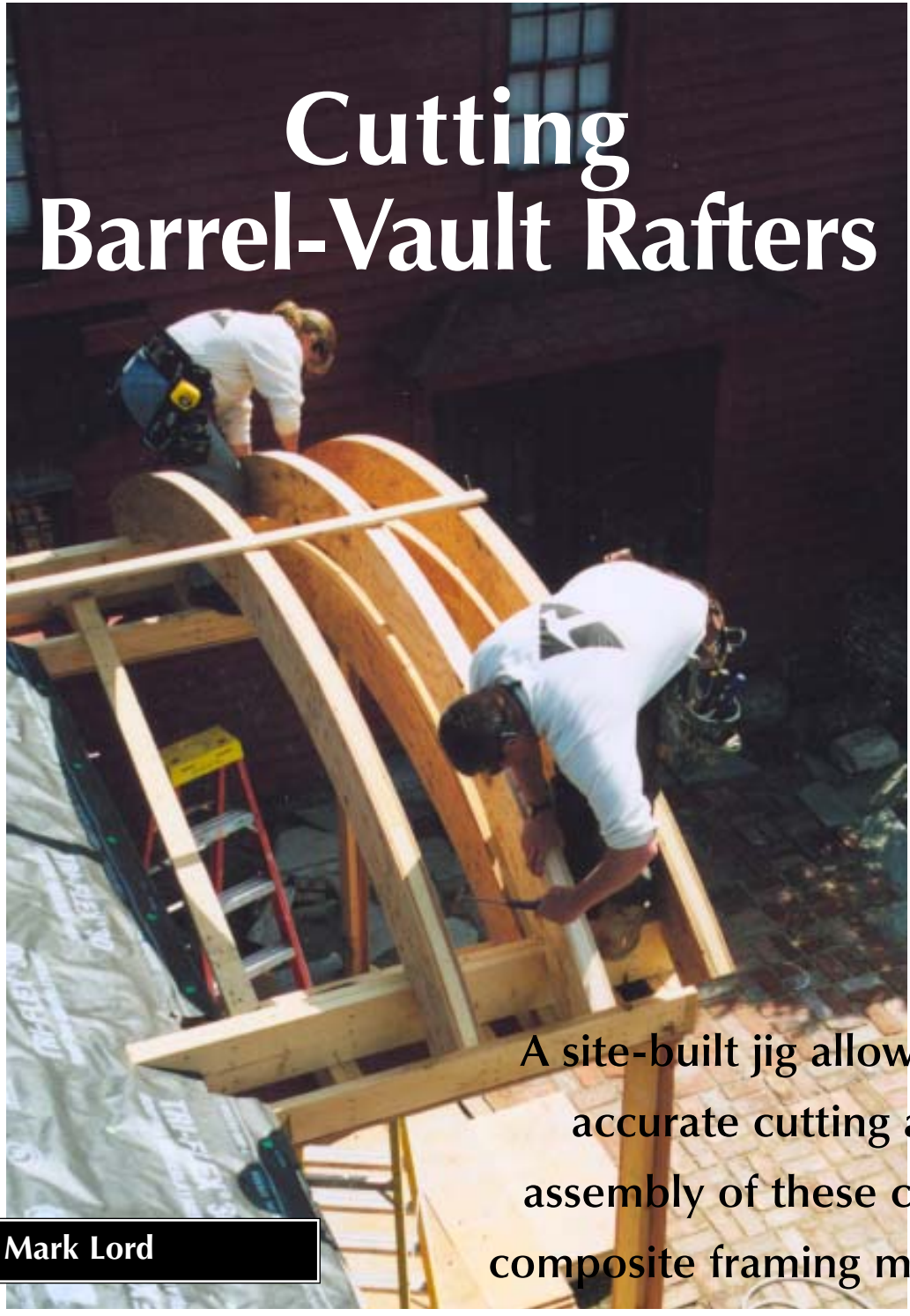
Cutting Barrel-Vault Rafters



A site-built jig allows fast, accurate cutting and assembly of these curved composite framing members

by Mark Lord

Our company recently completed an extensive addition and remodel job on an old New England farmhouse. Among the design challenges confronting us were two vaulted portico roofs abutting the main gable roof.

The rafters were specced by a structural engineer, which eliminated any guesswork about strength. The design called for the rafters to be built up from 2x12s sandwiched between 3/4-inch exterior-grade plywood. Each rafter consisted of three pieces of 2x12, cut to specified joining angles from a 16-footer, and four 16-inch by 8-foot plywood gusset panels cut to butt at a general slope that covered the full arc. The engineer provided drawings and details showing the makeup of the rafters, the necessary joinery, and a fastening schedule of adhesive and clinch nails.

Building the Right Jig

Building the curved rafters seemed simple enough. We would attach a power cutting tool to the end of a pivoting trammel arm, set the appropriate radius, and cut. We started by fixing

Figure 1. The crew first tried cutting the curved rafters by hand with a circular saw. The technique was fairly accurate but slow.

a heavy-duty router to the end of a 2x4 trammel arm and swinging it over a full-size pattern drawn on the subfloor of the new kitchen. We cut the 2x12 rafter stock first, then laid out and cut the plywood.

