

# TIMBER FRAMING

JOURNAL OF THE TIMBER FRAMERS GUILD

Number 108, June 2013

*Raising in Warsaw*



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### Erratum

On page 17, TF 107, the Estonian town of Tartu was misspelled  
Tarfú. The editor regrets the error.

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*On the front cover, interior of the Gwozdziec Synagogue replica roof frame raised this winter inside the new Museum of the History of Polish Jews in Warsaw. Frame was produced in 2011 at an outdoor building museum in Sanok, Poland, in a collaboration between the Timber Framers Guild and Handshouse Studio. Photo by Jacob Bach-Jensen. On the back cover, views of the frame and the elaborate polychrome ceiling as visitors to the museum will see them. Photos by Laura Brown.*

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## LETTERS

### Flaunting Wealth?

*To the Editor:*

The latest issue of *Timber Framing* (No. 107) was fascinating, as usual. Phil Pierce's article on the Bartonsville covered bridge especially caught my eye. Perhaps I can add in a side trip to see the bridge in conjunction with the August TFG conference.

The other articles inspired me to go out and build something. Nothing as large or involved as an Estonian log building or Kevin Kiwak's beautiful half-timbered house, and certainly nothing as complex as the roof framing described in Steve Chappell's new book. But whatever it is, it has to have riven pins!

The one article that left me scratching my head was Ben Brungraber's "When Good Timbers Go Bad." While the solutions that he developed will certainly be useful to others facing similar situations, were some of these problems self-inflicted? In particular, I am thinking about the massive curved *taiko* beams in the first frame, which Ben described as "a superb expression of our craft." But was it? Or was it an over-amped caricature of timber framing?

Ben is dismissive of "trimber framing," the use of decorative timber frame elements that serve no structural purpose. But what are we to think of structural elements that serve no structural purpose, or that actually serve a destructive purpose? We learn that the ridgepole was strong enough to support the roof by itself, even to lift the corners of the building and to shear a kingpost pin. So if the tie beams and kingposts were unnecessary ("redundant") structural elements, why were they included in the frame? Was this frame, "immense in the scale of the space," the architectural equivalent of huge breast implants or monster tires on a Jeep? Ben's article has made me stop and reflect a bit on our craft. I would hate to think that we prostitute our profession merely for clients wanting to flaunt their wealth.

BRUCE BRITTAIN (bsb6@cornell.edu)  
Ithaca, New York

*Ben Brungraber replies:* First, I would mention that I did not design the frame; I only investigated its response to drying-induced deformations. Nor would I be ashamed of having designed the frame. In fact, a part of my background mental noise during the investigation and article-writing was a sense of there-but-for-the-grace-of. I absolutely have structures out there with potential for rending themselves if the large timbers choose to deform as they dry.

As for the writer's questions about taste and patronage, I generally cleave to *De gustibus non est disputandum*. I have, even, worked on structures that are flat stupid, but which paid my bills and were not my own. I only cringe when folks insist on heavier and more complex structures than simple durability demands and then kvetch about the cost of the resultant frame.

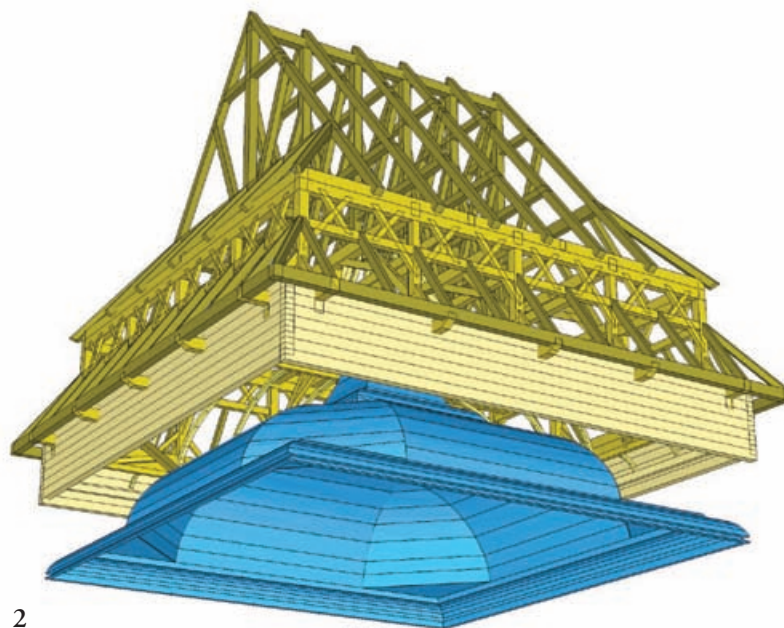
The frame in this room is quite redundant, with several very strong load paths. Normally, structural engineers love redundant load paths (so long as clients are willing to invest in them)—they help us to sleep well. Had I been asked to "value engineer" this frame in order to shave a few bucks from the budget, I might then have pressed to be rid of the tapered plan, first. Until seeing this project, it had never occurred to us that timbers could so powerfully distort, the prime inspiration behind all those involved being willing to share the knowledge gained.

R. L. ("BEN") BRUNGRABER, Ph.D., P. E. (ben@ftet.com)  
Fire Tower Engineered Timber  
Providence, Rhode Island





Jacob Bach-Jensen



Ed Levin

## Raising in Warsaw

**R**ETURNING to Poland this past winter to assemble and install the Gwozdziec Synagogue replica contrasted sharply with the trip I had taken in the spring of 2011. Instead of working in the open on a lush meadow across the river from the small town of Sanok, we were inside a still-unfinished concrete and steel building in the middle of a web of Warsaw streets. Where there had been sunshine and heat, there were clouds and snow. Where there had been axes and pit saws, there were now welders, jackhammers and grinders. Compared to over 100 builders in Sanok, our group of 14 project veterans felt intimate.

The one thing remarkably unchanged was the great deal of work to be done in a very short time—a daunting prospect but a small concession, because the Gwozdziec Synagogue project is the kind of work that one fantasizes about when getting into timber framing. These three weeks were the last construction phase of this multiyear, multilayer, multientity project to replicate a large part of a lost 17th-century Polish wooden synagogue and to install the replica in the new Museum of the History of Polish Jews in Warsaw (see “A Synagogue Roof in Poland,” TF 101) to represent all the wooden synagogues systematically destroyed in the 20th century. Gwozdziec was selected to replicate for its beauty, detail and surviving documentation. The museum stands in the Muranow district in view of the memorial to the Warsaw Ghetto Uprising of April 19, 1943.

Built to 85 percent scale to fit the museum’s designated space, the frame measures 34 ft. square by 30 ft. tall, representing the top two-thirds of the original synagogue. The chief purpose of this frame, the centerpiece exhibit in the museum, is to display an elaborate polychrome wooden ceiling painted by an international group of students led by Laura and Rick Brown of Handhouse Studio and the Massachusetts College of Art, who also codirected the entire Gwozdziec replica project, ten years in the making.

Thus it was in January of 2013 that I was part of a five-person crew that returned to Poland to install the Gwozdziec frame in the museum in Warsaw. On the Guild side, I joined Alicia Spence, the project coordinator, Jim Krick, the millwright who had managed the curved work in the frame and much more, English framer Barbara Czoch (of the UK Carpenters Fellowship as well as the Guild, and who came to fame leading the pitsawing in Sanok), and the Danish woodworker Jacob Bach-Jensen, youngest of the team, bringing with him skills of a timber framer and of a fine furniture maker. We met up also with Polish timber framer and log builder Witold Łaski, Sanok alumnus turned indispensable general contractor for this phase of the project.

Touching down at the same time were Rick and Laura with their dedicated crew of four ceiling artists (*painters* does not quite do them justice). Rounding out the crew were Olga Micińska and Ania Sikiera, two Varsovian volunteers who had been part of the effort in Sanok and were happy to contribute again.

