Tying a Bow to an Eyebrow

Carpenters mix compound curves to build a bow window topped by an eyebrow roof

by Joseph Wood and Robert Caine

Silicon Valley is a symbol of the future. At its heart are row upon row of gleaming, mirror-clad offices and laboratories. Carreras and RX7s fill the parking stalls around the buildings, while technicians inside dust-free workshops probe the mysteries of microcircuits and disk drives.

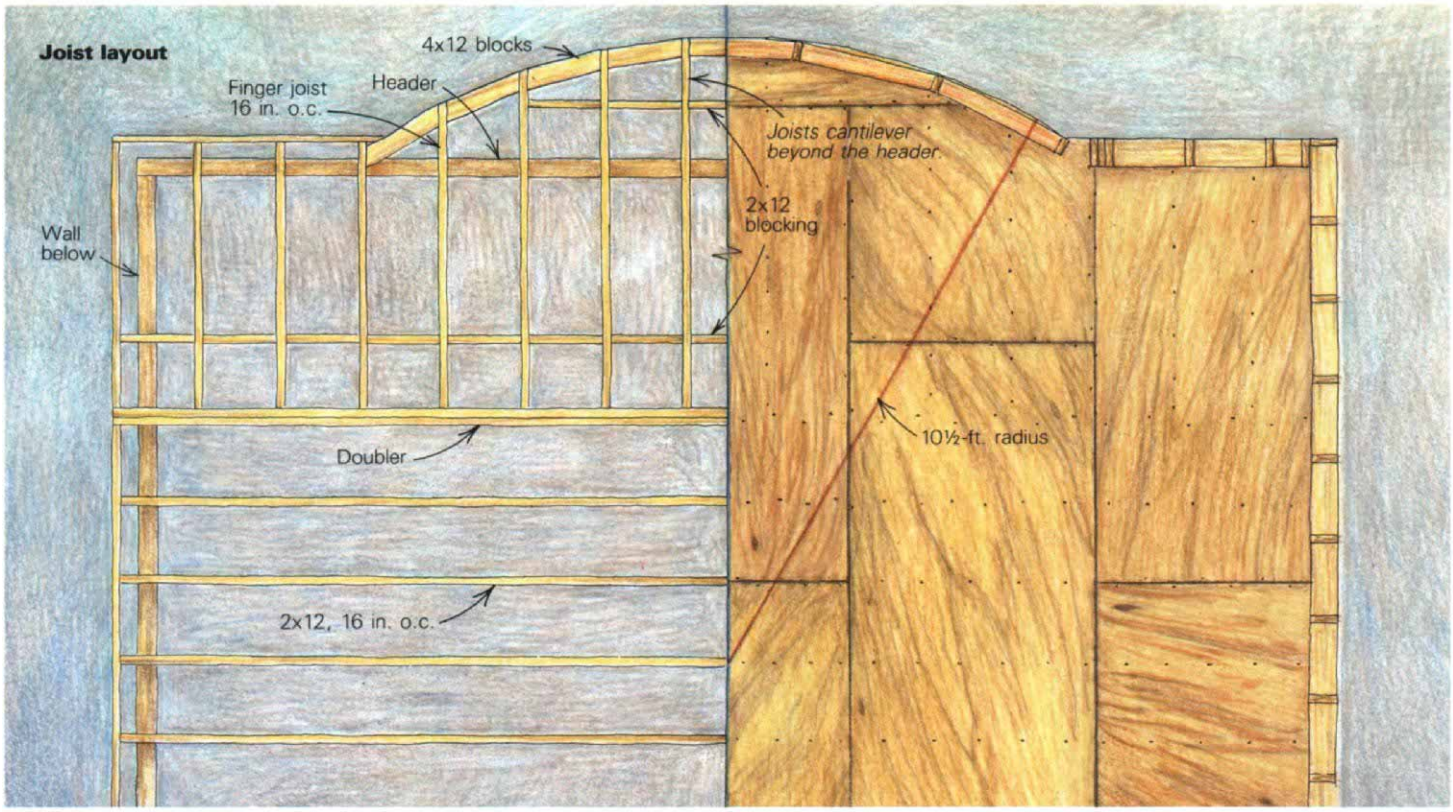
But you wouldn't know such contemporary pursuits were under way after a drive through some of the local neighborhoods. It seems that many of the Valley's home owners want to ignore the future and live in houses that evoke a simpler past. Brand-new houses cloaked in Victorian, French Provincial and Colonial detailing are common sights around here. So are Tudor Revival houses.

