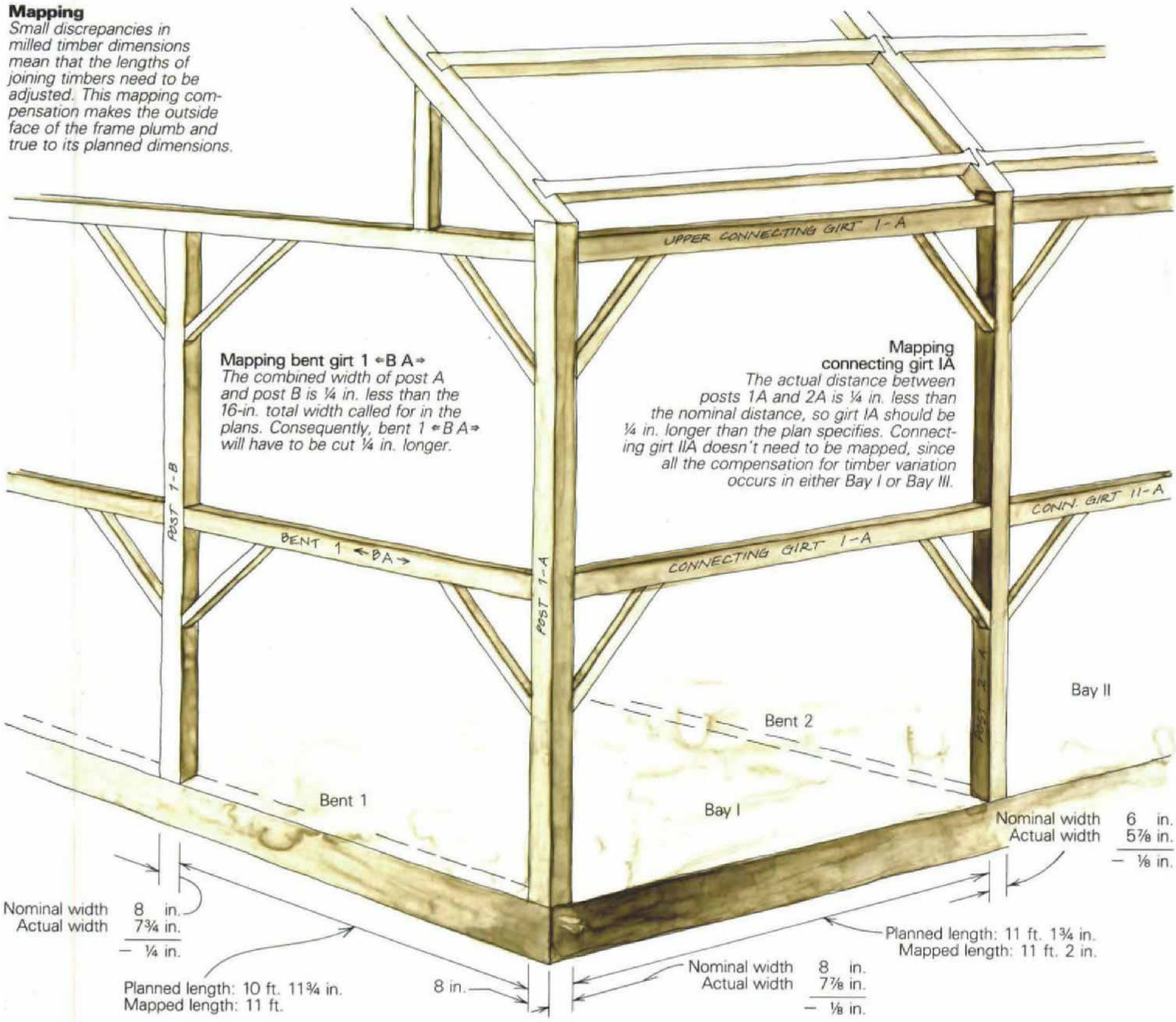
The 1½-in. tenon width that we use on nearly all mortise-and-tenon joints in a frame is convenient because the tongue of the framing square—our principal layout tool—is 1½ in. wide. Oak is strong enough for 1½-in. tenons; a frame of pine or fir would be better off with 2-in. wide tenons (which conveniently coincides with the width of the square's blade). In either case, we don't rely on the tenon alone to carry loads; we add a shoulder or housing to the joint for this purpose. The tenon holds the members together, but doesn't usually have to withstand shear forces.

2. When 1½-in. mortises and tenons are used to join two 8-in. wide timbers, the layout is 3¼ in. from the outside of the building, or from a central bay, bay II in this case.

3. The tenons that join the posts to the subfloor are all 1½ in. thick. Those on the perimeter are laid out 1½ in. from the outside of the building. A and C post tenons run parallel to the walls; B post tenons run parallel to the bents. Interior post tenons are centered.

4. The joints for joists, purlins, headers and

Layout rules. **Standardizing the size and location of mortises and tenons makes it possible for a timber-framing crew to work timbers individually, without having to test-fit each joint. Though the joinery in the post shown in the photograph looks complex, it is mostly mortise and tenon. The layout parameters that governed this post's joinery are explained in the drawing above.**



summer beams that don't fall on posts are laid out from centerlines.

Mapping—Compensating for slightly out-of-dimension timbers in the frame at the layout and cutting stages is a process we call mapping. It puts the variation in beam dimension in a predictable direction, keeping the timbers flush and plumb on the outside of the building and in any other plane that's important.

The timbers that we use to build a frame do not arrive from the sawmill cut to the precise dimensions described on the plans; they are roughsawn, and their thickness can vary by as much as ½ in. We have solved this problem by squaring the timber at the joint area with a portable power plane. We surface the rest of the timber with the plane for flatness and smoothness only. Then we compare the actual dimensions of the timber at the joint area with the dimensions called for on the blueprints. The difference between these two measurements is either added to or subtracted from the length of the joining timber. Essentially, that's mapping.

Let's say that post 1B (bent 1, B wall) measures 7¾ in. by 8 in., rather than 8x8, as called for in the plans (drawing, above). If the bent is going to be plumb, the length of the bent girt that joins the post at its narrower width will have to be increased by ¼ in.

Some parts of a frame don't require mapping adjustments. On the frame shown here, we laid out the joinery for all the timbers in bent 2 and bent 3 from bay II, so the variance in beam dimension was thrown toward bays I and III. Girts, summer beams and purlins in this midbay can be cut to their blueprinted dimensions. Knee braces throughout the frame don't have to be mapped because the bottoms of all girts are held to a prescribed measurement. On the other hand, some timbers have to be mapped in more than one direction, making the mapping operation quite complex.

Because of this, we make charts to keep track of dimensional variations throughout the frame as joint layout progresses. These charts are simply copies of the blueprints with blanks at each joint where actual measurements are filled in next to their nominal counterparts. We keep the mapping charts close at hand at all times, since some joining pieces are cut at different times.

Joint by joint, mapping adjustments are made according to the charts. This means we have to cut the beams in a predetermined sequence, which might change from frame to frame, depending on the interrelationship of the joints. By cutting the posts first, for example, we can note actual dimensions at the joint area and adjust the lengths of bent girts and connecting girts accordingly. After cutting the posts, we usually cut the bent girts, then the connecting girts, summer beams, rafters, collar ties, struts, purlins, ridge beams, joists and headers, and finally, knee braces. □

Tedd Benson's timber-framing company is based in Alstead, N.H.