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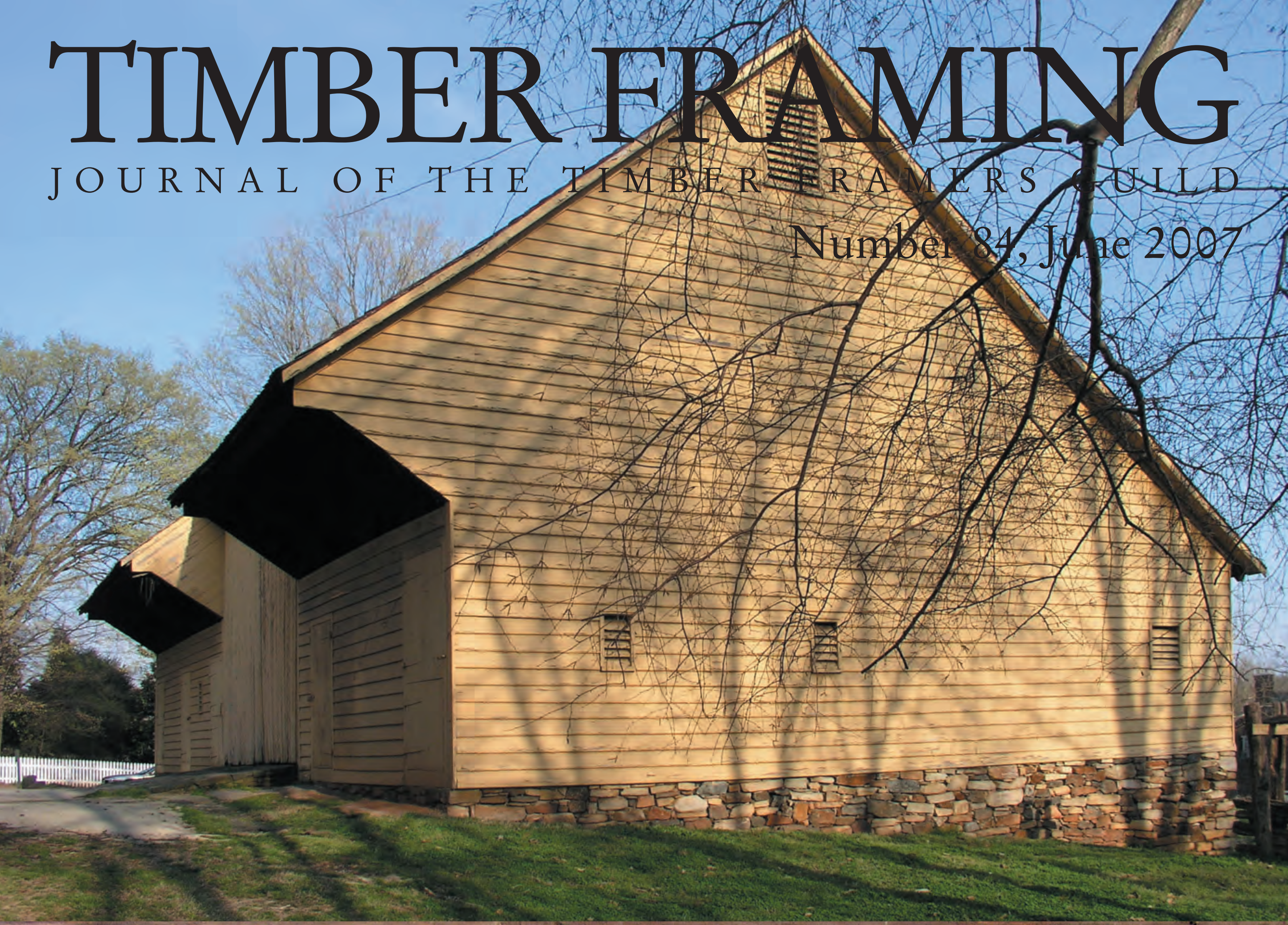

TTRAG at Old Salem

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On the front cover, exterior and interior views of the tavern barn at Old Salem, N.C., built in the 1840s in anachronistic style reflecting early technology and moved from Bethania. Photos by Ken Rower.

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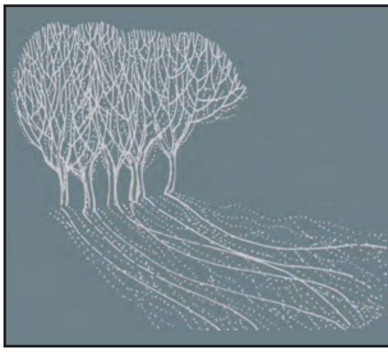


TOPICS

Against Entropy

STRUGGLING to find a reason to build that satisfied my desire for social contribution, I nearly quit the building industry. There was a whole list of reasons, among them boredom and frustration with the residential construction industry for its lack of intellectual and social demands on builders, a felt disconnection from clients (I've always acted as a subcontractor) and difficulties finding local resources for our most basic raw material, timber—not to mention the difficulty of finding a good balance between making a living and making a life.

But a recent timber framing job (pictured on the facing page) that followed on the heels of a commercial truss job for our local billionaire, satisfied, at least in part, some of those desires. Though far from groundbreaking or unique in the timber framing field, it represented both a milestone and a stepping stone for me personally and as the operator of my company.

We found a mill not too far away harvesting trees big enough to make real timbers—white fir, Engelmann spruce and some Douglas fir. The trees we used were harvested in a beetle-kill area in an attempt by the US Forest Service to manage the bug problem before it destroyed the entire forest. Those factors, plus surprisingly low costs, were the positives. On the downside, our timber arrived in less than ideal condition: poorly packaged, dirty and with significant handling damage. The mill's mechanized tumblers had left a pair of black grease streaks every 6 ft. on most of the timbers. Almost none of the timbers arrived without broken corners from the tumblers or forklifts. Muddy footprints and piles of dirt were part of the package. A few sticks flatly failed grade (even though they all had a grade stamp), and more than a few others were definitely at the bottom of the grade. We asked for and got free replacement of about ten sticks. We used a few we really didn't want to.

Fortunately, we had very enthusiastic clients who loved the fact that the timber was local. We solved a big portion of the handling damage by planing the entire frame, even though we had sold it originally as roughsawn. It seemed the right thing to do, considering the level of expectation I had for the finished product and what I felt the clients had a right to expect. They also accepted some less than perfect surfaces and corners that another kind of client might have rejected.

I'm proud of the project socially for a few reasons. The clients are local by any standard (nine miles from my house to theirs) and, in the process of building their house, all the participants seem to have managed to increase the size of their human communities. As one measure, at the raising there were five paid staff and 13 working volunteers, plus a few observers and photographers. A few of the volunteers came because of an invitation I sent out to about 150 people; the rest were friends or family of the client, or people who had somehow heard about the event and showed up, happier to work than to stand by. Contribution to a local cause, even if it appears to benefit only a few people specifically, I consider to have a huge impact on true community. Thus my obsession with local interactions above any other concern about our environment or the status of the world. We're as likely to care for people we've helped as we are to care for people who've helped us.

Built in northern Colorado where the foothills meet the plains at an altitude of about 4800 ft., the frame used 17,120 bd. ft. of white fir and Douglas fir and covers 2428 sq. ft. (including porches), measured inside the straw bales that will enclose it. Roof snow load, which varies widely in Colorado, is only 30 lbs.

Isaac McCoy Sulentic

My largest goal as a builder is to influence the relationship people have with their built environments. I'm convinced that people who contribute real work in whatever way they can to the houses they live in will have dramatically different experiences with their houses from those of folks who merely stand by and watch the whole process. I've never worked in the Colorado ski towns and have no plans to chase the trophy work there. I'm not saying I wouldn't build a trophy house if the job landed on my desk with a pile of money, mind you. It just seems way more satisfying and interesting to be involved with people who intend to live in their house 12 months a year (imagine that).

I understand that none of us is in business particularly to make new friends. But it's satisfying for me when our status with the future owners of a house looks a lot more like trusted advocate than necessary contract holder. These clients included as part of their contracted payment (honestly) oatmeal cookies, fresh eggs, dog-sitting and consultation about our marketing strategy.

I can't actually yet prove to myself that what I do solves my appetite for social contribution, but I have some evidence. The several local carpenters who've worked on this job plus more than a few passersby seem to have a new understanding of the possibility of craft. I hesitate to use the word inspirational, but it may fit. Even the metal stud and drywall carpenter who has been remodeling the space we rent was fascinated enough by what he saw in our shop to come to the raising and help out for a couple of hours. I like, in general, when men and women doing the daily grind of building are able to elevate their imaginations and their perspectives. Pride in workmanship may be one way to describe it, although that term insufficiently explains what I'm interested in. Good work and right livelihood are connected here, beyond my ability to describe but not beyond my ability to appreciate.

As for intellectual demands on residential builders, some stuff began to satisfy. Working from a basic, undetailed set of drawings by a straw-bale designer from Massachusetts, I designed the frame with the help of two engineers and one veteran joiner. This required halting the already started concrete foundation work until we had really finished the design. Interior pads and the turned-down haunch for the monolithic slab (the thickened portion at the perimeter that generally replaces the footing and frost wall) were all eventually respecified, and all the buried runs of hot water pipes, rebar and electrical conduit were mapped out to avoid our Timberlinx anchors and the epoxied threaded rod below them.

Through the project, I've fulfilled some of the role of a good general contractor. Which I could have done officially, I suppose, but I found I enjoyed the position of advocate for the homeowners without the day-to-day responsibility of a general contractor. The homeowners, who acted in this case as their own general contractor, called when they needed something or were worried; otherwise it was their baby. Their questions covered materials availability, relationships with other subcontractors, contracts, payment structures, how to handle estimating error in a job—and what to do when you feel unqualified to do your job.

Two itinerants worked on this frame. That they were on the road seemed less relevant than it used to. I used to feel of itinerants (and I have been one) that being on the road was really their story, as I think most people believe. But the story is just about good people, not how they got here or how long they're staying. Five good people cut the frame in the shop, and I'm as proud of the camaraderie that prevailed there as any physical product we produced. As far as I can tell, we all shared lunch and cared for one another as brothers. Best crew I've ever had.

Some of my expectations remain vague even to me but I'm willing to enjoy what already feels successful. Elevated tradespeople, community involvement, client involvement, good shop culture—I'll take it. The problem of making a living (including a profit) and making a life is partially solved. During this job it took me 12 hours a day to get done what I had to do, more than I like to schedule for myself. But if part of the excess represents the work and energy needed to get a real business off the ground, I'm willing to do that. I also continue whenever I can to hire people more skilled and more educated than I am. A new marketing company, a new bookkeeper and Curtis Milton here for a week to do compound joinery are a few examples.