Right away we were warned about the Polish hoops we would be required to jump through on our first day—workers’ rights education, safety instruction and a health exam. All of which we honored, though not without growing impatience, for we were itching to see the site and touch the timbers. The site proved an unfamiliar environment for most of us, a huge, and at first glance severely modern, edifice still under construction, in the middle of a big city, completely fenced off, underground, surrounded by metal and concrete, immersed in dust and noise from other trades. But all the timbers were there!—somerly draped under black landscape fabric at the edge of the dim cavern (Fig. 1).

It took a day and a half to sort out the nitty-gritty of staging areas, light and power, and navigating the halls and stairways. Getting to know the people we were to work with and figuring out communication took a bit longer.

**Assembly** For practical purposes, we who built the frame had divided the structure into three sections, which can be distinguished in Fig. 2. The lowest (light yellow) was the partial walls 30 ft. 6 in. square, 4 ft. 2 in. tall and 6 in. thick, hewn of square tapered logs laid alternately to finish level, with dovetail corner joints. Crosspieces sandwiched by the top layers hold the outboard flying plates and cornice, and sills for what we called the box frame.

The box frame (dark yellow) forms the next stage, 28 ft. square and 7 ft. 4 in. tall, made of hewn and pitted timbers with mortise and tenon joints as well as many, many half-lapped half dovetails. Above the box frame rises the roof system, comprising a central roof truss over 17 ft. tall and six rafter pairs each with two collar beams and struts (olive).

The ceiling (blue in the figure) has four levels: the cove, the main dome, the zodiac level and the lantern. Geometrically patterned trim pieces cover transitions between levels. The ceiling boards, generally about 7 in. wide, are hand planed and hand painted in glorious colors. The shape of this ceiling takes inspiration from tents introduced to eastern Europe in the 16th and 17th century by the Ottomans during their many military campaigns. The most elaborate of these tents, made of rich tapestries, were used for the Sultan’s court, but also for prayer.



Those who have worked on Guild projects know that when you have to break out the lights after dinner, it's crunch-time. Well, it was day one, shortly after breakfast, and we had brought out the lights. We had 16 workdays to assemble a frame of about 500 pieces, make all the necessary corrections for the twisting and shrinkage that had taken place in a year-plus of storage, scribe and re-cut some of the ceiling curves, make preparations for the structure to be suspended from brackets in the ceiling, and hoist the whole thing off the floor. And we were already down one day thanks to the Polish hoops.

While the squared logs for the base walls had grown much lighter in the past year and a half, we still needed mechanical assistance to handle them, and Alicia had found us an awesome little crane that rode elevators and worked quietly on electricity (Fig. 3). It came complete with a stone-faced crane operator named Woytek.

We noticed immediately that a dry timber in a stack does not look nearly as twisted as when extracted and set up for assembly, but the redeeming property of these long skinny pieces was that they could be wrangled with clamps and levers and subsequently held by structural screws (Figs. 4–6). In this manner we moved along without having to do too much kerfing or paring of joints. The top of the log walls included many half-lap notches, which made us a bit nervous in prospect about the fits of crossing or joining pieces. But our concerns proved excessive, for shrinkage had provided extra space in the joints for twisted shoulders.

Relieved at having arrived at the top of the hewn-log walls in the allotted time, our anxieties shifted to the box frame with its many tight fitting joints. Fortunately there was not enough time to fret, so we simply found all the pieces (not one missing!), worked our way into a new numbering system (different from the log walls) and started putting pieces together. There were minor wrinkles in the assembly, yet these box frame walls were a lesson in the virtues of redundancy. Plenty of braces ran in all directions from the posts. Our Polish volunteers Ania and Olga were all over this puzzle and few amendments needed to be made. If there was an occasional loose joint, or one too tight that had caused a fracture, we took five steps back and looked at the whole (76 joints per side), to realize it would be just fine. Top plates were on before lunch on day five (Fig. 7).



Jacob Bach-Jensen, also at left below and at bottom



Gerald David

1 Space provided for replica in Museum of the History of Polish Jews, Warsaw. Concrete floor two levels below grade is surrounded by covered stacks of timber. Glass enclosure, at entry and street level, with steel railings, surrounds opening in mezzanine while new sheetrock just beneath hides 30mm-square beam of concrete and steel. Anchors for suspended structure (nine showing in photo) are fastened to underside of beam.

2 Structure was built in three sections: log walls (shown in light yellow), box frame (dark yellow) and roof frames (olive). Polychrome ceiling boards (shown monochrome blue for simplicity) were preapainted on sawhorses, with transitions and touch-up done in place.

3 Small electric-powered spider crane proved invaluable, soon trapped itself inside building.

4–6 Twisted members were legion after 18 months storage unrestrained, yet generally yielded to clamps and fasteners.

7 Compared to the slow rise of the refitted solid log walls, the timber-framed box assembly swiftly created a big volume. Crane is now captured inside rising structure.







8 Gerald David



9

Other photos this spread, Magda Starowieyska, staff photographer, Museum of the History of Polish Jews, Warsaw

By the last day of the regular workweek, the ceiling crew had completed the photography of the painted panels in our staging room and were antsy to start putting them into the frame. Jim had installed the cove ribs that give shape to the lowest part of the ceiling (Fig. 8). With the ceiling crew soon to be installing the first painted boards on the lower cove we needed to keep ahead of them (Fig. 9).

**Truss lift** We spent most of a morning with preparations for the biggest lift of the raising. The ridge truss, which would support the peaks of the rafters, had been assembled flat on top of the box frame and was to be carefully tilted up with the crane. Alicia had done the calculations, expecting the crane to hit its limits in extension as well as weight. By noon a small crowd of spectators had gathered at the glass enclosure above us on the ground level of the museum. They too wanted to witness the ship-in-the-bottle feat that we had told everybody we could do.

In a slow and deliberate process including two fully planned riggings, one with the truss nearly vertical, we stood up the ridge (Figs. 11–12). Having been deprived of a complete raising in Sanok we now for the first time got an idea of the full height of the roof. (Alicia quietly asked Jacob to measure the remaining space between ridge and ceiling.) With everything tied off and braced, and a huge psychic weight off our shoulders, we went to a late lunch and looked forward to our first day off. It turned out to be a short day. Even those of us who did not have to accommodate jet lag needed the rest. We made sure to visit the castle and see the old town, though. Monday showed up predictably quickly.

**First frame lift** Before we could continue with the roof we needed to lift the entire frame. The now trapped crane was needed on the outside to hoist the rafters and a scissor lift now needed inside for ceiling work. Hanging the rigging proved to be much slower than expected. The design (by Mike Beganyi and Alicia) clashed with the reality of nonconforming metal fabrication, and tight quarters did not help. While three people took turns grinding metal shackles to make them fit ceiling hangers, Jacob and I drilled sixteen 1¼-in. holes through more than 50 in. of log walls, to accommodate the permanent suspension rods. That took a day and a half (Fig. 10).

Alicia and Barbara satisfied themselves with the rigging: eight massive yellow chain hoists each with bright-red 5-ton straps and 10-ton load cells that measured real-time readout on the load of that particular hoist. Not only the rigging nerds were excited. Alicia hollered “Ten pulls!” or “Another ten!” and the chains rattled, the straps tightened and the frame lifted off the cribbing to sway gently to and fro (Fig. 13).



10

8 Cove ribs installed and ready for first ceiling boards.

9 A partly visible Laura Brown lying on floor tightening gap on lower cove board while Jason Bashaw fastens it with screws.

10 Author, left, and Jacob Bach-Jensen use guide designed by Alicia Spence to drill long holes for suspension rods.

11–12 Spider crane at work inside frame lifting central truss that will support rafter peaks. Two successive rigs were necessary for lift.