Tudor houses are probably best known for their half-timbering, in which dark, exposed wooden structural members contrast starkly with whitewashed stucco infill. Just as important to creating a Tudor look are complex rooflines—especially dormers with slighty curved hips. Covered with a roof of slate, these houses look like quaint old English inns, where you would expect to find a bed under a down quilt, a stable for your horse and a flagon of ale to slake your thirst.

Last year contractor Ray Anderegg hired us to frame a huge Tudor Revival house in Los Gatos, a bedroom community in the foothills to the west of Silicon Valley. Anderegg is well known locally as the builder of fanciful homes rooted in the European past. This Tudor, which was designed by Irving Haws, features layer upon layer of slate-covered roof planes. Perhaps the most striking of these roofs, and certainly the most challenging for us to build, was the eyebrow roof sheltering the master bedroom (photo above). It not only arcs above the adjacent rafters, but bears on the curved wall of a bow window as well.

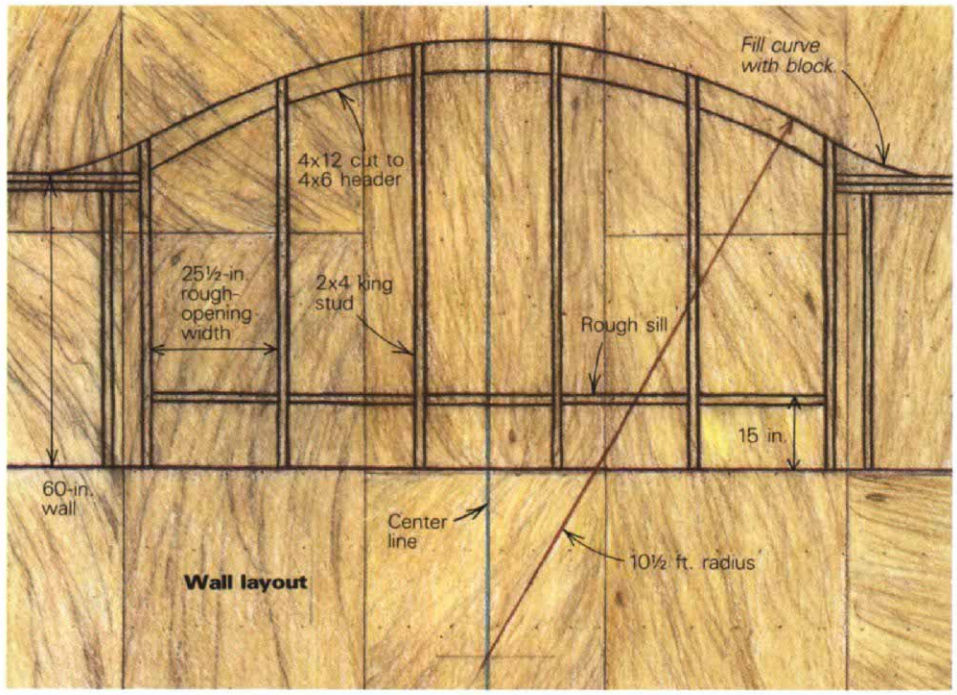
Calculating the windows—We used Pella windows almost everywhere in the house, including the simple bow window below the bedroom. Pella (Pella Windows and Doors, Dept. T39H7, 100 Main St., Pella, Iowa 50219) makes four, five and six-unit bow windows as stock items. The glass ranges from 16 in. to 24 in. in width (in 2-in. increments) and the stock assemblies will fit radii from a little less than 8 ft. to nearly 11 ft. Depending on how wide the glass is, these bow-window assemblies will fit rough openings ranging in width from 7 ft. 3 in. to a touch over 14 ft.