I appreciate our timber framing trade for its relatively high percentage of people who have social consciences apparently equal to their business instincts. I think both of those faculties should increase constantly and equally for people to fully resist worldwide entropy. —Adrian Jones

Adrian Jones (adrian@frameworkstimber.com) founded Frameworks Inc. in 1996, put it to rest for a couple of years to go on the road as an itinerant, then started up again as Frameworks Timber in Wellington, Colorado, not far from the Wyoming border, in 2005.

1700s Germanic Framing in Moravian Salem, N.C.

THE Pennsylvania Germans have been thoroughly studied and their cultural contribution to their state remains undeniable. By the mid-18th century, however, Pennsylvania had begun to export its Germanic culture in a migration pattern that edged down the Alleghenies and the Blue Ridge Mountains through Maryland and the Valley of Virginia, following the Great Wagon Road down into the Piedmont region of the backcountry of North Carolina. Packed in their cultural baggage, the Germans brought with them construction traditions and building plans. In the southern climate, however, they would be confronted with a new set of environmental conditions. In the end, they would cling to their traditions, but increasingly with a southern accent.

The most culturally cohesive, conservative and enduring of this group of German immigrants—and therefore the most accessible for study—are the Moravians. Their excellent records preserved today in the church archives and their extant buildings provide rare insights into the forces that influence building construction.

The Moravians are a Protestant religious group that traces its origins to the 15th-century martyr Jan Hus. In 1722, following years of persecution, they were granted refuge on the Saxon estate of Count Nicholas Ludwig von Zinzendorf. Here they established the town of Herrnhut near today's border between Germany and the Czech Republic. In this Central European background one can first observe the construction details that define the Germanic architecture of Salem, North Carolina.

By the 1730s, the Moravians had begun their missionary work (particularly in Africa and the Caribbean), retaining Germanic forms and construction details in their buildings, and including a mission in Savannah, Georgia. In 1740, they abandoned their mission in Savannah and shifted their focus northward to Bethlehem, Pennsylvania, into an area that would eventually include the towns of Nazareth and Lititz. By 1751, however, the Moravians began to look toward North Carolina as a place where they could acquire sufficient land to enjoy the isolation and autonomy necessary to build the theocratic community they had not been able to achieve in the more heavily populated Pennsylvania. In 1753, they purchased a tract of nearly 100,000 acres in the backcountry of North Carolina, which they named "Wachovia" after the Austrian estate (Wachau) of the Zinzendorf family.

From the start, the Moravians enjoyed a distinct advantage over other settlers in the backcountry. Carpenters, masons, and even a surveyor would be sent from Europe and Pennsylvania to support the building of the Wachovia settlements. These trained craftsmen would quickly develop the architecture from the rude, single-room log cabin, ubiquitous throughout the region, to a much higher level of sophistication. These artisans came with a cultural tool kit assembled from their Central European experience and often tempered by their time spent in Pennsylvania, but the conditions in North Carolina quickly began to affect how buildings were constructed. On the whole, the builders would streamline and choose the simpler of various Germanic framing options.

When 15 brethren arrived on foot from Pennsylvania in the winter of 1753, they settled first at at Bethabara, a few miles north of the later Salem settlement. The first structure they built was of post and log, the posts grooved to receive horizontally stacked and scribed logs. In rudimentary form, the logs were left round and the ends probably tapered to engage the groove. On better examples, the logs were hewn on two or four sides and ended in tenons engaging the grooves and sometimes pegged. This log construction, so common in Pennsylvania, was soon abandoned by the Moravians and seemingly by other 18th-century Germanic settlers in North Carolina in favor of a corner notching system. The log structures of early Salem a decade or so later were defined by a preference for white oak logs, hewn on two sides, with rocks and shims used as chinking. The full dovetail was the preferred notching. The purlins, plates and sills extended beyond the plane of the log walls (Fig. 1).

John Larson

Fig. 1. The Lick-Boner house, 1787, Salem, N.C. Mature chinker log construction with hewn logs and dovetailed corners.

Although log construction would continue well into the mid-19th century, gradually shifting over to pine and the V-notch joint, the Moravians viewed it as wasteful of precious building material.

In 1765, as plans for the construction of Salem began, the administrator of the Wachovia tract, Friedrich Wilhelm Marshall, offered this practical advice: "I do not advise the building of log houses, as there is not enough proper timber in the whole neighborhood, but it will be better to use framework, like the apothecary shop in Bethabara, for which shorter timbers can be used; and an attempt should be made to use stone."

Because of this concern over the long-term availability of wood and a shortage of lime mortar, the early buildings of Salem were half-timber or *Fachwerk*, one, one and a half or two stories tall.

Construction of Salem began in January 1766. The appearance of half-timbered framing strongly speaks of Central European antecedents, yet in the simplification of design and construction detail the southern accent begins to be seen. The three-room, central chimney plan—often referred to as the *Flurküchenhaus* (hall-kitchen-house) plan—is the signature form of domestic architecture in Wachovia. Surviving multiple generations, this simple house form would be produced in *Fachwerk*, frame, stone, and brick well into the second quarter of the 19th century. A large central chimney served the combined kitchen-hall, while the other two rooms were heated by a corner fireplace or a stove of ceramic tiles or iron.

In the framing of the *Fachwerk* houses the non-Anglo details are most visible. Roof frames comprised common rafter pairs, each with a single collar and tie beam. Purlins ran under the collar beams and were supported by posts resting on a false plate. These posts also served as studs to support lath and plaster in the occupied attic spaces. Rafters terminated directly over the wall plate and required a change in roof pitch to extend the eaves beyond the plane of the wall without descending inconveniently far. Hence a small wedge-shaped extension was attached at the foot of each rafter. This "kick" is a defining detail of 18th-century Germanic roof framing in North Carolina (Fig. 2).

Ken Rower

Fig. 2. Miksch House, 1771, a* Fachwerk *house with the characteristic roof pitch "kick" at the eaves. Note cogged tie beam at front plate.

The more complicated gambrel roofs or even simple jerkin-head and hipped roofs so prevalent in Europe and Pennsylvania never found their way into North Carolina's Germanic backcountry. An exception to the streamlining of the roof was the continued use of dormers to admit light into the occupied attic spaces, especially at the top of stairways.

Although simple in design, the early roofs of Salem appear over-engineered in their use of closely spaced light trusses and their sizing of the common rafters when compared to contemporary English examples. These roofs were clearly built to support the weight of clay-tile roofs. Roofing tiles were high on the list of essential construction materials and they were manufactured within three years of the Moravians' arrival in North Carolina. The shape and method of installation can be seen in 18th-century publications and in European and Pennsylvanian prototypes. The tiles are held in place on top of the lath by a clay lug molded on the back of the tile. Any leakage through the aligning joints is addressed with small wooden slips. In Salem, roofing tiles became a visual signature (Fig. 3).

John Larson

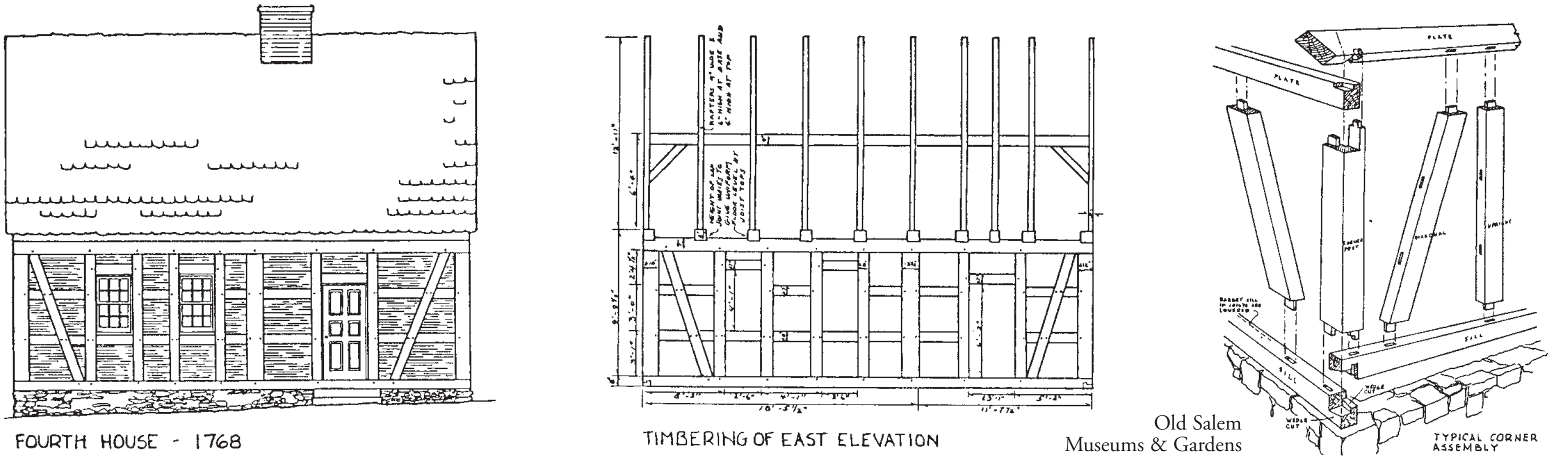
Fig. 3. Roof tiles are laid in straight files without staggering the joints. Instead, thin wooden slips under the joints shed onto one another.

Other details also gave early Salem buildings a distinctive appearance. The walls of these half-timbered buildings continued the pattern of simplifying Germanic prototypes. Initially the *Fachwerk* buildings were nogged with wattle and daub: horizontal staves of wood wrapped with straw and mud slid into vertical slots in the posts to support a pargeting of mud. But soon the Moravians shifted to a soft-fired albeit more durable brick nogging laid in a mud bed and pointed with a lime mortar, with walls one brick, or 4½ in. thick. Wattle and daub subsequently were relegated to protected interior walls. Also, a clay-straw mixture was placed between the floor and ceiling boards at each floor level, sometimes as wrapped staves or as a straw-mud mixture laid over ceiling boards.

The wall frames of these early houses rested on sills that supported the posts and infill, but not the floor joists, which floated inside on a separate sill not visible in Fig. 4. Common wallposts measured about 5x8 in. set flatwise. Larger posts up to 12x14 in. were set at the corners and where interior partitions engaged the exterior walls. To maintain the 5-in. wall thickness and square corners on the interior, these larger posts were hewn into L sections. Full-height corner braces consistently ran from the sill diagonally up to the plate without engaging the corner posts. Horizontal 5x8 members connected the posts at approximately 3-ft. intervals, providing support for the brick nogging panels (Fig. 5 overleaf).