This worked, but stooping over the stock on the floor while dragging the router through the 2-by lumber in multiple, slow passes was uncomfortable and inefficient. We switched to cutting individual templates of the separate components with a circular saw and then assembling them into whole rafters (see Figure 1). This was reasonably fast but not as clean and accurate as we would have liked. By the time we worked our way around to the second vaulted roof, we were ready to try something different.

Getting off the ground. Our new approach was designed around an outdoor platform, which allowed us to perform much of the work at a comfortable height rather than kneeling on the deck (Figure 2, next page). The rafter span of 13 feet dictated the 16x12-foot size of the platform, and the need for an extreme pivot point determined its gable shape.

Using lumber already on site and destined for future reuse, we spanned several sawhorses with 5x9 Parallam beams, set roughly level to each other on the irregular site grade. The rest of the platform was framed with 2x4s, which were covered with 3/4-inch plywood, screwed down for easy disassembly. We shimmed the platform to a reasonably level condition to ensure a true flat surface to build on.

For the trammel arm, we used an LSL (laminated strand lumber) 2x4. One end of the 2x4 was fixed to the platform at the pivot point with a 3-inch #8 screw. Framing, centered under the plywood at the pivot site, provided good "bite" for the screw. We made sure that the pilot hole was large enough to allow the 2x4 to pivot freely but snug enough to stay accurate. We didn't want the screw to thread in and out as we rotated the arm around the bench.

Mounting the saw. Previous experience had shown us that we could make the radius cuts using a circular saw, since the desired 10-foot radius was relatively shallow. This led to the design of the business end of the trammel — a 5/8-inch plywood "sled" that wrapped the saw shoe in a full, drop-in surround that held it perpendicular to the trammel arm. A second, matching cutout, offset by the depth of the curved rafter, let us cut the upper and lower edges of the rafters by moving the saw from one cutout to another, rather than moving the pivot point on the trammel. To establish the sled's alignment over the rough stock, we drew a full-sized rafter pattern directly on the bench, using

Figure 2. A temporary assembly platform provided a flat, comfortable outdoor work surface (above). A trammel arm, equipped with a mounting "sled" for a conventional circular saw, made it possible to cut the components quickly and accurately (right).

Curved Rafter Jig

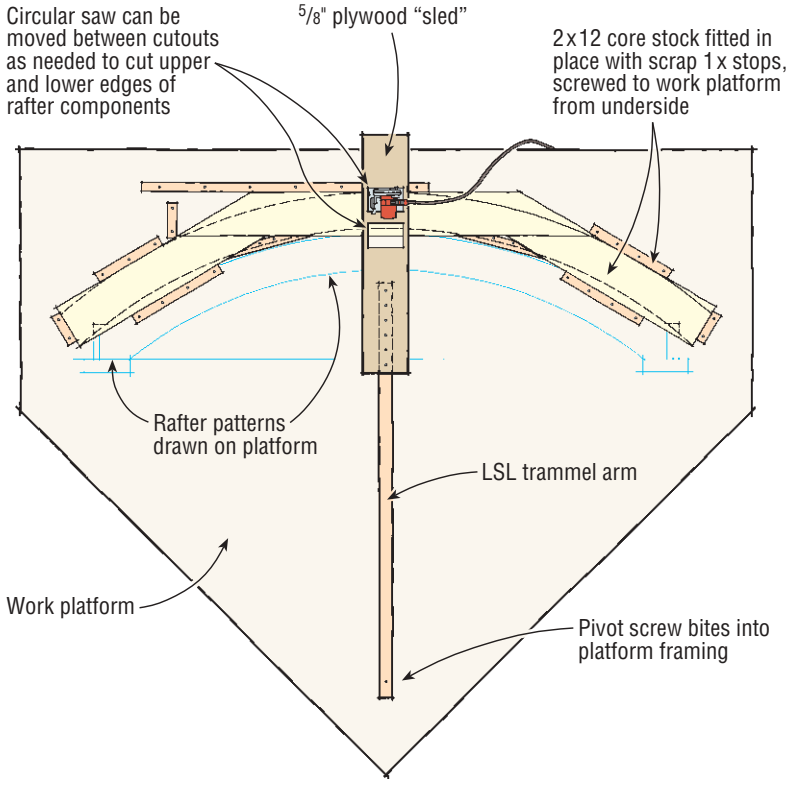


Figure 3. The first layer of plywood was glued and tacked to the 2x12 core, which was then moved to the edge of the work platform and fastened according to the engineer's specifications (above). The assembly was turned over and the protruding nails clinched (top right), then the second layer of plywood was fastened in place with more construction adhesive and three additional rows of nails, offset from those driven from the other side (bottom right).