13 Liftoff! Witold Łaski was one of eight pullers, each on a mechanical chain hoist, spread around the structure.









14

This page and below right, Magda Starowiejska, staff photographer, Museum of the History of Polish Jews, Warsaw

What a marvelous thing! A quick tally of the load cells revealed a preliminary weight of just under nine tons. A later tally with most of the ceiling installed and all the roof timbers yielded a weight of around 13 tons, to which some sheathing and wooden shingles were to be added. Eventually the weight to be carried by the rods would be in the range of 15 tons (the design weight was double that). We then took the opportunity to test how the frame reacted to being lifted unevenly, a likely case in the final lift. Our experiments brought next to no complaining from the frame and our pride in it only grew (Fig. 14).

**Raising the lantern** We celebrated the achievement that night but stayed mindful of our schedule, so the following day (our ninth) we freed the crane and trapped the scissor lift, which would be the next piece of equipment to be tested to its limits. The lantern, the topmost part of the ceiling, needed to be raised. The frame had become too congested with timbers for the crane to operate on the inside, and it did not have enough reach to use from the outside. But there was plenty of room in the center of the structure for a straight shot up! The lantern, which, unlike the rest of the frame had never been dismantled, took ten people to heave it onto the scissor lift. Then it was on its own. I had my doubts, but Alicia shrugged and said it would be fine. It was. Though scissor lifts don't usually make that much noise (Fig. 15).

The ceiling ribs now became the priority, so all hands jumped on getting them amended and installed. Then, coming from left field, we got the biggest scare of the project. At the end of day eleven, a Friday, after working for hours in noxious fumes coming from a museum crew using two-part epoxy paint a scant 80 ft. away, we were told that work was stopped for the weekend because of the fumes, and continuation on Monday was uncertain. Of the five days left to us, two looked likely to be scratched, rendering what had been a tight schedule nearly impossible.

That almost took the fun out of a Saturday off. The Guild crew got to explore Warsaw with the help of Olga, while Rick and Laura fought battles with the site supervisor and the museum over rescheduling the paint work, turning on the air-handling system and opening all doors to ventilate. By dinnertime we had word that we would be allowed to resume work the following day, to make up for time lost. I was not the only one to remark on the oddity of feeling thrilled to be working on a Sunday.

But this meant that we had the jobsite truly to ourselves. There was cold fresh air coming from the stairwells and we got to it with a sense of determination. The crew worked to put together the rafter assemblies, leaving the "inside" for the ceiling installers to work freely. Jacob, who had assumed his usual position on the ridge, later remarked that there were five levels of people working on the frame: him on the top, Jim and Alicia on the collar beam



level, Barbara and I on the tie beam level, ceiling crew on scaffolding and on the ground. Meanwhile Ania and Olga circled the building installing lower rafters down to the flying plates. The famous “projects flywheel” hummed contently. We got a lot done.

The roof frame complete, a wetting bush appeared at the gable peak and the focus shifted back to the inside. Jim, having completed the main dome ribs, moved up the ceiling to the zodiac curve, which connects the main dome with the lanterns.

**Ceiling boards** Rick, Laura and crew had been putting up pre-painted ceiling boards at an amazing rate. Every peek inside revealed more completed animals, in startling color, which just a little earlier had been in slices on sawhorses (Fig. 16).

Pitching in, Jacob and I installed a single course of patterned trim board on all four walls, creating a continuous pattern along the bottom of the lower cove. We quickly realized the extra level of precision and therefore anxiety involved in cutting and fitting precious hand-painted patterned boards. The boards came together without too much trouble and the parts grew into a whole. Fewer and fewer spots remained through which to poke one’s head and catch a glimpse. The complicated negative space above the pendentives, the triangular corner pieces of the eight-sided dome, turned into a kind of attic (see front cover).

14 Rafters now applied to central truss, frame now well advanced, resting on cribbing, still rigged for further lifts.

15 Genie scissor lift provided the easiest way to raise the heavy lantern, already boarded, into place.

16 Rick Brown (at right), Jason Loik and Matt Jeffs (white hat) install boards for main dome, a continual negotiation between lining up painting subjects and fitting geometry of frame.



Jacob Bach-Jensen





We were on the home stretch, making more trim pieces to cover the transitions in the ceiling coves and reshaping more ribs, sweeping the floor, collecting surprising amounts of scrap wood, sorting out tools and packing them for our next day's early departure. Ten halogen lights threw up thousands of lumens through the scaffolding, reflected back as a technicolor wonderland (Fig. 17).

At 7 o'clock, a tired Laura Brown somewhat reluctantly called the day. The film crew needed to get inside and make their final shots of the completed ceiling. It took the dismantling of scaffolds to get the painters to quit. Already everyone was spending half the time looking up. Alicia brought out a bag with candles and handed them out, musing about what the ceiling would have looked like "way back then." Some started lighting candles, others found switches for the floodlights. Soon we were holding up our candles and looking and cautiously questioning. Is this how they saw it?

Cary Wolinsky, the senior cameraman, who together with his son Yari had been filming this endeavor for the past three weeks, calmly told us to give our eyes time to adjust. As our pupils opened and the candles appeared to brighten, the ceiling lost its dark spots and flowed together. An incredibly bright and busy set of panels under halogen light transformed into a warm tapestry. Eventually everyone simply stood still. As much from exhaustion as from humility and respect and wonder, we sat or lay prostrate on the floor (Fig. 18).

**Completion** We were no longer on a construction site but in a solemn space of spirit. I could imagine the *bimah*, the raised platform from which the Torah is read, in the center, as it would have been in Gwozdziec, and the ark for the Torah on the east wall. For millennia, groups of worshipers had gathered around the Torah and the Torah would be carried around them at the end of the service, accompanied by an age-old Hebrew verse. History was alive.

Wonderful things have come from this project, some intangible, like learning and teaching, friendship and confidence. And many people's hands and hearts have touched this frame. I am honored to have been one of them.

—GERALD DAVID  
Gerald David ([gerald-david@hotmail.com](mailto:gerald-david@hotmail.com)) is the founder of GFD Timber Framing in Plainfield, Vermont, and currently builds log houses at the Wooden House Company in Wells River, Vermont.

*Alicia Spence, project coordinator for the Guild, returned to Warsaw in March to see to the suspending of the structure by its permanent tension rods. Her report:*

GUILD and Handshouse crews wrapped up the project in January with the frame still hung on rigging and cribbed at the corners about 5 ft. off the floor, some 6 ft. lower than its ultimate position. This pause was planned to give headroom inside the glass box above for the roof shingling crew to maneuver. I returned to Warsaw for a few days in March with Joel McCarty, the Guild's executive director who had over the years managed the administration of the Gwozdziec project, to orchestrate the final lift and attach the hanging hardware. This trip felt a little melancholy, like visiting a gold rush ghost town. All was quiet (relatively speaking).

Preparation and calculation for lifting a design weight of 30 tons had been done and the rig tested. What remained was turning some bolts and many, many trips up and down a ladder. First we installed all 16 of the 24mm hanging rods through the predrilled log walls (see Fig. 10). With the help of local volunteers, we then hoisted the frame to full height and attached each Pfeifer tension rod to the anchor plates secured to the bond beam in the mezzanine floor. Finally, we added a pair of 20mm sway bars to each side. All associated components such as fork ends and barrel adjusters were off the shelf. The ridge rests comfortably now several inches below the finished ceiling. No more sleepless nights!

A note on rigging. Many schemes and tools were presented for

levitating this little gem of a structure, among them Tirfors (griphoists), hydraulic hollow rams—and hiring a house-moving company. The trick to rigging is to find the simplest, cleanest route. We found it in the five-ton chain hoists. They were easy to install, readily available and allowed us manually to adjust each position up and down, giving us the ability to lift evenly within a quarter-inch. Jim Kricker brilliantly suggested we add a lifting point to the ceiling anchor plates. By doing so, and by skewing the slings slightly at each pick point, we were able to keep all hoists in tension with room to thread in the hanging rods. To proceed with painted dome installation while leaving the rigging in place, we intentionally trapped the lower slings and later, with regret, cut them to strip the rigging.