Ken Rower

Fig. 4. Sill corner details in Salem, one cogged, one dovetailed.



Old Salem Museums & Gardens

Fig. 5. Framing details of typical Salem **Fachwerk** *house. European-style wall braces, direction reversed in the exploded view, rise from sill to plate. All rafter pairs are base-tied. Corner posts, hewn out on the interior for plaster corners, tenon to plate and tie at top, both sills at bottom.*

The largest *Fachwerk* building of Salem, the Single Brothers' House (1769), a National Landmark, shares the same vocabulary as the smaller dwellings. It took two days to raise the framing and 16 months to finish the building. It remains today one of the finest examples of 18th-century German framing in America (Fig. 6).

John Larson

Fig. 6. The Single Brothers' House at Salem, 1769, two stories plus finished attic and walkout basement at the rear. The pentice sheltering the entry floor is rare in North Carolina.

The Moravians were aided not only by having skilled craftsmen but also by having at their disposal textbooks and an education system that promoted an understanding of architectural principles. It is not difficult to see the similarity in drawings from the Boys' School in Nazareth Hall to a plate from Lorenz Johann Daniel Suckow's 1763 *Erste Gründe der Bürgerlichen Baukunst*, known to have been available in Salem. Such texts and the strong Germanic traditions of the culturally conservative Moravians influenced the framing systems of Salem (Fig. 7).

With the increased availability of lime, masonry became the preferred building technology after the American Revolution. The Moravians clung to their traditional common rafter system and to other throwback elements such as crucks (crank-headed) posts to support the purlin as late as the 1780s (Fig. 8).

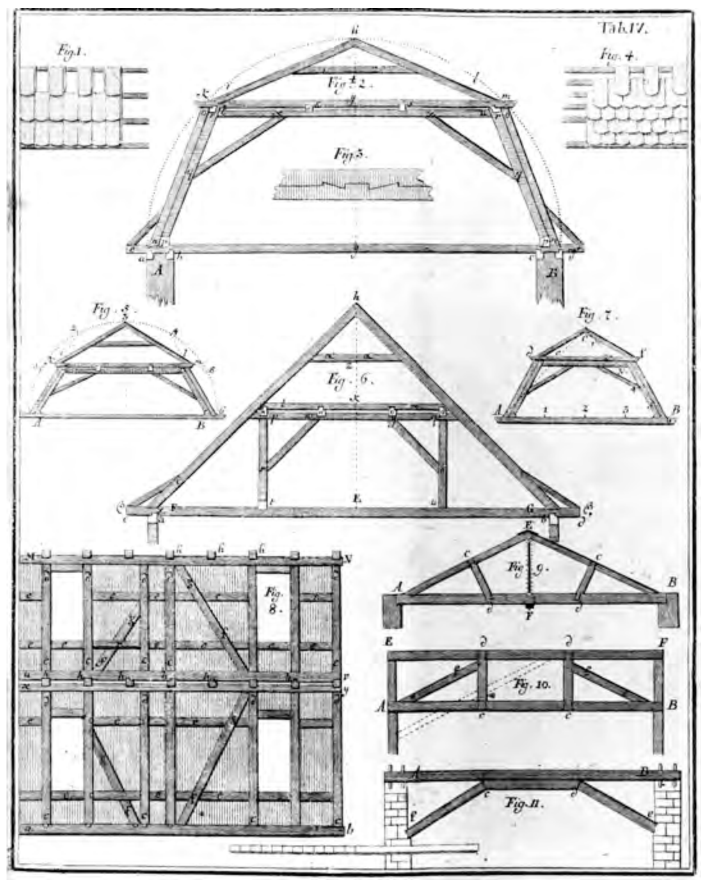


Fig. 7. Plate from Suckow's 1763 builder's textbook showing roof frame and truss typologies, wall framing and alternate methods of tiling roofs.

By 1800, however, they would increasingly embrace the architectural style of their southern neighbors and the culture it reflected. The remnants of *Fachwerk* framing, along with the distinctive "kick," had been removed from the roof framing system. By the time Home Moravian Church (Fig. 9) was built in 1800, Marshall's 1765 advice was irrefutable: there was no oak long enough for the rafters, so yellow pine was used. In using the pine, available in larger sections as well as longer lengths, the roof framing was redesigned (Fig. 10). Marshall's original low truss

Fig. 8. *Crucks post supporting purlin. Rafter is modern.*

David Bergstone

Fig. 10. Home Church principal rafters 8x12 carry tenoned and strutted purlins 5x6. Common rafters 5x7 run on 3-ft. centers. Strut, lower collar and rod at far left form part of truss to help hold up sanctuary ceiling.

design (Fig. 11), intended to hold up the ceiling over the open sanctuary as well as to support purlins carrying the all-common-rafter roof frame, was somewhat simplified, and larger-section principal rafters added to make full-height compound trusses placed on 12-ft. centers (Figs. 10 and 12). —John Larson

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Ken Rower

Fig. 9. Home Moravian Church, 1800. Arched canopies over entries are a signature Moravian device.

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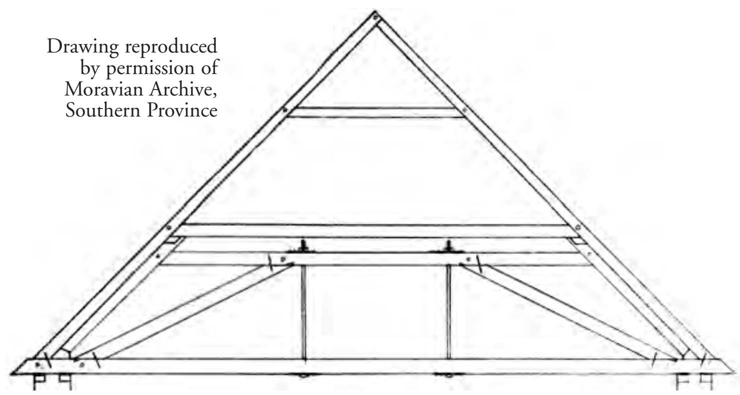

Fig. 11. Marshall's design for roof framing at Home Church (1800). Long, fairly light common rafters combine with two collars to form closely spaced light frames, while periodically a heavy truss is built into a frame to carry the ceiling load on iron rods. Clasped purlins (drawn on end as lozenges) would help carry intermediate roof frames.

Drawing reproduced by permission of Home Moravian Church

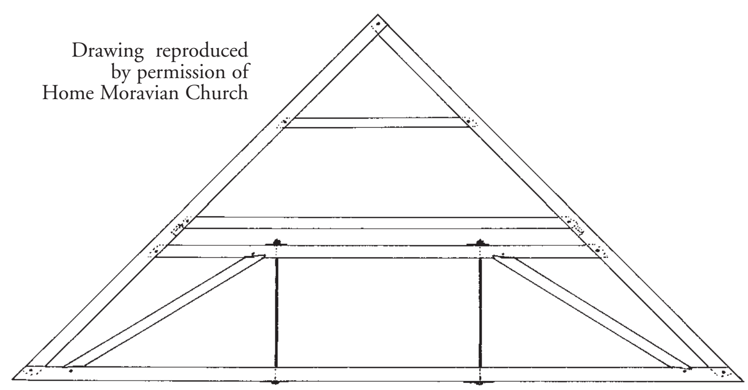

Fig. 12. Frank Albright's drawing of the truss as built. Secondary rafters supporting purlins are gone as well as thrust blocks at the tie beam. Purlins are interrupted at principal rafters and tenon into the lower 5 in. of the 12-in.-deep principals.

The English Barn in America

V. Finishing the Barn

WHEN I chose a principal rafter, common purlin roof, I fully intended to apply a board-on-board covering, as I believe many of these roof frames supported. As the project got underway, I scouted my forest for suitable trees to cut for the roof boards. Softwood boards are likely the most stable when exposed to the weather extremes of a roof. Of the white pine, red spruce, Eastern hemlock and balsam fir that grow in my woodlot, only the white pine is fairly rot-resistant and available in the required size and quality—18 ft. long, 8 in. and wider, all heartwood, straight grained, and clear or having at most small, tight (live) knots. In the original forest whence these barns were built, there was abundant material meeting these specifications. Replicating such a roof from my second-growth pine would have required harvesting the best of the stand while using only a small portion of each tree, making the undertaking hard to justify. I instead chose to single-board the roof and apply a steel covering, not inconsistent with many surviving English barns today. I typically do the roof before the walls (and did so here) to get the frame protected from water in the joints, but a case can be made for boarding at least the upper gables before the roof. With the purlins extending 8 in., the gable overhangs are substantial. The eaves, however, are minimal because the barn will be fitted out with gutters.

SHEATHING. It is apparent from surviving barns and from period writings that English barns were anything but tight. There were abundant gaps in the sheathing from loose-fitting, warped, cracked or shrunken boards. Often the board ends were not trimmed square but used right from the sawmill. Many barns had a single layer of boards from ¾ in. to 1¼ in. thick, up to 20 in. wide and merely butted at their edges. The resulting gaps, increased by seasoning, admitted a diffused light and provided good ventilation for the hay, crops and animals. With the doors closed there was still sufficient light coming through the boarding gaps to find your way around inside. Farmers, however, often tacked on battens inside to keep snow from drifting through the gaps. A cold, drafty barn increases the animals' food requirements.

A better, more weather-tight wall used a double layer of thinner boards (½ in. to ¾ in.) or a thin layer (½ in.) under the thick outer boards, with the vertical joints staggered. This virtually eliminated problems with gaps, knotholes, splits, etc. and allowed for a quick, almost sloppy installation, though there was increased cost in sawing at the mill. A handful of barns had vertical boards with joined edges, tongued and grooved or shiplapped. Tapered-width boards matching their source logs' natural taper are not uncommon. Flipping every other board end for end keeps the alternate joints vertical. Barns are occasionally found with original boards flitch-matched—that is, applied in the order they were sawed out of a log. We don't know if it was a conscious effort by the carpenter or simply that the boards were applied as they had been stacked by the mill. We do know that more-formal period-house carpentry shows book-matching and flitch-matching both in timberwork and finishing. Perhaps some sawyers routinely stacked their lumber sequentially in piles to give their clients the option.

For my barn, I used 1-in. boards, seasoned from one to four years outdoors in stickered and covered piles to a moisture content of 12 to 15 percent, and edged with a ½-in. shiplap. Almost all the sheathing is flitch-matched. Each of the lower gable-end walls is covered by one log's boards, 20 in. wide on the north and 21 in. on the south, creating a rather striking effect.