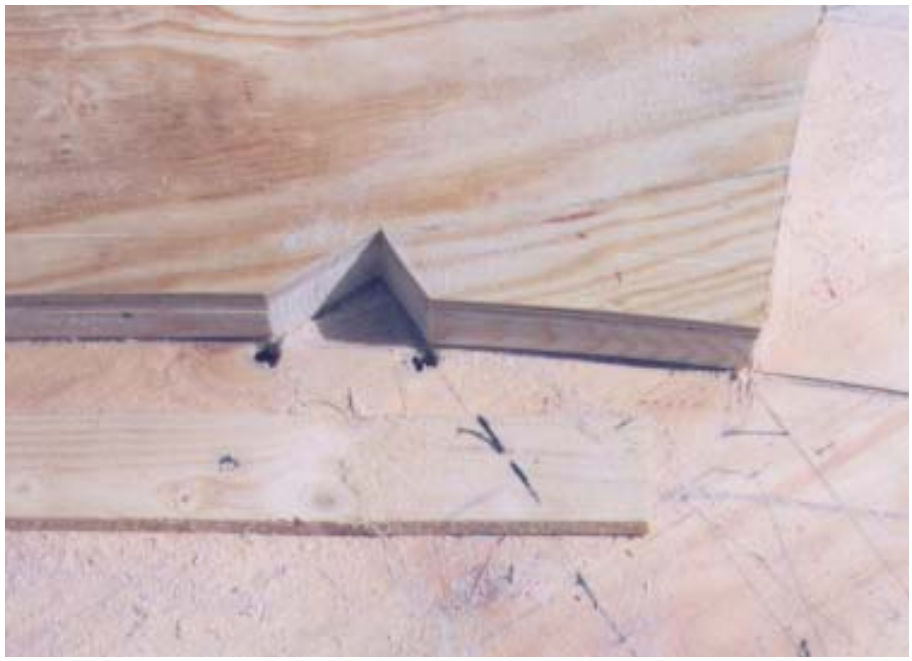


Figure 4. The rafter tails were cut with a circular saw, but seat cuts were made with a jigsaw to prevent overcutting (left). Starter holes in the platform simplified the cuts, and aligning each rafter with the layout lines ensured accuracy (right).

the trammel arm to swing the top and bottom arcs. After aligning the cut line over the pattern, we screwed the sled to the arm.

Finally, we secured stops to the bench to help position the 2x12 core stock. Once the lumber was correctly positioned, it was temporarily screwed to the bench from underneath, with screws placed safely clear of the saw blade. This step was necessary because the platform stops would no longer be effective once the milled edges of the stock had been cut back.

Cutting and Nailing

To cut the stock, one person helped move the sled and keep the cord free, while the other ran the saw from a position on the platform. To ease the friction in the kerf and reduce stress on the saw, we made a first cut halfway through the rough 2x12 blanks before finishing with a second cut. For the second pass, we set the blade depth to just clear the stock and graze the platform surface.

The next step was to lay out the plywood outer layers, screw them temporarily to the 2x12 core — which was still secured to the bench — and cut a matching curve in the plywood. We then put the plywood aside, applied construction adhesive to the core stock, and placed one of the plywood layers on top of it. After aligning the plywood carefully, we tacked it in place with a handful of screws in preparation for final nailing.

Nailing at the edge. The engineer's plans specified three parallel rows of 16-penny nails, spaced 4 inches apart within rows. We removed the screws that held the tacked-together core and plywood assembly to the platform, moved it carefully to the edge, and gun-nailed the plywood to the core, taking great care to avoid the emerging nail points (Figure 3, previous page).

After flipping the rafter over and clinching the nails, we spread more glue and nailed down the second layer of plywood. The opposing nails were offset from one another, but because the completed assembly was only 3 inches thick, the second set of nails protruded by 1/2 inch and also had to be clinched.

When each rafter assembly was complete, we made the seat and tail cuts in place on the bench, following the full-size pattern drawn there (Figure 4).

Framing the Roof

Our first assembled rafter became the check pattern for the rest, ensuring that they were identical. Because they were all sized and cut, ready to go right off the workbench, installing the rafters was a piece of cake.

A full-scale section drawing on the platform of the rafter layout and transition onto the main

Figure 5. The birdsmouth cuts in the main rafters sat on short girders, while a deeper pair of subrafters was nailed in below to create an arched soffit at the front of the entryway (left). The completed roof frame was sheathed with two layers of 3/8-inch plywood (above).

Figure 6. The completed portico was finished with curved trim that was laid out and cut on the same work platform used for building the rafters.

roof allowed us to figure the beveled seat cuts for these rafters right on the ground. We also made the required seat cuts in a pair of "subrafters" used to frame an arched soffit at the front of the entryway (Figure 5). These were deeper than the main rafters, but were easily made by moving the sled up the trammel arm to the required radius. Once we'd completed the frame, we skinned the roof with a double layer of 3/8-inch plywood, bent parallel to the face grain and nailed on 16-inch centers.

Looking back. The platform and trammel took two people one day to construct and used a substantial amount of material. We were able to reuse most of it in the course of framing, however, and the speed and accuracy of the final jig design made the extra effort well worth it. As a bonus, we found that we could use the same jig to cut all the radiused roof trim needed for the exterior finish (Figure 6). The platform also provided a great, waist-high work surface for other projects during the three weeks required to complete the roof and trim inside and out.

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