Before we started framing, we consulted Pella's specs to find which combination of units and glass widths came closest to matching the window shown in the elevations and plans. That turned out to be a 10½-ft. radius to the outside of the 2x4 framing, calling for a rough opening of a little over 12 ft. Given these dimensions, the



five-unit window with 24-in. glass seemed to fit our needs. In our experience, however, few custom details pop right in without some tinkering. In this case, we had to have king studs between window units to carry the weight of the second story above. Since the Pella specs assume the windows will nest tightly together, without studs between them, we decided on the five-unit window with 20-in. glass. That left us with enough space between the windows for our king studs.

Next came the tricky part. Pella doesn't make bow windows with curved heads, which is what we needed for the master bedroom. Instead, we had to find a window manufacturer that would be able to duplicate Pella's specs, and make the windows with curved heads that would match the swooping roof. But before ordering the windows, we wanted to draw the window-wall layout full size.



Floor framing and wall layout—We framed the bedroom floor with 2x12 joists. They cantilever over the window header below to support the curved portion of the floor (drawing, top). When we put down the subfloor, we sheathed the perpendicular rows of joists with staggered sheets of plywood.

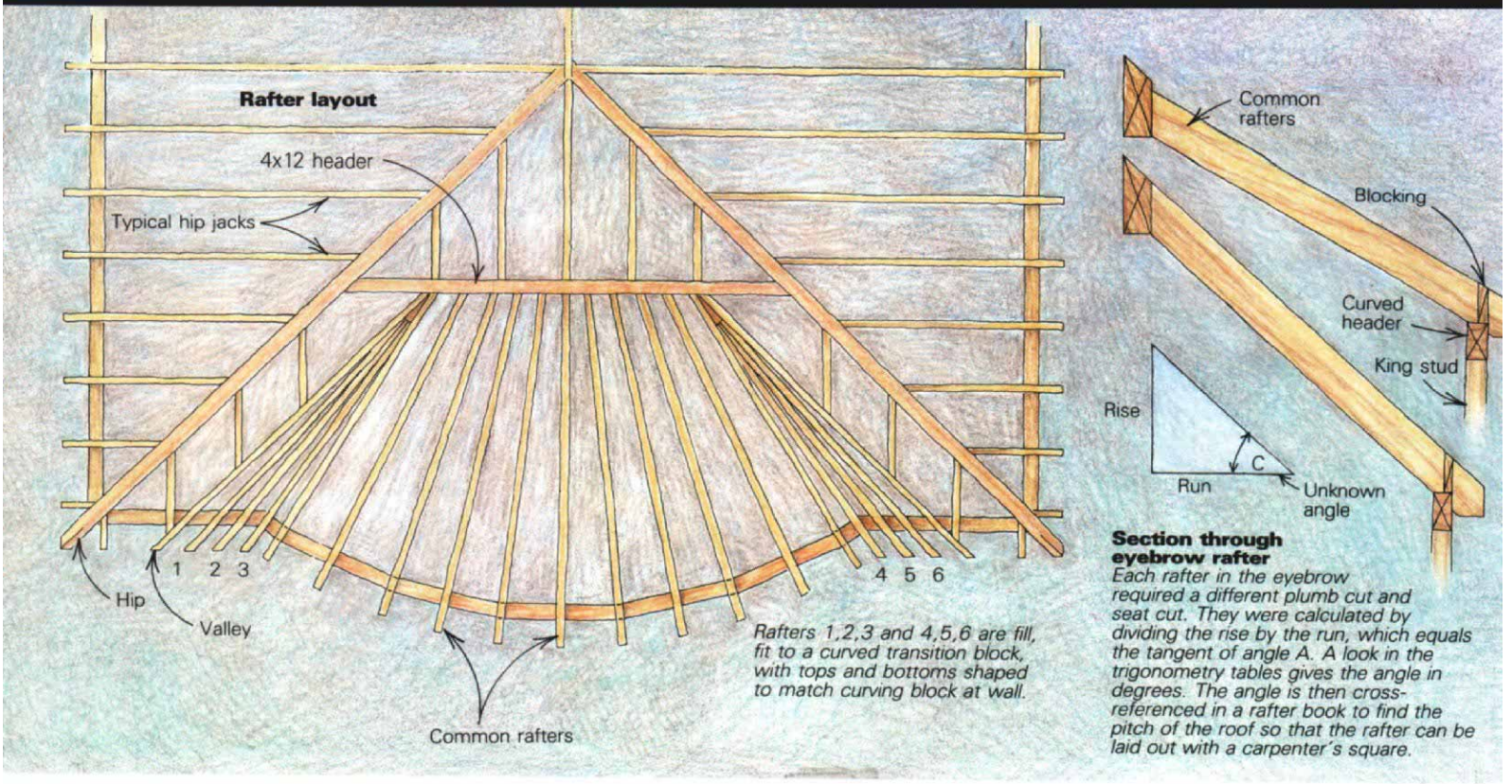
We let the ends of the joists run wild, and once we had them in place we located the center point and swung an arc to establish the window's 10½-ft. radius. After trimming the ends of the joists with a skillsaw to approximate the arc, we nailed 4x12 blocking at the ends of the joists. The blocks aren't curved to match the arc because we figured that the stucco finish we planned to add later on would smooth out the slight corners.