The extra effort plowing the board channel on the undersides of the projecting plates and ties (TF 82) now paid off in reduced labor applying the sheathing boards. For the most part, I could insert and nail the boards while standing on the ground, saving the time of setting up a scaffold and climbing ladders.

All photos Jack A. Sobon

Fig. 1. Wide flitch-matched pine boards make quick work of the south gable end. Most of the boards had to be reduced slightly at their tops.

I applied the boards heart side out, fitting them into the board channel and tapping them tight to the preceding board. A simple foot-levered pry hoisted the hefty board and freed the hands for nailing (Fig. 1).

I boarded the triangular upper gables while standing inside the barn on planks across the tie beams. Had the roof not already been covered, this task would have been considerably easier: the boards could have been left long and trimmed in situ above the last rafter. Working under the gable overhang, as the triangular space got shorter, I had to apply the last few boards from a ladder (Fig. 2).

Fig. 2. Most gable boarding could be done from inside while standing on planks. A few last pieces near the eaves went on from a ladder.

DOORS. English barn doors were typically hinged (rolling doors became common only after the mid-19th century) and of two types, battened and framed. The latter has a sheathed mortise-and-tenoned frame of scantlings, usually 3x4s, and often includes a let-in diagonal brace to keep the door from sagging (Figs. 3–4).

For windy exposed locations, a framed door is preferred. The brace always rises from the bottom hinge edge, to work in compression. Modern barn door copies often are done the wrong way.

A batten door has sheathing applied to 1-in.-thick horizontal battens, usually placed at the top and bottom of the door. Occasionally one finds a third, central batten. Like the framed door, the batten door usually has diagonal braces of 1-in. boards, often gained into the battens at their ends. Hinge straps are applied at the battens and strengthen the assembly. (A three-batten door would have three hinge straps applied.) Thanks to its simplicity, the batten door is far more common than the framed door (Fig. 5).

Surviving original doors on 18th-century barns are uncommon, but one usually finds the holes for the pintles in the doorposts and, in association with batten doors, curious rabbeted notches in the posts that match the sections of the battens, just visible in Fig. 5.

I have built a number of batten doors over the years but never found it necessary to provide these rabbets in the posts—I simply held the batten back an inch from the hinge side of the door to clear the post. Because this barn project endeavored to unlock certain mysteries of English barn construction, I gave these observed rabbets some thought. Surely they were done for a practical reason. What if they held the battens while the door was built in place? Working alone, I clearly saw the advantages of not having to heft the nearly 6-ft. x 11-ft. doors into position. After having built many doors the other way, on horses, measuring and squaring, then hoisting, I can say it is far easier and faster to build batten doors in place.

I began by cutting appropriate rabbeted notches into the posts and letting in full-doorway-width 1x10 pine battens (Fig. 6 overleaf). I drove in small wedges to send the battens tight to the top end of the rabbets, to compensate for later door subsidence, and temporarily nailed the battens. Then I clamped the 1x7 diagonal braces in position for scribing the gains. (But cutting the gain into the higher batten was better accomplished on horses than in place.) The braces temporarily secured, I began the boarding, continuing the flitch-matched effect across the doorways (Fig. 7 overleaf).

Fig. 3. Framed door in Savoy, Massachusetts, with ingenious lever-operated bolt.

Fig. 4. A small, one-stile cow bay framed door (whitewashed) in Buckland, Massachusetts.

Fig. 5. A mid-19th-century three-batten door in Great Barrington, Massachusetts.

Fig. 6. Rabbeted notch in doorpost for an upper batten.

Fig. 7. Gain in lower batten for doorbrace. Sheathing is held back on post for door to make a seal on the hinge edge (at right).

Fig. 8. Hinge straps (32 in. long on the big doors, 24 in. on the smaller doors) with decorative curled tips. Four 18th-century hinges were recycled from an old barn and additional new ones forged to match. Pintle (at right) with square tapered shaft was driven into doorpost.

Fig. 9. Completed animal door viewed from inside. Clinched nails holding strap hinges and sheathing can be seen on battens and let-in brace. Flitch-matched sheathing boards form striking patterns.

To fasten the boards, I used 10d (3-in.) cut box nails clinched on the inside (points bent over and driven into the batten). Where the two doors would butt, I left a ⅜-in. gap in the boarding. Every second board was nailed temporarily to the header and sill to keep the assembly in place.

After the boards came the hinges. Traditional forged pintles had tapered shanks, much like a very large wrought nail, and were driven into holes bored into the jambs. A few went completely through the jambs to be secured by threaded nuts. As I used an unthreaded type of pintle, I matched the hole size to the shank at about two-thirds penetration and chiseled out a squared opening in the pine sheathing to keep it from splitting. The hinge strap sat on the pintle during the driving to keep the latter from rotating and to tell when it reached home. (You don't get a second chance with this type, no adjustment!) When the strap lay flush against the door, I fastened it, again clinching the projecting nails on the interior (Figs. 8–9).

With the hinges in place, I removed the temporary nails, sawed through the battens where the doors met, and the doors were free to open. After testing this in-situ door-building theory on my barn, the first English barn I examined with intact original doors showed the grain of the battens continuous across the doors as well as the rabbets in the jambs. So at least one original builder did it this way.

To secure original doors when closed, a vertical pole, called a standard, was inserted into a loose mortise in the door header and lowered into another in the floor. The doors latched (via hook and eye) to the standard. Alternatively, a horizontal pole was fitted into slots in the doorposts on either side and the doors latched to it.

FLOORING. The primary floor in the English barn was the threshing floor, and it may have been the only framed floor (see TF 80). Though I used framed floors as well for the loft (1-in. boards) and for the animal bays (2-in. plank), I concentrated my efforts on the threshing floor. There I used flitch-matched 2-in. planks, many 18 in. wide and as long as the threshing floor is wide. They were applied over a layer of ½-in. slitwork, the latter to keep grain from sifting down between the planks. I secured the planks in a traditional manner using 13/16-in. riven ash square pins with blunt points and flared heads; the pinholes are angled for increased holding power (Figs. 10–13). The planks (maximum 15 percent moisture content) lie heart side up, wedged tightly together, fastened by two pins at each end and one on alternate sides into each joist, all set in about 2½ in. In some old barns, the pins were omitted at the ends where the sidewall boarding keeps the planks down; in others, pins were used very sparingly to minimize boring time.

Fig. 11.

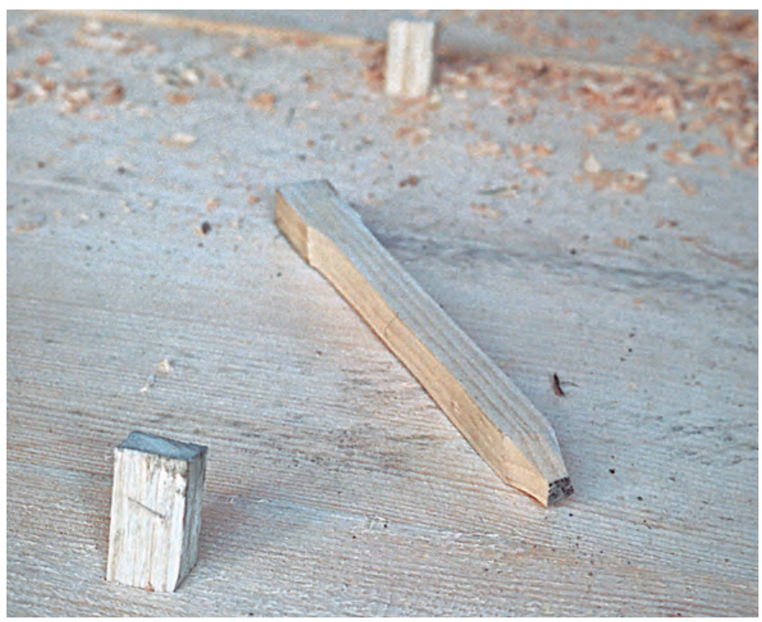

Fig. 12.

Fig. 13.

Figs. 10–13. Fig. 10, above, cleaving pin stock from clear ash billets 10 in. long using mallet and froe. Quarters are laid out on one end and further cleft into ¾ x 1-in. rectangles. Fig. 11, at right top, with author on the shaving horse, the pin is given a flared head, squared shank and blunt point. Fig. 12, at right above, ash pins are driven into 13/16-in. holes in the flooring, angled to increase holding power, until refusal. Fig. 13, at right, a pin sawn off flush.

GUTTERS. These days one thinks of gutters or eaves troughs as devices to prevent water from splashing up on the base of the building or dripping on our heads as we enter. In English barn provenance, however, they were used for water collection, not because of a lack of ground water, but as a labor saver. If an average animal (cow or horse) needed six to eight gallons of water per day and the farmer had 14 animals, that would be 72 to 96 gallons per day. If a barn was situated near an open water source, the animals could be let out to drink—but if the barn was not near water, imagine the labor of drawing this much water out of a well each day with a 2-gallon bucket. Using the barn's roof to collect water freed up the farmer for other chores. On an average 30x40 barn, 792 gallons of water would drain off in a 1-in. rainstorm. A well-placed cistern could hold several days' worth of water.

In the Carpenters Company of Philadelphia 1786 *Rule Book*, we find listed "Gutters of plank shingled in roofs" and "Common plain gutters under eaves, of scantling from three to four inches thick, and five or six inches broad." The former, built into the roof eaves and lined with lead or copper, were invisible from the ground. Common gutters would be visible but could be molded to form an architrave on the outside. Surviving common gutters from this period might be simple troughs shaped from solid timber and sitting on top of heavy pins (½-in. to 2-in. dia.) projecting from the wall, or they might resemble a cornice and be pinned or spiked to the timber frame. Barns typically show the former, houses the latter arrangement.

For my barn, I sawed out a pair of white pine heartwood 4x6s, 37 ft. long, hollowed them with a gutter adze and planed them smooth with a round-bottom plane (about 2-in. radius). Following this likely sequence required about six hours of work (Fig. 14).

I fashioned gutter supports following those in the Savoy, Massachusetts, barn described in the first article of this series (TF 80). The upper surfaces of the originals were eroded away, so my reconstruction is somewhat conjectural. For durability, I used black cherry heartwood, the only rot-resistant species (highest category in the 1999 USDA *Wood Handbook*) growing in my woodlot. (The original gutter supports found in the Savoy barn were yellow birch, a species with poor rot resistance.) The new cherry supports, one for each of the four posts, have 2-in.-dia. shanks, 10 in. long.

When I install the gutters, I will pitch them ⅛ in. per foot toward the south end of the barn to provide water for both the animal trough and a reservoir for the vegetable garden. The gutter supports will be notched out to carry the unfastened trough in a ½-in. housing. The gutter will sit slightly below the plane of the roof to prevent sliding snow from bringing it down (Fig. 15).