I'd like to give special thanks to the staff of Warsaw's Museum of the History of Polish Jews, most especially director of exhibits Robert Supel and his administrative dynamos, Łukasz Adamski and Agnieszka Szling. These remarkable people guided the multi-year project through bureaucratic halls of crazy built on both sides of the Atlantic. It's also important to thank Irene Pletka of the Kronhill Pletka Foundation ([kronhillpletkafoundation.org](http://kronhillpletkafoundation.org)), who donated specifically for this project, in what she said was her very first bricks-and-mortar philanthropic effort. The wooden synagogue replication project was commissioned by the Association of the Jewish Historical Institute of Poland ([szih.org](http://szih.org)), an NGO dedicated since 1951 to preserving and commemorating the history and culture of Polish Jews and their contribution to global culture. The Association was responsible for development, implementation and financing of the Core Exhibition at the Museum of the History of Polish Jews.

*Laura Brown, codirector of the Gwozdziec project, attended the limited opening of the museum in April. Her report:*

THE ceremony on April 19 was amazing, a very moving remembrance on the 70th Anniversary of the Warsaw Ghetto Uprising, followed by thousands of visitors to the museum in the next two days. For now, the timber-framed roof is the only part of the Gwozdziec replica to be seen. The painted ceiling, which must be viewed from the lower level, will not open to the public until next year. So the roof is now famous—over 7000 visitors saw it on April 20 and more than that on April 21. I watched as groups of 30 and more were guided and told the story of the roof in different languages, mostly Polish and English but also Hebrew. The roof is indeed beautiful. The Finnish architect of the museum, Rainer Mahlamäki, loved its relationship to his very modern building. It emerges from the floor of the main entry, the first thing everyone sees after entering (see back cover).

What's more important is that the roof and ceiling were made by some 290 people working for the love of learning and sharing skills and recovering a lost historical building. That story is what needs to be remembered now that the roof and ceiling are so alive. The object speaks for itself but the way it was made must be told to the world.

**17 View looking east into cove and lantern at top of ceiling. Short names are signs of zodiac, identified in Talmud with months of Hebrew calendar. Clockwise from right: Nisan (Aries), Iyar (Taurus), Sivan (Gemini), Tammuz (Cancer), Av (Leo), Elul (Virgo), Tishri (Libra), Heshvan (Scorpio) and Kislev (Sagittarius). Long text at bottom of picture is part of series of aphorisms that runs continuously around cove.**

**18 Completed ceiling illuminated by candlelight and admired by exhausted crew including transparent Jim Kricker at center and raising boss Alicia Spence at right.**





17

Above, Jacob Bach-Jensen; below, Gerald David



18





Photos and drawings Jörn Wingender

# The Liegender Stuhl Roof Style

**T**HE *liegender Stuhl*, or “lying chair,” a special roof support configuration in German carpentry, is a marvel of the non-engineered timber framing craft (Fig. 1). Dating back as far as the early 15th century, and much later brought to the New World by German immigrants, it was conceived in a time when timber framers sought ways to improve one of the standard roof framing systems in German-speaking Europe, the *Sparrendach* (spar roof). Strong and easy to produce, with its repeated units of base-tied common rafter pairs, the spar roof was the choice for many structures from small cottages to Dutch barns. It can be found in many parts of Germany except for the Alpine regions, where the low-pitched *Pfettendach*, or purlin roof, remains the first choice of timber framers. Inserting a *Stuhl* (chair) into a spar roof transforms it to a purlin roof while still displaying all the features of a spar roof, as we shall see.

In the early 1400s, frame design was part of the *Zimmermann's* (carpenter's) repertoire, region specific and purpose driven, with an overtone of fashionable trends, similar to architectural design today. The confinement of cities within walls encouraged vertical development and led to creative timber frame solutions to increase available floor space for people and traded goods alike, on a minimal footprint. Roof systems were an integral part of that expansion. To this day, attractive, storybook-like roofscapes pay tribute to these efforts (Fig. 2).

To understand the different configurations of Germanic roof framing systems and the *liegender Stuhl* in particular, it's best to divide the framing members into three categories: rafters (*Rofen* and *Sparren*); collars and ties (*Kehlbalken* and *Ankerbalken* respectively); and support frame (*Stuhl*).

A *Rofe* is a rafter in a purlin roof. It “hangs” as an individual unit on the purlins and can project past the wall purlin to create an overhang (Fig. 3).

Sparren come in pairs joined at the peak while a tie beam holds them together at the base. They employ an additional short rafter or sprocket (*Aufschiebling*) at the bottom to create an adequate roof overhang. The distinctive kink in the roof plane close to the drip edge is a characteristic detail of the spar roof (Fig. 4).

**Support frame, not truss** The *Stuhl* in the world of German timber framing is the distinguishable support frame in a roof system, which helps to reduce rafter size by offering midspan support and via bracing adds lateral stability. *Stuhl* styles include the earlier *stehender Stuhl* (“standing chair,” vertical post support frame) and the later *liegender Stuhl* (canted post support frame).

*Stühle* generally include posts (*Säulen* here, *Ständer* if not tied to a wall system), purlins, struts (*Streben*) and braces (*Kopfbänder*). The *liegender Stuhl* assembly has one additional member, a straining beam (*Sprengriegel*), which brings to mind the similar element in a queenpost truss. The *liegender Stuhl* at first appears to be similar to the queenpost truss, in that both follow the same structural principle for load transfer from the center of a clearspan to two load points at the opposing edges of the span. A tie beam acts as lower chord except in the case of a *liegender Stuhl* on buttressed masonry walls, where there is no need for one. One has to differentiate, however, between a *Stuhl* and a roof truss.

The goal of a queenpost truss is to bridge a large span while holding up a roof skin on top and a ceiling below. Tension members (queenposts or rods) are required to pick up the lower loads and the entire assembly is given space that serves only this purpose.

The *liegender Stuhl*, on the other hand, only supports roof and floor members above the straining beam. The tie beam at the base (if any) is not supported by the rest of the assembly. Multiple cross-frames—each composed of two canted posts, one straining beam and two braces—make up the core of the *Liegender*. Each frame





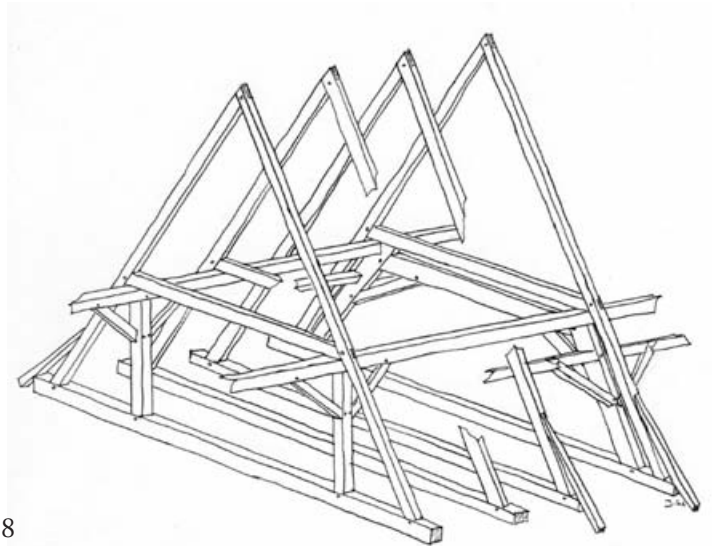
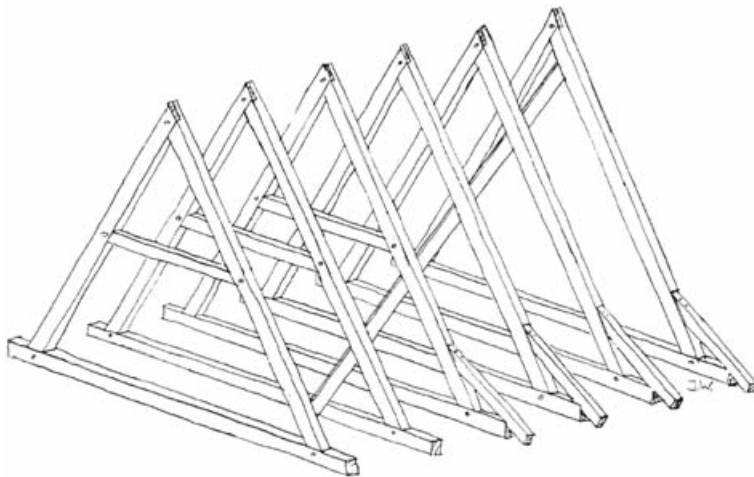
1 Second attic floor, Haigerloch Rectory, Baden-Württemberg, Germany. Crossframes in a liegender Stuhl spaced below every fourth rafter. Gable wall shows vertical purlin posts and curved baroque bracing between girts.