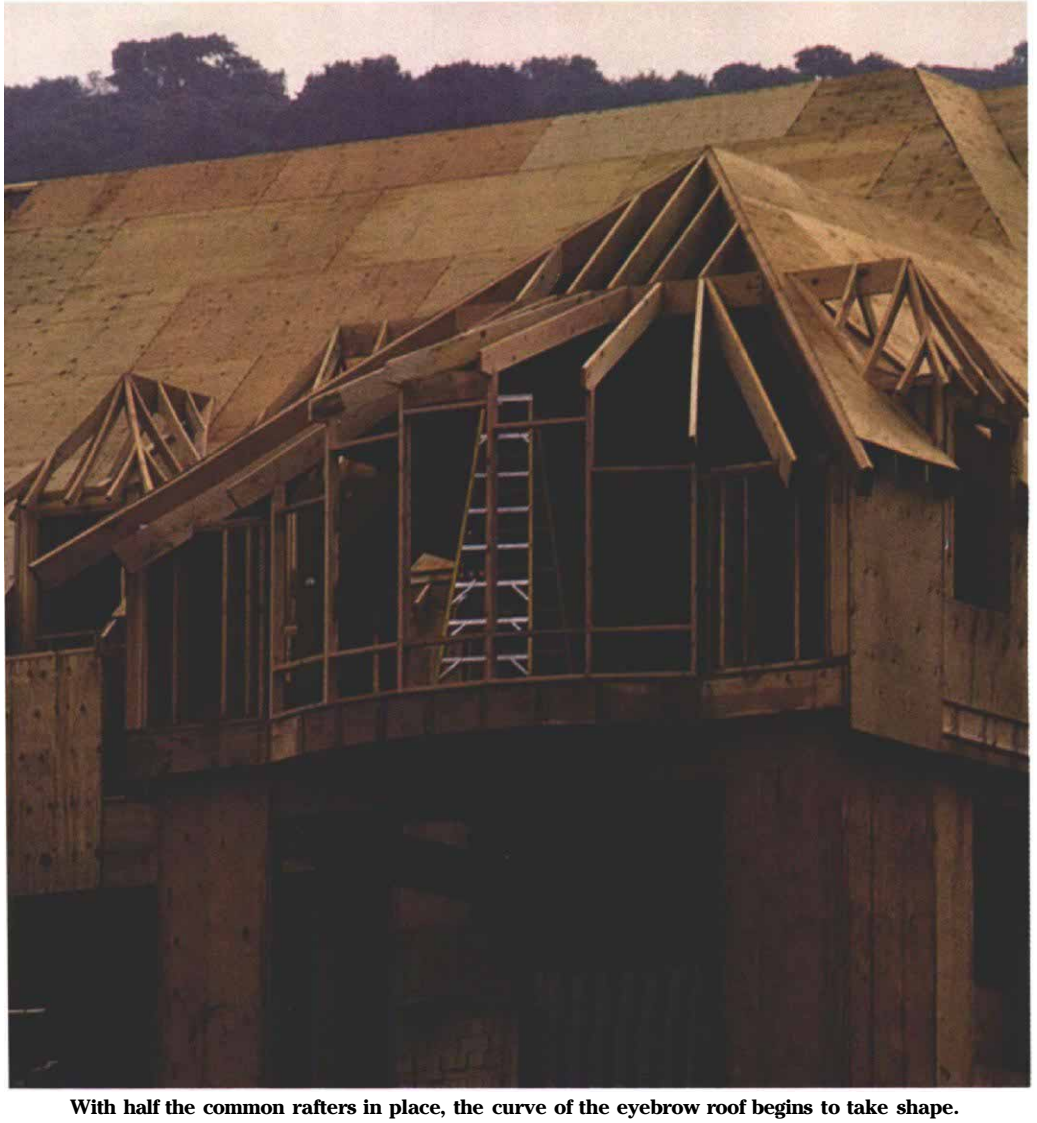
To determine the cheek cuts on each block, we held them in place atop the joists, and scribed the angles from underneath using the joists as straightedges. Then we extended the cutline by squaring down the side of the block, and used a Makita 16-in. circular saw to make the cuts.