Except for the occasional row of lights, or transom window, over the big doors, the English barn rarely had any windows installed originally. However, as mill-made windows came on the scene, they were added to these barns to bring in more daylight. Small, 30-in.-square, six-light sash were common, either fixed, hinged or sliding. I will be adding at least six of these in my barn.

—Jack A. Sobon

This article completes the series on the English barn. Previous articles appeared in TF 83 ("Raising the Frame"), TF 82 ("Scribing the Timber Frame"), TF 81 ("The Timber Frame") and TF 80 ("The English Barn in America"). Jack Sobon is an architect, author and timber framer in Windsor, Massachusetts.

Fig. 14. Gutters are hewn from white pine heartwood with an old gutter adze. A simple template is used to maintain a consistent profile in the 4x6 workpiece.

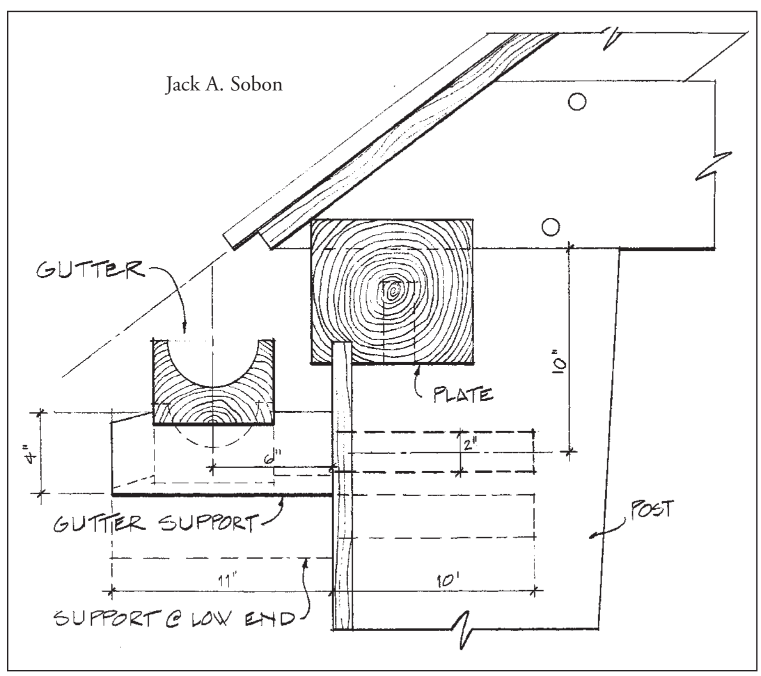

Fig. 15. End elevation detail of barn frame and gutter with support.

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Wood Handbook, Wood as an Engineering Material. USDA Forest Service, 1999, Table 3-10.

Upper side of author's completed barn, the built-in-place doors open to a warm autumnal sun. Below, pre-1893 view of English barn, with gutter plainly visible at right, in the then-pastured hills between North Adams and Adams, Massachusetts.

Picturesque Berkshire, 1893

TTRAG Proceedings 2007

TTRAG went to the South for 2007, to Old Salem, N.C., the restored elderly half of modern Winston-Salem that includes a museum village of Moravian buildings from the 18th and 19th centuries, Salem Academy and College and handsome private residences, all fitted along two avenues and a few cross streets. The Guild's Traditional Timber Frame Research and Advisory Group's 16th annual symposium March 23–25, two days of presentations at the Old Salem Visitors' Center and two field trips, drew a hundred or so framers and scholars to visit Salem's residential and ecclesiastical structures, including those at nearby Bethabara Park, a 1753 Moravian settlement. In addition to the presenters whose proceedings follow, Old Salem's John Larson discussed the evolution of 18th-century Moravian carpentry in North Carolina (see page 4) and Jack Sobon spoke on English barns and his latest experiences in building a new, authentic one (see page 8), while chairmaker and teacher Drew Langsner of Marshall, N.C., described his personal progress as a craftsman and the evolution of his traditional crafts school. A list of presenters and their affiliations appears on page 24.

Timber Frame Field School at a Shaker Village

Rudy R. Christian

WHEN Mother Ann Lee founded Mount Lebanon Shaker Village in 1787 in New Lebanon, New York, it's unlikely she would have believed that someday it could become the campus for a field school where students from a high school in Brooklyn, N.Y., a freshman from a trades college in Charleston, S.C., and two graduate students from the University of Florida would join four apprentices from the French Compagnon program to learn conservation practice while restoring a three-story granary her community built in 1838 (Figs. 1–2).

The Shakers built structures to last, but when a building became obsolete it was quickly modified for another use or dismantled and the various parts recycled into other construction projects. This fact proved to be one of the first challenges in creating a plan for the restoration that the field school would undertake. Since the Shakers were more likely to replace or remove than repair their buildings, little was available to study or document in the effort to do in-kind repairs that adhered to their methods.

During the granary's use for over a century, the Shakers added horizontal lap siding over the original vertical tongue-and-groove, slates over the original cedar shakes and a timber-framed two-story external elevator enclosure to protect the granary doors on the upper floor levels. When the Shakers left their Mount Lebanon community, the stewardship of the granary became intermittent and at times nonexistent; damage to the slate roof was ignored at first and poorly repaired later. Water allowed to enter the roof and wall systems eventually took its toll. The structural framing of the south wall of the granary became so deteriorated that it could no longer support floor framing inside, and the building began to fail.

The development of the nine-week field school program was a partnered effort of the World Monuments Fund, the Preservation Trades Network, the College of Design, Construction and Planning at the University of Florida and the Shaker Museum and Library, with our shop awarded the preservation services contract and the lead instructor position. We modeled the program on the concept of mixing apprentices of the trades with students in academic preservation programs. This interdisciplinary educational approach would allow students in preservation programs to see firsthand what happens in the field while at the same time expose apprentices in trades programs to documentation, the development of preservation philosophy and the writing of repair specifications. Students came from the preservation department at the University of Florida and Brooklyn High School of the Preservation Arts, and apprentices were hired from the American College of the Building Arts in Charleston and, in France, from the Association ouvrière des Compagnons du Devoir et du Tour de France (Fig. 2).

Although 1930s Historic American Buildings Survey documentation exists for other buildings at Mount Lebanon, and a historic structures report had been done as recently as 2002, no drawings of the granary existed that provided the type of documentation needed to repair the building. This offered the students a good opportunity to study the building and to step into the boots of the builder, to learn to think like a timber framer in 1838. They made the acquaintance of square rule layout and learned to find the layout faces of timbers and decipher the pattern the builder had in mind. The work was tedious and complicated by the fact that much of the interior had seen later modifications when used as a cabinet shop and a gift shop, but students were permitted to remove the added fabric to get to the components they needed to measure since the future interpretation of the structure would be as originally built. Measuring and documenting continued over two weeks as more and more fabric was exposed during dismantling.

We obtained several broken trailer springs from the dumpster of a local spring shop and converted them to specialized prying tools for removing boards and siding with minimal damage. James Murphy, the apprentice from the trades college in Charleston, not only enjoyed making and using these folk tools but also came up with an improvement when he ground grips into one end so they weren't so easy to drop.

One valuable lesson came when the students were challenged to figure out why all of their measurements included fractional inches when they had been told to expect the numbers to be in feet and whole inches. First they learned that the timbers were a different size when the builder had worked them green and had shrunk as they dried. When the appropriate adjustments made only some of the measurements come out better, the students remained dissatisfied. They next ran a tape measure from the top of a corner post to its bottom, clamped in place. Students then read off the distances from the top of the post to all the points that layout marks could be found. It soon became clear that the dimensional error started off small and grew incrementally as measurements were taken farther down the post. Could the rule the master carpenter used in 1838 have been different from the one they were using today? Using proportions, the students figured out that 12 in. on the "master's rule" must have been $^1/_{64}$-in. longer than on the rule they were using today, and that indeed the building had been laid out in feet and whole inches.

The repairs needed to restore the granary were significant and complex. Allowing water to enter the building when it was opened could cause new damage such as staining of the patina nearly two centuries old. And all of the students must return home in nine weeks. Thus we covered the building with a tarped scaffold built by Albany Ladder (who had also done the enclosure for the work

World Monuments Fund

Fig. 1. Photo from about 1880 showing Mount Lebanon Shaker Village, with the granary in the foreground.

Photos Rudy R. Christian except at top

Fig. 2. Students from three American cities and France and of widely different backgrounds came together for the nine-week course.

at the Washington Monument), located only 45 minutes from Mount Lebanon. The design they suggested included working platforms at each floor level with safety rails, which eliminated the need for safety harnesses and tying off. The enclosure worked extremely well and kept the project from being slowed by the two weeks of rain that came immediately after the roof deck of the scaffold enclosure was tarped (Fig. 3).

Fig. 3. Granary was fully staged and, with the roof wide open, tarped to protect interior surfaces and time-consuming frame repairs. Lunch was taken in style.

The dismantling of the south wall of the granary required supporting three floor systems and the rafter framing. This we accomplished by shoring up the first floor from the concrete floor in the basement and using structural scaffolding with adjustable jack posts between first and second floor and second floor and attic. The rafters were then supported on a temporary knee wall constructed of 2x6s on the attic floor. This system also allowed for the sagging floor systems to be jacked into a flat condition, or "righted," so that the repairs could be effected correctly. This gave the students an opportunity to learn how to use a laser level to collect measurements of existing conditions and then chart the configuration of how the building had settled during its life. Using these data, the floor systems were adjusted before the repair work began. The reference was established by setting the laser "out of level" but parallel to a flat surface that was now "right" for the building as it exists today.

Dismantling the damaged granary wall was an important part of the learning experience since it offered a chance for the students and apprentices to learn about salvaging historic fabric. This turned out to be a challenge for the French apprentices. They had trouble seeing a building framed in 1838 as old and clearly wanted to just fix the problem so the building could be used. It took several meetings and a bit of show-and-tell to convince them that in America an 1838 Shaker granary is a treasured piece of our history that deserves careful and well-thought-out work.

Fig. 4. Wall repairs shown above included new posts, girts and sheathing as well as carefully scarfed tie beam ends. Some braces, apparently original, were recycled from a demolished Shaker structure.

Once the extremely damaged timber frame was exposed, documented and dismantled, we began the process of restoration (Fig. 4).