2 Multistory roof systems in Schaffhausen, Switzerland. Roofs covered with beavertail clay tiles, most common of historic materials.

3 Typical Bavarian *Pfettendach* with simple purlins fully supporting rafters to develop large gable overhangs for low-pitched roof.

4 Spar-rafter roof system at Thayngen, Switzerland, with liegender Stuhl framing exposed on gable end. Small outshot hammer beam assembly with tie beam-stub and hanging post (with lap dovetail) as rafter-wall plate connection. Typical spar-roof broken roof line created by rafter sprocket in overhang.





could be compared to a queenpost truss with half-length principal rafters that rise to a purlin at midrafter length. The entire Stuhl assembly consisting of crossframes, bracing and purlins is a three-dimensional frame, compared to a two-dimensional truss. The latter could be described as a single link in a series making up a trussed roof system.

Early versions of the Liegender featured long passing braces lapped to the canted posts and across the straining beam and collar, similar to lapped wall braces that traverse multiple rows of girts. Some earlier frames even showcased the crossframes with their canted posts in the exterior gable framing (Fig. 4). Gable frames in later work might have a “standing” or vertical post with an interior brace supporting the purlin as a lateral stiffener.

With its roots in the Middle Ages, the Liegender features the interconnected joinery of the time. Rafter, collar, straining beam and canted post come together in one location and, although not necessarily connected by joinery, find themselves in a symbiotic relationship. The collar beam, joined by tenon or half-dovetail lap to its rafter, acts as a lock for the canted post–straining beam joinery just below. (In the 15th century, before tenons replaced lap joints for braces, the brace could even be lapped as a single piece from rafter over post and straining beam all the way into the collar.) This detail can be considered good evidence that the liegender Stuhl has its origins in the spar roof with collar (Fig. 5).

The Liegender with its struts and braces adds lateral stability to any system, beginning with the basic condition of a simple spar roof (Figs. 6–8). The Liegender configuration on a tie beam is typical in buildings with framed walls, as the tie beam acts as a stabilizer for the walls as much as a tie for horizontal roof loads. Since the main goal originally of the Liegender design was to free up attic

floor space, all bracing is tucked away under the rafters in the same plane as the canted posts. Struts are used where sills are available at the base of the roof, typically on masonry walls. Sills would receive the bottom of the strut and the post, while the strut top joined the post.

During a raising, struts double as an assembly aid, bracing each new crossframe of the Stuhl against the previous one. In spaces with shorter posts or where no sills are available, as in the Stuhl on tie beam, *Riegel*, short mortised members in the roof plane analogous in position to wall girts, assist during raising. Braces are applied afterward, via a lap joint. *Riegel* lie in the same plane as the posts and bracing, parallel to the rafters, and thus are convenient to join (Figs. 9 and 10), unlike the plumb-positioned purlins, which would require compound connections if braced to the posts.

The similarity of wall and Stuhl framing culminated in the 19th century when, in an attempt to simplify the Liegender for economic reasons, the Stuhl wall on joists replaced the crossframe on tie beam. Another driver for this design change was that roof frames were now installed on masonry walls rather than being an integral part of a timber-framed wall system. A series of liegender Stuhl canted posts mounted on the newly introduced sill formed a canted wall (*Stuhlwand*), which connected to the supporting joist system via lap joints. In this design a whole floor diaphragm would act as the tie instead of individual ties supporting individual crossframes.

The complexity of liegender Stuhl fabrication, in combination with changing functional demands for roof structures, led to its slow decline. Disconnecting the Stuhl from the tie beams was a first step. Canting the purlins from their plumb position into the roof plane to simplify layout for bracing and rafters was another. A reduced social need for extensive attic space led to lower pitched





- 5 Collar beam joined to its rafter restrains canted post-straining beam joinery just beneath.
- 6 Haigerloch rectory third attic floor, spar roof peak without Stuhl.
- 7 Spar roof schemes with and without collars and sprockets.
- 8 Composite drawing showing stehender Stuhl on left, liegender Stuhl on right, under spar roof.
- 9 Haigerloch second attic floor, liegender Stuhl with girt bracing, looking through to first attic floor.
- 10 Haigerloch first attic floor, liegender Stuhl with St. Andrew's Cross bracing.







11, 12 Evolution of the stehender Stuhl in spar roofs. At left, Renaissance frame from northern Hesse, single post under collar purlin, seen protruding at two levels from gable end. At right, 1801 church from Ederbringhausen, now two posts under collar purlins spread out close to rafters, seen protruding under collar close to belfry (and no doubt lending support). Note sprockets. Both buildings at Hessenpark Open Air Museum.

roofs, which in turn ultimately led to the cousin of the Liegender, the queenpost truss, or *doppeltes Hängewerk*, in the 19th century.

**From Stehender to Liegender** The generally steeper pitch of roof systems with a Liegender can be traced back to the Liegender's origin as an additional support system inside a self-supporting spar roof, ultimately to meet demands for more storage space in early-15th-century German cities, as we saw earlier (Fig. 2). Limited room for horizontal expansion led to the creation of multistory buildings with steep roofs. The increased volume of attic spaces and particularly their height allowed for multiple floors within the roof system.

The spar roof with collars (*Kehlbalkendach*) was a common roof system, with one or more joist runs (collars), already built in, but without the capability of carrying any significant load. A single purlin centered at midspan under the collars and supported by posts was the initial solution. It is known as the single (*einfach*) stehender Stuhl (Fig. 11).

Its evolution progressed similarly to the Roman (kingpost) truss evolving to the queenpost truss: it was noticed that two posts are better than one, and the double stehender Stuhl was born. The purlins were still placed below the collar, but close to the rafter-collar joint, effectively yielding an independent floor system on purlins that happened to have a rafter attached to each joist end (Fig. 12).

To further increase the load capacity of the collars, a single and a double might be combined to form a triple stehender Stuhl (Fig. 13). The purlins under the collars would be posted at every third or fourth collar. This additional support frame was a convenient place to add lateral bracing in the form of struts or braces from post to purlin—appropriate additions to a heavily loaded and tall roof frame. On the other hand, the stehender Stuhl turned out to be an inconvenience, with its additional posts obstructing access to the attic space. That, and additional point loads from the posts that had to be transferred to interior footings or exterior walls, spurred on the Stuhl evolution. What followed was the liegender Stuhl, which canted the posts and their braces into the roof plane. Stehende and liegende Stühle can be found in spar roof systems and purlin roof systems and in hybrid combinations. With a myriad of hybrid and Stuhl variations out there, it's important to understand for frame repair and restoration how a given Liegender

in any roof system works. Well-intentioned alterations performed without knowledge of the structural workings of a Stuhl-framed roof system can be destructive. Knowing if some parts are simply missing might be critical to the work to be performed. The restoration timber framer has to have the knowledge to identify the roof system and the Stuhl configuration to make informed decisions about the restoration approach.