Once the plywood subfloor was nailed off, we had a surface on which we could draw at full scale the wall framing for the master-bedroom windows. We began the layout by drawing a baseline that represented the floor. A perpendicular line bisecting the baseline gave us our centerline, and a mark on the centerline at 7 ft. 3 in. established the distance from the floor to the interior edge of the ceiling framing. For the sake of consistency, we made all our framing measurements to the interior edges of the framing members.

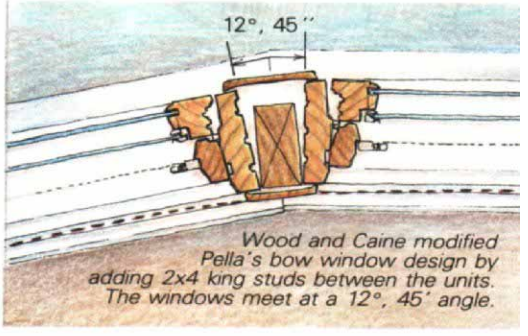
Coincidentally, the eyebrow radius is the same as that of the bow window. As shown in the drawing, we swung a 10½-ft. radius on our centerline to intersect with the mark for the ceil-

Drawings: Christopher Clapp





With half the common rafters in place, the curve of the eyebrow roof begins to take shape.



Wood and Caine modified Pella's bow window design by adding 2x4 king studs between the units. The windows meet at a 12°, 45° angle.

A 4x12 header secured to the roofs hip rafters carries the upper ends of the common rafters in the eyebrow roof. At the wall, every other rafter bears on a king stud. The chalklines on the floor were used to calculate the run of each rafter. In the center bay of the window, one segment of the arched header has been Installed just above a temporary spacer.

ing framing. Then we drew in the king studs at 26¼ in. o. c., which left us the necessary 25½-in. rough opening for our windows. We drew the curved outboard headers 5½ in. wide to give us the equivalent of nominal 6-in. stock. Finally, we drew the tops of the rough sills at 15 in. from the floor line. This wasn't an arbitrary distance, though. Once the finished sills and sash were figured in, the glass would end up a bit over 18 in. above the finished floor. Any glass closer than 18 in. to the floor is required by code to be tempered or laminated, and we didn't want to add that extra cost to the project.