Shaker Museum and Library's Boyd Hutchinson, with years of forestry experience, was invaluable in helping us identify the various species used by the Shakers to build the granary, including hemlock and chestnut for the timber frame, spruce for the sheathing and flooring and white pine for the horizontal lap siding. The preservation philosophy developed for the field school required matching species when possible for the repairs. This was less problematic for the softwoods than the chestnut. As a way of sourcing materials, the Shaker Museum and Library put out a request to patrons of the museum for donations of trees. Lore Squier's 85-acre woodlot five miles north of Mount Lebanon turned out to offer a perfect opportunity to teach the apprentices and students how to cruise for trees suitable for harvesting for timber. Boyd was a real asset as well when he used his core drill to determine the health of the heartwood in the trees that were chosen. When the hemlock trees were selected, Lore mentioned she had a white pine tree that we might want to look at, which turned out to be the perfect stem for cutting the needed quartersawn siding and trim boards. The entire field school insisted on being in the woods to watch as the timber was harvested.

To match the appearance of the original conversion methods, we hewed out the posts, plate and sills and cut the remaining scantlings on a bandsaw mill. The tracks left by a bandsaw are a close match to those left by the blade of the up-and-down sash saw that the Shakers used to produce the original. The braces and sill timbers in the original frame had been cut from chestnut, which no longer exists in American forests, but the museum had chestnut braces from a dismantled building in storage. As the Shakers would have done, we used them to cut the replacement braces for the granary. The only deviation from the original material that had to be made was in the sills. We could find no chestnut at a local salvage yard and determined that white oak would be the best substitute.

Laying out and cutting the repair joinery was very enjoyable for the students and apprentices as the rainy weather had given way to beautiful sunny days and the sawhorses were staged in the open yard in front of the granary (Fig. 2). All of the work was completed during a four-week period. Maneuvering the repair parts into place was the next challenge. The structural scaffolding again turned out to be a significant asset: it allowed for hoisting and rigging of the timber without a crane. The assembly sequence started at the top where the new 26-ft. scarfed repair section of plate came in under the repaired rafter tailpieces. Once the plate had been hoisted up and staged on stacks of blocking that bridged from the attic floor to the scaffold platform, the plate was slowly pushed out until the step-lapped rafter seats were engaged. The halved and bladed scarf joints, chosen because of examples found in other Shaker buildings at the site, allowed the plate to be slid horizontally as the joinery was aligned (Fig. 5).

Since the plates originally would have been offered from above after the bents were raised, it was now necessary to use free tenons on the post tops. We mortised the tops of the posts and inserted free tenons from above, taking advantage of through-mortises in the plates. Siding and trim had not been removed from the gable ends of the granary, but we were able to use convenient raising holes in the corner posts to insert drift pins as attachments for slings to pull the posts sideways onto the wall girt and tie tenons.

Assembly of the entire wall frame took place over a two-day period. The next step was to reinstall the original random-width quartersawn spruce tongue-and-groove sheathing boards, which had served as exterior siding and interior finish when the granary was first constructed. Spruce logs were sourced and quartersawn for needed replacement pieces. With a set of match planes found at a local antique tool dealer, we worked the new tongues and grooves. Reinstalling the original sheathing boards in their original locations was important since the interior surface was exposed. Had the boards not been placed back in their original positions, the ghosts left by wall framing would have revealed that they had been moved. Each board location had been recorded on the digital drawings and the boards numbered as they were removed. As they were reinstalled, an awl aligned them with their original nail holes wherever possible. This improbable process worked well enough that the old graffiti scrawled on the walls were all readable after the work was done. The apprentices were quite pleased with their work when they realized how much the wall looked as it had when they started in June—and rightfully so.

Nine weeks had disappeared so fast it seemed that the suitcases lined up at the dormitory door had just been unpacked the night before. As new friends hugged and said their good-byes before being taken off to the train station and airport, the long summer days standing under the locust trees cutting mortises and tenons were already just a memory. The French apprentices spoke much better English now, and some of the American students were taking home a little French to impress their friends. What had seemed an impossible task in June had been finished right on schedule, and everyone involved went home with a new appreciation of Shaker construction and its conservation. They also had a much better understanding of the knowledge and skill it took to build a structure with the technology of 1838, and what it might have felt like to wear the boots of the builder.

Fig. 5. After scarfing-on of new rafter ends, the repair sequence called for insertion of the new step-lapped plate from below. Plate will be hoisted further and blocked up on cribbing spanning from the attic floor to the staging, then slid outward to engage the rafter feet.

Historic Framing in Northeastern North Carolina

Reid Thomas

NORTHEASTERN North Carolina retains a wealth of surviving and frequently unaltered 18th- and 19th-century timber-framed buildings. This mostly rural region of the state consists of numerous small farms, picturesque towns and small cities. Plenty of navigable inland waterways provided easy access for 17th- and 18th-century settlers of predominantly English descent. The region was also attractive for its abundance of old-growth yellow pine, cypress, oak and walnut, as well as fertile farmland. Surviving buildings from the 1730–1830 period reflect largely the traditional Anglo-American timber framing system. Common house plans of this period included one-room, hall-chamber and three-room, as well as side-passage and center-passage, one and two rooms deep.

One-room dwellings were the most common house type in the region and persisted well into the 19th century. The majority of these houses were one-and-a-half stories with steeply pitched gable roofs. Examples of two-story and gambrel roof one-room houses have survived, however. The oldest known house in the region, oddly enough, is a brick two-room-plan dwelling built for a Quaker family. The Newbold-White House, now a museum, was dated through dendrochronology to 1730.

During 17 years working in the eastern division of the N.C. State Historic Preservation Office, I have visited dozens of one-room houses dating to as late as the mid-19th century. Some of these have survived largely unaltered while others are hardly recognizable. Most of these early dwellings were converted to kitchens or slave quarters, were overbuilt into a larger house or became an appendage to a new and larger dwelling. One of the most intriguing survivors is the 1742 Robson House in Pitt County (Fig. 1).

Drawing Reid Thomas

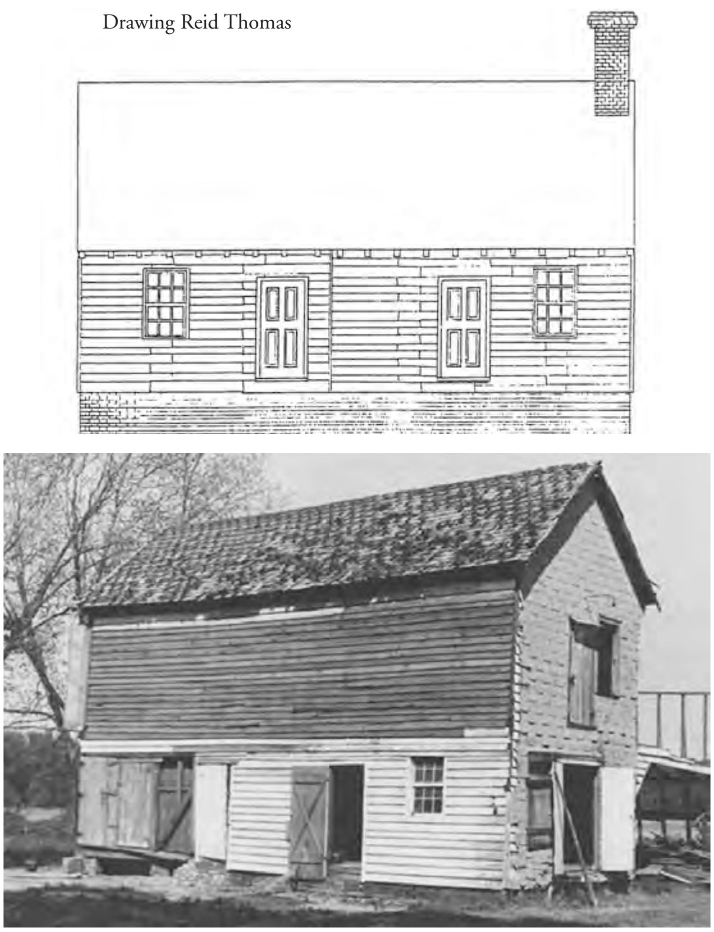


Fig. 1. The Robson House, Pitt County, N.C., 1742. One-room house enlarged to two and later converted to tobacco packing barn.

Photos Reid Thomas

Fig. 2. The ruinous Brown House, Pitt County, ca. 1780.

Fig. 3. Dressed and beaded joists in Brown House.

Fig. 4. Log joists in Edwards-Adams-Elks House.

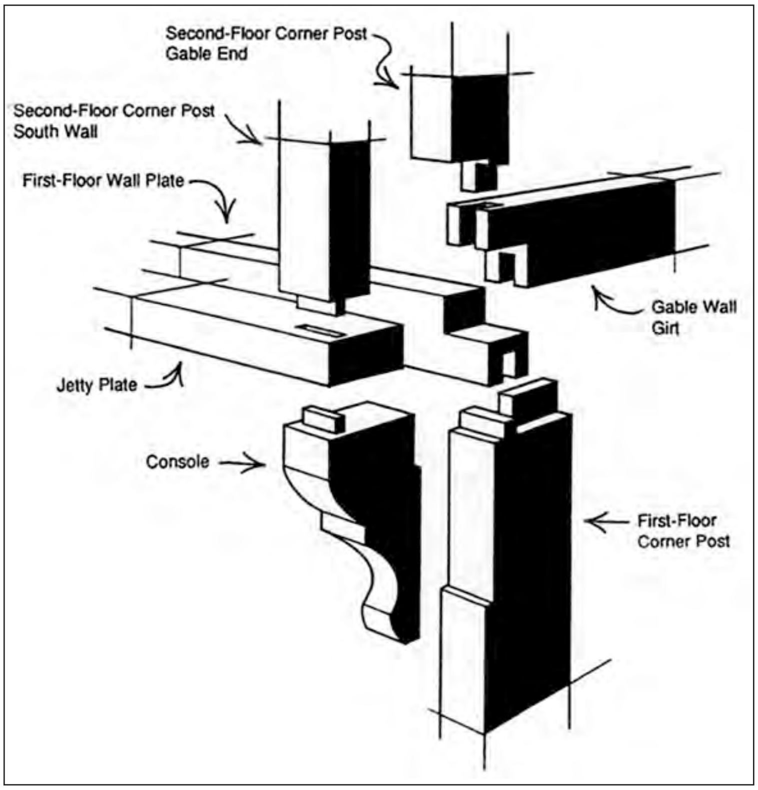
This one-room house was essentially doubled in size in 1750, creating a hall-chamber plan. The interior was finished with vertical beaded shiplap sheathing and exposed hewn ceiling joists. In the early 20th century, a second story was added and the house was converted to a tobacco packing barn.