As in the Hebron church described in the next article, some alterations can be obvious, like the addition of an intersecting roof or the fracture in a collar beam because of altered load patterns. Others, like the disappearance of some of the collars, require more detailed investigation to determine if there are significant consequences for the structural integrity of the roof frame (see photos pages 19 and 21).

**Footnote, a liegender Stuhl in history** The Stuhl in the roof frame of Haigerloch Rectory, pictured in detail earlier, can be found over possibly the most significant beer cellar in modern history.

Both church and rectory (though not the brewery) can still be enjoyed in the Black Forest today because of a priest at the 1756 church of St. Anna, who in 1945 prevented Colonel Boris Pash of the US Alsos Mission (Army Logistics Support to Other Services), a part of the Manhattan Project, from blowing up the rock formation both buildings and a palace of the local earl are sitting on (Fig. 14). The cellar, which belonged to the local brewery, had been rented to the German government in 1944 to house a prototype nuclear reactor.

American Alsos forces knew about the nuclear research in the beer cellar and had orders to blow up the whole rock after cleaning out the remains of the German lab and the reactor, which the Germans had dismantled. What changed the Americans' minds was an invitation by the priest, who took them up the hill into the church to show them what was at stake. A minor but satisfactory explosion in the cellar destroying a storage tank that had belonged to the project, the Alsos detail then forwarded the message "Mission Accomplished." The brewery closed in the 1990s and its equipment was shipped off to Africa. Cheers then to another Liegender saved.

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13 Ruinous 18th-century barn near Hechingen, Baden-Württemberg, reveals gradual development of Stuhl system. First rafter pair still standing resembles spar roof (two rafters attached at peak). Deflection of spars indicates need for collar to equalize rafter loading. Second pair in has collar still attached and, despite failing Stuhl, pair of spars maintains original roof shape. As merely a building cover, this would be sufficient. Desire to fill loft space above collars required upgrade of roof framing, here seen as triple stehender Stuhl in the foreground, while addition in back with its liegender Stuhl reflects need for more open attic space.

14 Haigerloch ensemble. From the height downward: palace at the back; church in the middle; and rectory, looking comparatively small, though actually about 45 x 73 ft., at bottom right. Entire ensemble narrowly missed destruction in WWII.







Photos Douglas Harnsberger

1 Hebron Lutheran Church, Madison, Virginia, originally the German Chapel, 1740. South annex, 1802, in foreground.

## Virginia Church, with Liegender

**H**EBRON Lutheran Church in Madison, Virginia, is a living legacy of 18th-century German settlement in Virginia. The main body of the extant church, completed in 1740, is the oldest building in continuous use as a Lutheran church in the United States (Fig. 1). The earliest parish register identifies the founding congregation as the German Evangelical Lutheran Congregation, Culpeper County, Virginia. From the time of its formation in 1717, the congregation was one of the most vibrant and industrious Lutheran groups in America. Until the name Hebron was adopted around 1850, the church was variously called the German Chapel and the Old Dutch Church.

Hebron Lutheran is one of only five surviving colonial-era, wood-frame churches in Virginia. Only one other, Providence Presbyterian, ca. 1747, was built by followers of the Reformation. The other three were Anglican: Slash Church, 1729, in Hanover County; Tillotson Parish, 1757, now Buckingham Baptist Church, in Buckingham County; and St. John's Church, 1739, Richmond. Between 1720 and 1770, 83 wood-framed Anglican churches were built in Virginia. Until 1786, Anglican parishes were the official, state-sanctioned and taxpayer-supported religious bodies in Virginia. Non-Anglican congregations such as the Hebron Church congregation demonstrated exceptional initiative and financial commitment in building their respective churches.

The design of the original 1740 church was consistent with that of other small churches erected by German Protestants in 18th-century America. Typically such a church featured a compact volume; a short rectangular plan with a high pulpit on one long side facing a main entrance on the opposite wall; a nonliturgical

arrangement of interior furnishings; galleries, often around three sides; and simple detail and ornament.

**The first building campaign, 1734–1740** When completed in 1740 and known as German Evangelical Lutheran, Hebron was rectangular in plan, measuring about 50 ft. long by 26 ft. wide and 30 ft. high. A 9x13-ft. separate vestry room was centered against the north wall. The foundation followed a regular rhythm of independent rubble-stone piers, a typical 18th-century German construction detail. The building was clad in weatherboard siding “sawed to a feather edge” and capped with a steeply pitched (12:12 slope) gable roof. To project rainwater away from the foundation, the builders constructed flared eaves by adding a sprocket at the base of each rafter. Several weathered wood shingles discovered in the attic in 2012 are evidence of the church’s early roof covering. The shingles were riven and hand-shaved to a taper from heart pine 3, 4 and 5 in. wide, with a 6-in. weather exposure. A single stone chimney stood in the center of the north wall, between the small vestry and the main block of the church. Like the foundation, the chimney was constructed of rubble fieldstone and limestone from the Hebron Valley.

A German cultural distinction is revealed in the slightly uneven dimensions of the rectangular footprint of the church, which in US feet measures 26 ft. 5 in. by 50 ft. 2 in. In 1740, each of the different German states determined its own version of the 12-in. *Fuss* or foot. In southern Germany, in Bavaria and Württemberg, the foot varied from 289mm at Ulm to 307mm at Aichstadt. In the north, in Prussia, the foot varied from 236mm in Wesel to 291mm





2 Fine ethnic carpentry of longleaf yellow pine timber in Hebron attic rendered even more exceptional by directly formed arch.

at Stralsund, etc. The German foot was eventually standardized with the introduction of the metric system in 1872.

The original church embodied a typically German organizational design characterized by a compact volume and its “short” rectangular plan. Most 18th-century Anglican churches in Virginia were somewhat more elongated, generally 60 ft. long and either 24 or 25 ft. wide.

The gable roof at Hebron Lutheran may reflect another German building preference. While most 18th-century Anglican churches in Virginia had hipped roofs, the majority of colonial churches built by Lutherans or Presbyterians were gabled. In addition to Hebron, both Providence Presbyterian in Louisa County and Peaked Mountain Lutheran (1769) in Rockingham County had gable roofs. In Delaware and Maryland, where German building traditions were more pronounced than in Virginia, churches typically had gable roofs. The Anglican propensity for hipped roofs may be the result of exposure to a hipped roof-framing plan published in London in 1741 by Batty Langley. The German preference for gable roofs is most likely rooted in continental European building tradition.

The most distinctively German feature of Hebron’s architecture, hidden from public view in the dark attic, is its longleaf yellow pine heavy timber roof system. Composed of 11 elegant crossframes that span the 25-ft.-wide sanctuary, with longitudinal girts and bracing, the traditional medieval *liegender Stuhl* (“lying chair”) design is a hallmark of the German *Fachwerkhäuser* building tradition. The support frames, spaced regularly on 4-ft. centers, support a compass or barrel-vaulted ceiling along the 52-ft. axis of the church. The framing members, presumably hewn by carpenters from the congregation, were assembled in the traditional German framing manner with pinned mortise-and-tenon joints (Fig. 2).

The identifying component of the *liegender Stuhl* is the canted or lying post. Measuring about 10 ft. in length, each canted post at

Hebron tapers from 6½ in. wide at its base to 11 in. wide where it terminates under a collar beam and against the end of a straining beam. The post is wider at its top to accommodate a double row of purlins that run the 52-ft. length of the original sanctuary. To achieve the profile for the barrel-vaulted ceiling, the carpenters struck a radius along the bottom edge of each post, continuing along the lower edge of the transverse windbraces and the bottom edge of the straining beam, the central horizontal member spreading the two opposing canted posts, somewhat as in a queen-post truss. The radiused surfaces carried across the base of the truss formed a continuous arched profile of the ceiling vault.