We took direct measurements from the drawing to get the rough openings for the curved-head windows. Then we special-ordered them from Pacific Wood Windows (81 Hanger Way, Watsonville, Calif. 95076). This company is familiar with all brands of wood windows, including Pella, and has the cutterheads necessary to make compatible sash. Since the radius was the same for each window, we didn't bother to make full-size templates. At the same time, we put in our order for radiused head casings to Haas Wood and Ivory (64 Clementina St., San Francisco, Calif. 94105). This company has been around since the turn of the century, and has the equipment necessary to mill just about any molding profile, straight or radiused.

Wall and roof framing—We measured the king studs on our full-scale layout, and instead of subtracting 1½ in. to allow for a bottom plate, we cut them full length. The bottom "plates" we used are individual blocks with their ends cut at a 6½° angle. We cut a bunch of blocks with this angle—all at 25½ in. on the short side to maintain the rough-opening measurement. The extra blocks were used as rough sills and as temporary spacers near the top of the wall. As spacers, they locked the king studs in place so that spacing would be exact from plate to rafter (photos facing page).

The eyebrow starts out as an ordinary hipped roof and quickly gets complicated (photo facing page, left). There are valley rafters 2 ft. inboard from both hips. At the high end (inboard), they bear on a 4x12 header with its top beveled to match the 12-in-12 pitch of the cripple rafters above the eyebrow (drawing, facing page, top left). The first common rafters on each side of the eyebrow intersect the inboard header so that they just touch the valley rafters. The remaining common rafters are spread out across the header so that the spaces between them are equal. Once we calculated the spacing, we marked the position where each rafter would meet the header.

Every second rafter bears on a king stud. The others bear on arched headers. At the wall, the rafters end up about 13 in. o. c.—pretty close, but helpful in maintaining a smooth curve in the roof deck. Once we knew where the rafters intersected the curved headers, we could calculate the cuts needed to fit them in place. As shown in the drawing, facing page, top right, each rafter required a different plumb cut and seat cut. To figure them, we measured the height of the king stud upon which the rafter would bear. Then we subtracted that height from 10 ft., which was the distance from the subfloor to the bottom of the 4x12 header (remember, all measurements were made to the inside edge of framing members). This gave us the rise of the rafter.

We found the run of the rafter by first dropping a plumb bob to the subfloor from the face of the 4x12 header. Then we measured from that point to the base of the king stud carrying the rafter. That distance was the run, and let us put some trigonometry to work. The rise divided by the run equals the tangent of angle C (drawing, facing page, top right). A look in the trig tables will reveal the angle for the tangent—let's say it's 28¼°. Now we turn to the degree column in our rafter book (we use *The Full Length Rafter Framer,* by A. F. Reichers, Box 405, Palo Alto, Calif. 94302) and find that a 28¼° angle is equal to a 6½-in-12 pitch. That gives us the settings we need to mark off plumb cuts and bird's mouths with a framing square.

To complicate matters even more, the plumb cuts were all cheek cuts (the compound angle formed when roof members meet at less than 90° and other than level). To find them, we struck chalklines on the subfloor that represented the centerline of the header and the centerlines of the rafters. Then we used a bevel gauge to set the shoe of the skillsaw to the desired angle. We followed this sequence for every second rafter until we had them nailed to their king studs. Then we added curved headers (photo below).

A bandsaw is mighty handy to have on site during a job like this one. We kept our 6-in. Rockwell very busy on the day we cut out the headers. We cut them out of 4x12s, using a plywood template to scribe the radii on the stock. Then we used our full-sized drawing of the wall framing as a guide for marking the end cuts. Aligning each radiused header with its sketch on the floor, we marked the location of the king studs. Then, using a square, we projected our marks to the top face of the headers to get our cut lines.

Like the rough sills and the bottom plates, the headers have a 6½° bevel on the cheek cuts. But instead of a chopsaw, we used a 16-in. circular saw to make these compound cuts. Since we didn't have room for trimmer studs to carry the weight of the headers, we used angle brackets to support them, along with steel straps on the exterior side of the headers. As we added the missing rafters, we didn't mess with cutting their tails to a finished profile. Instead we waited until they were all in place to trim them with a jigsaw.