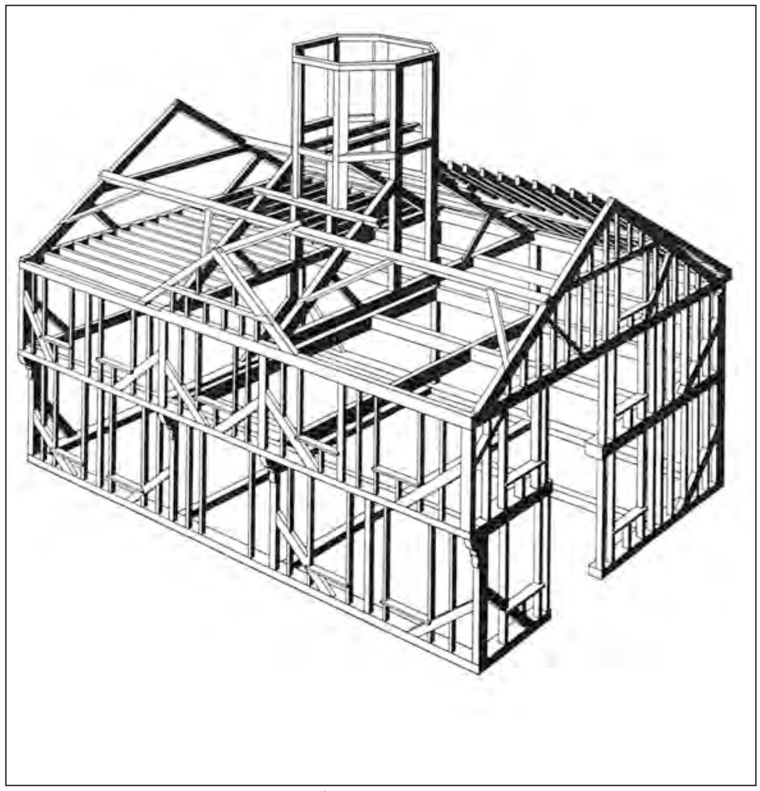
For those who live in colder climates, it may be difficult to imagine living in a frame house with only thin split clapboards protecting you from the elements. This was a common treatment, where families could see the greater part of the framing system when they entered their house. The circa-1780 Brown House, also in Pitt County, is a good example of a typical one-room house plan with exposed interior framing. Unlike the Robson House, the Brown House has dressed ceiling joists, hand-planed and beaded (Figs. 2–3).

At the circa-1800 Edwards-Adams-Elks house in Pitt County, the framing is essentially the same as at the earlier houses with the exception of the round log floor joists that appear in the region by the first decade of the 19th century (Fig. 4).

The 1758 Cupola House in Edenton preserves one of the most fascinating framing systems in the region. In the early 1990s, the house underwent extensive studies including dendrochronology and a videoscope investigation. During this period a team from Colonial Williamsburg facilitated an intensive study of the framing system, a difficult task since the house retained historic plastered walls and ceilings. Uncovering the mysteries of the framing system followed minimal removal of exterior siding, measuring flooring and trim nailing patterns and probing into inaccessible areas with a videoscope, a small-diameter, flexible tubular viewing instrument containing a miniature high-resolution color camera system on one end and a camera control unit on the other. With fiber-optic illumination on the camera end, the team witnessed clear and true color images on a monitor.

Saw marks, wood types and insect and water damage could clearly be seen along with the structural framing members and joinery. Understanding the framing system of this extraordinary





Drawings courtesy of Willie Graham, Colonial Williamsburg Foundation

Figs. 5–6. Analytic drawings of Cupola House, Edenton, N.C., 1758, with exceptional jetty and cupola but otherwise framed in local style.

house has been of interest for many decades. On the exterior, the second-story jettied overhang is more characteristic of 18th-century New England architecture. The massive cupola is also an oddity for a house of this age in the region. By and large the frame clearly appears to have been constructed by a builder experienced with local timber framing systems. The traditional jetty construction in New England and England is to cantilever or hew out the jetty. The builder of the Cupola House pinned a jetty plate to the main front plate and heavy consoles to the posts (Figs. 5–6).

Located 30 miles from the Cupola House at Windsor, Hope Plantation includes a sophisticated two-story house with a massive timber framing system of hewn and pitsawn yellow pine and cypress (detail, Fig. 7). Built for planter, lawyer, governor of the state and US Senator David Stone around 1800, Hope Plantation is remarkably intact. There we reconstructed a kitchen outbuilding based on extensive archaeology and historical and architectural research. Our project team studied dozens of surviving kitchens in the region from the late 18th and early 19th centuries. The majority of these buildings had exposed whitewashed wall framing and open ceilings. (The attic flooring we found in a few kitchens was added later.) This open space allowed for needed ventilation, especially in a hot and humid climate (Figs. 7–8).

Fig. 7. Detail of Hope Plantation, Windsor, N.C., ca. 1800, where sills average 10½ x 14 in.

Figs. 8–9. Reconstructed open-ceiling kitchen at Hope Plantation. Ventilation overhead relieved heat of a wood-fired southern kitchen.

Varieties of Steeple Framing

Jan Lewandoski

STEEPLE timber framing displays more varied forms than the trusswork of accompanying church roof systems. Steeples are also more difficult to examine: tall, narrow, often dark and with the framing of one stage penetrated deeply into the stage or stages below, virtually filling the space with large timbers and their joinery. In recent months the Guild's steeple research project has visited numerous steeples and observed many variations in builders' approaches to framing a very tall slender object.

THE South Woodstock Community Church was built in 1839 in the Greek Revival style, using many framing elements from the recently torn down 1792 Meeting House. Most of the roof frame is from the previous church, reconfigured to a fashionable lower pitch and now square ruled. The first two telescoping levels of the steeple were new spruce timber combined with some hardwood bracing that carried the marriage marks of the 1792 scribed frame. The eight turned butternut columns forming the belfry level were from the previous church and carried both joinery and relict hand-forged bolts that once fastened tall spire rafters. The 1839 church appears even in 19th-century photos with a more modest short cone of a spire.

Typical of the period, the first stage of the steeple sat on the truss tie beams and its 19-ft. posts emerged through the roof as a square tower. The front of this tower was supported by the front wall of the church and the rear stood over an open choir with an unsupported span of 42 ft. The two rear posts were treated as queens in a queenpost truss, with the principal rafters as main braces, in an attempt to bridge this distance successfully. Since this level carries the weight of all the stages above, as well as a significant roof load, this truss was not strong enough and had sagged noticeably by 2006.

The second square stage rose from sleepers 6 ft. down within the first tower and carried the heavily framed bell deck at its plate level, 18 ft. above. Eight ft. below the plate of the second square stage, four sleepers lodged diagonally across the wall girts to carry the eight butternut columns that surrounded the bell and supported the conical spire above. The 18-ft. butternut columns were notable for being turned to a tapering cylinder for their upper, visible 10 ft., and left as unimproved debarked logs for their lower 8 ft. (Fig. 1).

The columns, irregular in form, were tenoned into the sleepers using a layout system that located the tenons relative to the center of the tailstock of the large lathe that turned the columns, and thus to the central axis of their upper, visible portion. An original gin pole base, still in place across one of the corners of the second stage, suggests that the butternut columns were brought up one at a time and pushed through their openings in the bell deck. The lack of any joinery between the columns short of the spire framing, and a general lack of space, suggest that the upper octagon was not brought up from below as a whole, as was often the case.

The key to dismantling, restoring and re-erecting this steeple was that the three stages were merely lodged on sleepers within each other, attached by no more than the nailed small lumber and flashing of their skirting roofs. Consequently, pulling the flashing away allowed a crane to lift off the conical spire, the eight columns separately (they all needed repair or replacement), and the entire second square stage, setting them in carefully prepared frames on the ground. On the same day a lightweight temporary roof was placed atop the first square stage, which would be worked on in place since large portions of the church roof still depended upon it. Restoration entailed copying the dimensions, species and joinery of the various elements and reassembling them. The tower that stayed on the church required extensive free and slotted tenoning since it couldn't be fully pulled apart. With the second tower we were free to rebuild it as it was originally. The butternut columns were elaborately repaired and two were replaced, although finding halfway straight and sound 13-in.-dia., 18-ft. butternut logs was difficult because of the diseased state of the species today (Fig. 2).

Structural improvements were made only where excessive stress was observed. The truss that incorporates the rear posts of the lower tower was strengthened by the addition of another set of queenpost main braces and another straining beam, parallel to the originals. These were installed when the entire truss was lifted to level on structural scaffolding, and the original truss connections, now relaxed, were wedged tight as well. The sleepers for the octagon columns were increased in size from 7x9 to 10x11 in response to observed sagging. The entire ensemble was then lifted stage by stage back into position.

Jan Lewandoski

Fig. 1. Steeple columns are turned where they emerge to view, left merely debarked where they remain concealed.

Fig. 2. Scarfing painted remnant column to new base. Newly reframed tower roof, partly boarded, in the background.

An Approach to Frame Repair

Dan Boyle

FEW things seem to stir people like a picture of an old barn in a rural setting, but the buildings we see in glossy coffee-table books are few in life. The majority of early timber-framed buildings are in various states of disrepair. Damage can result from poor original design, neglected maintenance and previous renovations. Even so, many buildings can be repaired, without large disruptions for their owners.

Repairing these early structures requires many more steps than simply replacing the failed elements. A detailed investigation is the first task. In the first days of a new project, frequently the only tools I use are a flashlight and a tape measure. First question: What was the original layout system? Repair techniques will vary according to whether the building was built using the square rule or the scribe rule. Next question: What has caused the failure? Decay of the wood (rot, animals chewing) or overloading the member? The repair must address these issues as well as making good the member. It doesn't do to repair a plate if the roof continues to leak.

Once the initial survey has been completed, it's time to make a work plan, to include a materials list, a safety equipment list, a plan for rigging and stabilization and, finally, a list of needed repairs.

Before repairs can start, the building must be appropriately stabilized, by cribbing, cross-bracing and restraining the frame (Fig. 1). Stabilization systems can stand in as building elements—the cribbing as foundation, the cross-braces as wind braces and the restraints (chains and binders) as tension joinery. During this stage, it is necessary to identify the point loads in the building. If a post has a rotten bottom, the weight intended to travel along the post's path has been diverted. Where did that weight go? Frame elements that were never intended to carry weight now may have become structural elements by default. If the frame element has failed, the temporary stabilization needs to be at least as strong as the original piece. Also, if the cribbing system is built to hold up the weight, keep in mind that it may receive much more loading once a different part of the building is lifted.

Photos Dan Boyle

Fig. 2. Repair or replace? Here, one choice for sill, the other for posts.