To produce the ceiling, riven and joined boards, painted white, were nailed longitudinally across the frames the length of the building. Wrought rosehead nails that once attached the ceiling boards remain on the windbracing today, spaced 8, 10 and 12 in. apart. This nailing pattern suggests that the original ceiling boards varied in width from about 9 to 13 in. (Fig. 3).



3 Nails fastened boarded ceiling, spaced for widths 9 to 13 in.





4



5



6

Roman numeral marriage marks carved into the ends of each joist ensured correct alignment during installation. In some joints, hand-wrought iron nails and spikes added stability. Distinctive carpenter's marks form another German hallmark at Hebron, coded symbols for position carved into individual members during scribing, and different in character from their English counterparts. German carpenter's marks may resemble Roman numerals but with added embellishments such as arcs, flags, triangles or small circles, chiseled or cut with a race knife. These marks, generally called *Abbundzeichen*, are similar to mason's marks found in hand-carved decorative stonework. Fig. 4 shows *Zwei Rut*, *Neun Ausstich*, indicating second lengthwise wall and ninth crossframe from reference end. (Wall and roof framing are labeled in similar fashion.) *Rute* walls or assemblies are parallel to the ridge, *Ausstich* assemblies perpendicular. Seen from the same viewing direction, the brace on the opposite end of this crossframe can be expected to show a single stroke with nine flags. Given the angle of the post in the photo, leaning rightward, the carpenter chose axis 1 to be to the right of the ridge, axis 2 to the left.

Other scored marks found in this roof frame identified locations for mortise-and-tenon joints and holes for pins.

**Yeocomico Church** Though we may no longer see Hebron's original high barrel vault finished with painted boards—all that remains of any vaulting is the organ loft in the annex, with a plaster rather than wood finish—a cousin of Hebron's ceiling may be seen on the Northern Neck of Virginia at Yeocomico Church, an Anglican parish church built in 1706 in Westmoreland County. The vaulted wood ceiling here is riven clapboards laid thick-edge up. The partly exposed, cased trusswork marks a different style from Hebron's but dramatic light enters through gable-end windows to light the sanctuary, as it did once at Hebron (Figs. 5 and 6).

**Hebron's second building campaign, 1790–1802** Between 1790 and 1802, a rectangular annex, 25 by 30 ft., was added to the south wall of the 1740 building, creating a T-plan for the expanded sanctuary. The annex expanded the seating capacity of the sanctuary and incorporated an organ-and-choir gallery. The intersecting gable roof matched the 12:12 pitch of the original roof and the barrel-vaulted ceiling on the interior of the annex was comparable with that of the original church building, but the liegender Stuhl configuration of the original church was not repeated. Rather than hewn timber, sash-sawn timber (produced at nearby Hoffman Mill, a water-driven sawmill), was framed in a combination of 7-in.-deep principal rafters and 3½-in.-deep common rafters, paired and joined by collar beams (Figs. 7–10).

The compass ceiling was achieved now by thin, nonstructural nailers, not with the hefty, structural windbraces of the 1740-era construction. The radially shaped nailers were fastened to the bottom edge of the collar beams and then boarded to replicate the finish of the original sanctuary. This construction greatly simplified the original 1740 liegender Stuhl system. The many differences in the two roof systems, built about 60 years apart, indicate that American building construction practices in use by 1802 had been fully assimilated by the third generation of Hebron Church carpenters.

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4 Carpenter's mark for second wall (or roof) frame, ninth crossframe.

5 Painted wooden ceiling, Yeocomico Anglican Church, Westmoreland County, Virginia, 1706.

6 Exterior view, Yeocomico Church. Early brick churches are more common in Virginia than frame because of masonry's greater termite resistance.

7 Detail of 1802 annex roof framing at Hebron Lutheran. Rock lath wall is at back of organ loft seen in Fig. 8. Note sash-sawn timbers.

8 Organ loft in annex preserves only remaining vaulting, now plastered, from what was once two vaults at right angles ceiled with painted boards. Today's decorated flat ceiling conceals all else.

9 View from 1802 annex attic into 1740 attic showing falsework at groin and new approach to hanging vault.

10 View of upper regions of 1802 attic with its crisply sawn timber.





Photos Shannon McIntyre, Sarah Purgus and Liz Johndrow

# A Quaker Meetinghouse in Costa Rica

DEEP in Central America near the Continental Divide, where you might not expect to find chisels, mallets and an antique boring machine in working condition, the tink, tink, tink of timbers being framed can be heard above squawking toucans and screechy parrots. I came to Monteverde, Costa Rica, in January to spend three months helping to lay out timbers and coordinate volunteers to build a new meeting hall for the community of American expatriate Quakers who've settled these hillsides. Building this frame has been a remarkable demonstration of the potential for collective accomplishment when people are organized and dedicated. Although this was not a Timber Framers Guild project, it certainly fell in line with the Guild's central mission and it was orchestrated by some of its members. Timber framing is not part of the local vernacular in Costa Rica, nor the tradition for those who moved here and founded this community, but it sits well with Quaker values of simplicity and an appreciation of the natural world, and it brought people together in that special way a timber framing project does.

The physical and spiritual center of a Quaker community is the Meeting for Worship, where people come together in silence unless moved to speak. Quakers believe that any person is capable of sharing profound messages and communicating with God without intermediary clergy. The new meeting hall will be for this prayer service, a large open space so every person can see and hear every other and feel present with all. The space will also serve as a community center for monthly square dances and for the many large events hosted by the adjacent Quaker (Friends) School. To meet all these needs, the main hall is a sizable 31x65-ft. frame with a 30-ft. clearspan in four of the six bents. The building is between the school's library and the existing school building, and a 15x45-ft. covered courtyard closes the space between the school and meeting hall and will provide space for eating and gathering. Dancers will enjoy not only the wide open space, but also a sprung floor.

The vibrant community in Monteverde has a unique history. In the late 1940s, three members of a Friends Meeting in Fairhope, Alabama, were arrested for refusing to register with their local draft board. Pacifism is a deeply held belief for Quakers, and they could not accept the first national draft during a time of peace. They spent a year in prison and were motivated by their experience to form a separate Meeting in 1950 in Costa Rica, which had recently abolished its army and pushed forward a series of social reforms. They were dairy farmers in search of land suitable for pasture. The land they eventually found within their means required a long trek up a (still) treacherous road in Puntarenas province. Since the 1980s, the surrounding area has become internationally celebrated for its unique cloud forest ecosystem, but in the early days much of it, cleared by squatters for pasture, was a blustery hilltop full of wild animals, complete with mudslides. The 40 or 50 people who moved here built their own houses, delivered their own babies, fed their families and set roots down deep.

The first meetinghouse was a disused squatter shack. When they were ready to build a better space, the community held a pie auction to raise the funds for the materials and built the first schoolhouse, part of which served as a meeting hall. Nearly constant winds combined with 118 in. of rainfall per year were tough on the schoolhouse. The next meetinghouse, also on school grounds and dating to 1957, was a "bee" project in which members of the meeting all pitched in money and time to get the project done without outside help. It's beautifully built and has served the community well.

The design for the newest meeting hall includes a hip roof on one end of the building to moderate the wind's effects, along with a concrete retaining wall to combat weather-driven erosion.

As the population of Monteverde has grown and changed, Quakerism has remained the fundamental root of the community. More expats have settled in the area and many children and grand-





Facing page, walls and three trusses up, hand-raising proceeds apace. At top, volunteers at the ready and celebrating the halfway construction point. Above, from left, David Hooke tutors elementary timber framing; sawyers hard at work with portable mill; sprung floor layout.

children of the original families have stayed close to home. Many have married Costa Ricans, and Meeting is now held in English and Spanish twice per week. David Hooke, a partner in the building company Timberhomes in Vershire, Vermont, decided to spend a year in this community with his family. The idea of making a new meeting hall as a volunteer-built project seemed a natural fit to him. David revels in doing these projects at home in Vermont and seems to have been drawn to timber framing mostly as a vehicle for bringing people together.