To make the transition from the curved headers to the adjacent plates of the straight walls, we fit in a pair of curved blocks. As shown in the top drawing, facing page, we slipped three fill rafters into the V-shaped gap formed by the valley rafters and the outside common rafters.

Building curved shapes out of rectilinear materials makes for some oddball junctions between framing members. Long tapers, radical cheek cuts and square corners that needed

The temporary spacers between the king studs have been removed, and in their place the curved headers define the radius of the eyebrow roof. At the far side, a curved block atop the straight wall makes the transition to the arched form of the bowed wall.

smoothing out characterized this portion of the job. We kept our power plane close at hand as we tinkered with the rafters, planing their tops and bottoms to sculpt the framework for the curved roof and ceiling.

When the rafters were set, we trimmed their ends to match the slight overhang found on the adjacent eavelines. Then we cut ¼-in. thick sheets of plywood into wedge-shaped pieces to make our roof deck. Using panel adhesive and 1½-in. staples we bent the pieces to the curves. Then we added two more layers, carefully staggering the seams and using plenty of adhesive to laminate the three layers into a unified shell. We did the same thing to the interior side of the eyebrow, which turned the assembly into a curved box beam.

Both the soffit and fascia have compound curves, and we used boatbuilding techniques to make them. They are laminated from ¼-in. by ⅜-in. strips of Honduras mahogany, soaked in cold-cure epoxy resin (West System, Gougeon Brothers Inc., Box X908, Dept. CP, Bay City, Mich. 48707).

This is a messy job that requires patience and rubber gloves. Using sponges, we liberally applied the resin to each strip. The epoxy penetrates the wood fibers, making the strips a little easier to bend. While each piece is still wet, it has to be bent into the desired shape. We used our staple gun to tack the strips to the ends of the rafters as we bent them. To keep the gun from becoming hopelessly fouled with epoxy, we regularly sprayed the entire tool with WD-40. This made it easier to chip away any errant plastic drips once they had set up.

We formed the soffit first, then used a low-speed auto grinder to smooth it out. We built the fascia the same way, but after grinding its face smooth we trimmed its lower edge with a router, using a straight-flute bit with an oversize bearing on the bottom. The bearing registered against the smooth surface of the soffit, while the bit trimmed the fascia edge. After the fascia and soffit had been painted, the sheet-metal man installed a copper gutter against the fascia. The gutter has an ogee profile, and it was made of 6-in. long segments soldered together in place to conform to the curves.

Careful drywall work shows off the curved canopy above the bow window. Arched casings trim the tops of the windows. The casings were a special order, stickered to the desired radius and finish cut in place with a Japanese draw saw.

Interior finish—The interior walls are finished with drywall—including the curved portion of the ceiling (photos at left). We built up the curve with a double layer of ¼-in. material, screwed to the plywood at 6-in. intervals. It took plenty of joint compound and sanding to get the curves just right, but they finally emerged to everyone's satisfaction.

Haas Wood and Ivory made up our carved head casings (photo, at left) in pieces that were about 6 in. longer than necessary for each window. The secret to getting them to fit right was to finish-cut the miters in place. We started with the vertical casing. Allowing it to run long, we tacked it in position and then held the head casing in place. We marked the casing pieces where they overlapped, indicating the position of both the inside and outside corners. These marks guided our rough miter cuts, which we made on the chopsaw. Then we tacked both pieces in position, with their mitered corners pressed tightly together.

Now the trick. Using a Japanese draw saw, we recut the miter, taking a little wood away from both pieces. This cleaned up any protrusions and allowed the pieces to fit tightly together without gaps. Once the cut was complete, the vertical casing was nailed in place, and the head casing was repositioned to fit tightly against the vertical casing. Adjacent head casings meet each other at compound miters, and have a 6½° bevel at the ends. We followed the same procedure to get them to fit correctly. □

Joseph Wood and Robert Caine are licensed general contractors in the state of California. They build as partners in the Cusano Rojo Woodworking Co. Photos by the authors.