The frame was designed by David and Timberhomes's Josh Jackson to meet the diverse needs of the community. In December, David invited me down to be his assistant in layout and in training volunteers who would cut the joinery. By the time I arrived in January, framing was already under way.

I was energized by the idea of a community project, but also aware of the realities of constructing a building this size. I spent the long, dusty bus ride to Monteverde poring over the drawings and pondering how beginners would fare with the modified English tying joints, curved braces and tropical wood. All told, 1292 joints would be cut by volunteers. The extent of the tool set was a single boring machine, a single bit to drill all 260 pinholes, and enough chisels, saws and planes to keep the anticipated ocean of workers busy. The framing site was half a basketball court, thanks to the compassion of the schoolkids and generous support from their teachers. Heavy tropical timbers had to be loaded by hand from the sawmill onto a pickup truck, driven to the school over rocky roads that locals navigate with ATVs, and unloaded at the site. This community is well versed in working together but had only one resident with timber framing experience. The budget was tight, the timeline abbreviated and the supply of power tools short. Given these constraints, I had serious doubts that we could even come close to our deadlines. But with plans in hand we began training volunteers, and the sawyers started up their portable bandsaw mill.

Almost all of the timbers are a Mexican species of cypress from a mature grove of suitable trees within a half-mile of school planted as a windbreak in the 1970s by Jon Trostle, a Quaker settler. Much of the forest in Monteverde is in reserves (one a 26,000-acre territory where biologists come to study cloud forest ecology) and harbors endemic wildlife valued and protected by both locals and the international community of biologists studying here, but Mexican cypress is non-native, and therefore less valued for its role in local ecosystems than other trees. The windbreak provided nearly all the wood needed—timbers, roof boards, floorboards and infill wall framing. It is rare for the person who planted the trees to witness them put to use in one's own lifetime: Jon (second from left in photo top left) celebrated his 91st birthday during construction and, with his wife Sue, was a regular volunteer.

**Roof trusses** The trusses' interrupted 7x9 lower chords are housed into the kingposts and held in tension by 1¾x5-in. Guapinol (*Hymenaea courbaril*) splines 5 ft. 9 in. long and transfixed by six 1¼-in. pins, in a design reviewed and approved by a structural engineering professor at the University of Costa Rica in San José. (Drilling 1¼-in. holes through this tropical hardwood resembled how I imagine arm-wrestling a large angry puma must be.) Two of the trusses are reinforced across the tension joint at the kingpost by frequently fastened steel plates as part of the lighting system for the theater. The 6x7 upper chords are at a 3:12 pitch, and their tenons, 3 in. thick, bear on one another inside a through-mortise in the kingpost rather than conventionally bearing on the kingpost itself. If the kingpost shrinks, the chords will retain nearly full bearing. The outer-wall end of the tie beams is part of a modified English tying joint.

The professionally built foundation for the meeting hall comprised a grid of deep concrete piers linked together with structural grade beams around the perimeter and parallel to each bent.





At top, raising complete at courtyard end of frame. Above left, truss assembly on horses: David Hooke drills for spline pins while assistant eyeballs plumb and author checks for drillbit blowout. Above right, swervy brace accommodates procedural error in great style.





From left, wedding dancers test the sprung floor of multipurpose building, which will serve as meetinghouse, school theater and monthly square-dance hall; all-star volunteer David Guindon wields a prize commander; sunrise Quaker Meeting in completed frame ready to cover.

Reinforced block walls additionally connect these piers particularly in the stage area. Building a sprung floor meant keeping the foundation separated from the floor. A grid of metal joists spans the transverse concrete stem walls, providing some of the needed flex over 12 ft. spans, and floats on rubber cow mats where the joists cross the concrete. So far, all dancers approve. The local crew building the foundation also fabricated steel hold-downs for each post, welded to rebar inside each pier, to prevent the frame from slipping off the foundation during earthquakes. Seismic and wind forces are primary here. The posts were routed for a flush fit of the hold-down that would not interfere with wall siding.

The final load of timbers came a mere six days before raising. Toward the end, it became difficult to find large-enough trees for the bigger members of the frame, the sawyers were working hard to meet deadlines, and the volunteers were now up against sopping wet, heavy wood and some serious wane. By that late in the game, over 60 people had come to volunteer once a week or more (mostly more), for two months, and over 100 people had participated in some way. A smaller, dedicated crew had formed who would put in a few hours every day. People rallied beyond all expectations to put in over 4000 hours of work just in cutting joinery. The massive efforts to treat and oil the timbers and to raise the building were additional. The school ran a weekly minicourse for 15 middle school and high school kids to learn the basics of timber framing. After three or four sessions, many could follow layout lines on their own. Even with hand tools and limited experience, eight to ten people chipping away at joinery at any given moment started to feel like a well-oiled machine chugging toward the finish line.

Between layout, cutting joinery, moving timbers, treating for termites, oiling, test-fitting bents, keeping tools sharp and rust free, and maintaining some minimal sense of organization, there were more than enough tasks to go around. Schoolkids came out at recess to lend a hand. Numerous original Quaker expats, now octogenarians, were consistent volunteers, and even people from other nearby schools all came out to help finish the frame. Excitement grew as we marched toward raising day.

Talk of renting a crane to lift the trusses met with antagonism by those managing finances and by community members sure that enough people would come out to get it done. The financial cost of getting a crane up that hill and the moral cost of raising with machinery were too great. In the first two days bents and wall sections went up by hand, and then came a break for a wedding, during which the sprung floor got its first test by happy guests. We were then ready to face the trusses.

All told, the trusses weigh approximately 1200 pounds each and had to be lifted up piece by piece and assembled in the air. Two towers of staging carried cribbing level with the wall plates. Large

crews of 20 to 30 people moved each truss member aloft, where the whole truss was assembled, cinched together with truck straps and pinned. At this point, all 30 people on the staging would line up, lift the entire truss and lower it down one end at a time onto its respective posts. None of these trusses required trimming on raising day, a testament to the newfound skills of the volunteer framers and the test-fit crew's attention to detail.

With relatively little funding, limited electrical power and a small tool set, this community built its own space to gather, worship, hold weddings and funerals, and come home to. Building a large timber-framed structure this way has been an eye-opening lesson in the key elements to make such an effort feasible, safe, of long-lasting quality and enjoyable for all involved. David Hooke, as the orchestrator of the project, came up with the list of requirements below.

It goes without saying that each community is different and that, when they are really needed, characters come out and shine: the practiced woodworker who fabricates 260 beautiful hardwood pegs, or the enthusiastic youngster looking at things like this for the first time and who asks the questions that spark fresh debate, or the architecture student who works behind the scenes to make it all happen. My initial doubts about finishing the meeting hall arose from seeing a lack of tools, equipment and experience, but I now realize that what makes this kind of project a reality comprises a much different list.

—SHANNON MCINTYRE  
*Shannon McIntyre (sionainn.mcintyre@gmail.com) was a Heartwood apprentice and works at Timberhomes, LLC, in Vershire, Vermont.*

### Checklist for Volunteer-Built Project

- ☞ Consensus that there's a need for the structure.
- ☞ Active support by those directly affected by construction.
- ☞ The necessary trees.
- ☞ A crew of skilled carpenters to do things impractical for volunteers (such as to build the foundation or put on the roof).
- ☞ Enough money to pay the skilled carpenters.
- ☞ A vast number of volunteers, willing to work consistently with hand tools, the important characteristic of a volunteer being not age, strength or experience, but consistency.
- ☞ Enough young bucks to help move many very heavy timbers.
- ☞ Enough handsaws, chisels and planes to keep the workers going, and someone willing to keep the tools sharp.
- ☞ A solid core of three to five people who are completely comfortable doing layout and at the same time able to shift easily to teaching someone how to start a saw cut, pare a tenon or whatever else it might be—and to do this teaching over and over and over.



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