When it comes time to lift buildings, first figure out where you want to end up. During our initial surveys, we usually make a drawing of post elevations relative to each other. If the frame was damaged, heights may have changed. In the early English scribe-ruled buildings of our New England region, we have found the top of the plate usually serves as one of the controls; in later square rule buildings, the top of the posts.

Fig. 1. Stabilizing a building can effectively replace its functional elements.

When lifting, a few things must be kept in mind. Lift at the structural elements, and don't try to lift too much or too fast. Frequently, buildings sank over a period of years, slowly bending the frame elements. It's very difficult to bend a member back in one day. Also, make sure that all of your lifting systems build in safety measures. This can be as simple as placing cribbing and shims under a piece as it is lifted. If the lifting system fails, the cribbing will hold the building.

When it comes time to repair the frame elements, the first big question is whether to repair or replace (Fig. 2). For the sake of preserving the historic fabric, I try to repair an element rather than replace it, but this is always a judgment call. Will a repaired piece function as well as a new piece? How was the original designed to function? Some pieces work in tension, some in compression, and where in that piece are the forces the greatest?

Repairs of early frames are entirely possible without totally dismantling a structure. I frequently look at buildings and try to determine the original raising sequence, then work backward to get to the piece that needs to be repaired. Virtually any building can be repaired in its location with careful and proper planning. The result is a building that retains its original features and stays in its original location.

Mortars: Portland vs. Lime, Hard vs. Soft

Douglass Reid

WITHOUT masonry foundations, timber frame buildings would have little chance to survive with their wood sills resting directly on the ground. Before the turn of the 20th century, most foundations were built of stone laid up with soft lime mortars absent of Portland cement. With the advent of cement-based mortars, beginning commercially about 1880, lime mortar receded into near oblivion. By the 1920s, Portland cement was almost exclusively used in mortar for all types of masonry. Four to five generations of masons were trained with Portland cement mortars and lost thousands of years of knowledge in the use of lime mortars.

About 35 years ago there was a growing recognition that the stone and soft brick generally used in older structures dating before 1890 needed softer mortars than the very hard Portland cement mortars permitted. Beginning about 1988, several enterprising masons retrained themselves in the art of using lime mortar and lime's manufacturing process. They in turn have trained hundreds of other masons throughout the US and Canada. With growing awareness, training and product supply, it's now possible to hire well-trained and experienced lime-mortar masons.

Why is it so important to stay away from hard Portland cement mortars? The conclusion of a 30-year empirical test has proven that Portland mortars are far more impervious to the transpiration of moisture through a wall than once thought. Even with the addition of a mason's hydrated lime, Portland cement mortars are now known to be a very poor choice for use as a pointing or bedding mortar in an older building where the majority of the older bedding mortar survives and the masonry modules are soft bricks or sedimentary stone such as limestone. The newer, harder cement mortars, even when mixed with extra lime and sand, will simply trap moisture within a masonry wall, hasten the breakdown of the chemical bonding of the molecules of the earlier lime-based bed and pointing mortars and eventually destroy the capacity of the older lime mortars to do their job. Over a 30-year span or so, the deteriorating lime mortar hidden behind the Portland cement pointing will subside, ever so slowly. The result is a bulging wall where the exterior wythe of brick will bow outward and delaminate from the inner wythes of the brick walls surrounding the building.

Cement mortars also are bad for historic structures because of their hardness when cured. Portland mortars do not expand and contract the same as lime. Thus when brick or stone expands against the harder Portland, it may break and lose the faces of the masonry units, as shown below. Irreparable harm often occurs.

Douglass Reid

Spalling damage caused by 1970s Portland cement mortar used to point 1816 bricks.

Lime mortars suitable for use in historic structures are now readily available in this country. Suppliers of lime mortars will take the time to explain the properties and use of lime. One supplier will train masons for free at the plant.

Here are two (of several possible) sources for information, training and appropriate lime products: Jim Price, Virginia Lime Works, PO Box 516, Monroe, VA 24574, 434-929-8113; Andy DeGruchy, Pennsylvania Lime Works, PO Box 151, Milford Square, PA 18935, 215-536-6706.

Rebuild of a Rebuild of 18th-century Barns

Shaun Garvey

UNDERSTANDING the Chase barn in Royalston, Massachusetts, tested our timber frame detective skills. Once inside the large sliding gable doors and standing at the head of the long center drive, both features of an industrial-age New England barn (Fig. 1), we saw hewn gunstock posts lining the eaves walls and marriage marks etched with a raze knife. Later we discovered a board channel in the wall plates and gable tie beams, as well as timbers squared with a sash saw. These were not the features we expected to find but the call signs of a much earlier scribe-ruled English barn.

This barn had actually been moved, paired end-to-end with another barn and then split down the middle and widened. Successive visits revealed two distinctly different styles of marriage marks. Half of the barn had a 10-in.-wide plate while the other half only a 8-in. plate, with a simple half lap joining the two cleverly hidden behind the gunstock post in an English tying joint.

To add a center drive aisle, the barn had been cut in half at the tie beam and spread apart an additional 10 ft. A new beam added over the drive aisle reconnected the two halves of the original barn and served as a center aisle tie beam. The original roof system was common purlins over principal rafters; the modified roof system was common rafters over principal purlins (Figs. 2–3).

We finally determined that the 40x65-ft. Chase barn, built on its site in the 1890s, was the product of modifying and joining two 18th-century 30x40-ft. standard English barns. By the time we got to it, the 1890s barn had to be removed from its original site, so on-site restoration was not an option. The question became what to do with it. Some preservationists would say to rebuild the two original barns, others to rebuild the combination as it currently stood. The building was missing too much of its original fabric—one complete bent, all rafters cut in half and purlins nowhere to be found—to consider rebuilding it as two separate barns. Rebuilding it in its existing form just didn't seem to do justice to its wonderful 18th-century roots. So we compromised.

The barn was moved to a new site and a plan developed to rebuild it at its original 30-ft. width while keeping the 65-ft. length. This plan suited the wishes of the builders as well as the clients. The new configuration would allow the gunstock posts and English tying joints to shine again without the clutter of the center drive. The barn's long history as both 30x40-ft. English and 40x65-ft. New England barn would be preserved by keeping the two connected and leaving the modified principal purlin roof system intact.

The Chase barn in its third transformation will see new use as a house in a hilltop meadow in the Berkshires of Massachusetts. Some of its original siding was reused and will be visible from the inside. The design was carefully done to ensure that the rebuild carries the form and appeal of a barn from both inside and out. Very few windows will be added and the only partitioning of the inside will be for a bathroom. Outside, earthen ramps will rise to swinging barn doors hung from strap hinges, and the original threshing floor planks will be reinstalled as finish flooring.

Photos and drawings Shaun Garvey

Fig. 1. The Chase barn as found, apparently 19th-century.

Fig. 2. English barn cut and spread apart, with new roof framing.

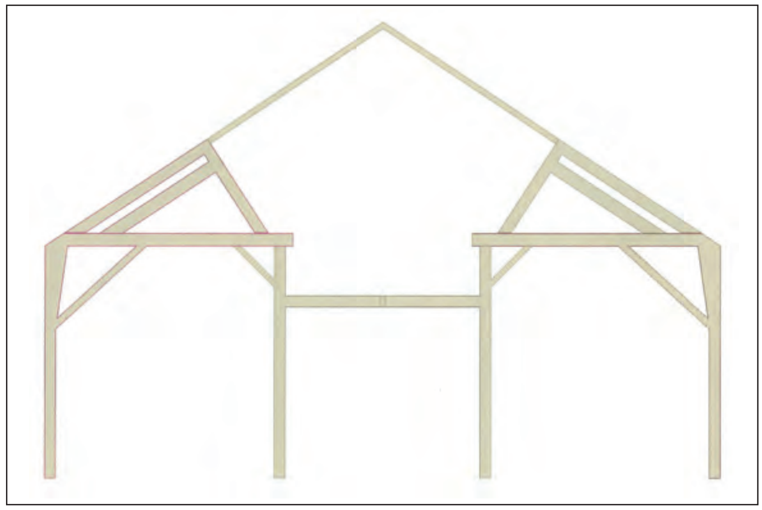


Fig. 3. Cross-section of the 40x65-ft. Chase barn as found, with cut and spread tie beam and canted purlin posts. English tying joints were first clues to barn's origin as two 30x40-ft. English barns.

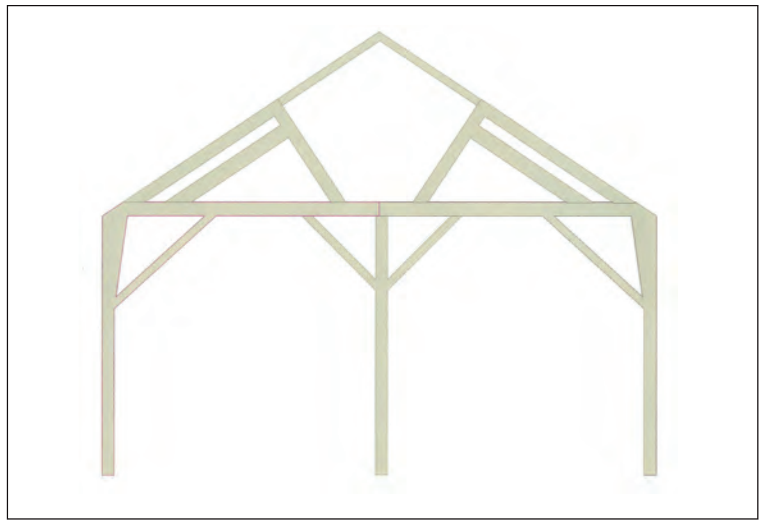


Fig. 4. Cross-section of barn rebuilt as house frame on new site.

Projects at Old Salem, North Carolina

David C. Fischetti, P.E.

A UNIQUE covered pedestrian bridge passes over Highway 52 and connects the Visitor Center and the Museum of Early Southern Decorative Arts at Old Salem, site of North Carolina's first Moravian community (Fig. 1). To enhance and blend with the cultural landscape and historic architecture of Old Salem, several types of covered bridge structures were considered. The final choices were the Burr arch truss and the Town lattice truss. The Burr truss is a two-hinged arch combined with multiple kingpost truss; the arch affords great stiffness. The Town lattice has many redundant members; it affords great toughness. Though Theodore Burr's patent of 1817 claimed nothing but the arch combined with a multiple kingpost truss, it became the most popular covered bridge structural system in the United States (see TF 78).

The Moravians arrived in Salem in 1753 from Bethlehem, Pennsylvania. Of the seven surviving covered bridges in Lehigh and Northampton counties near Bethlehem, all are Burr trusses. This was likely the type of bridge that the Moravians would have constructed for themselves during the first half of the 19th century.

THE roof structure of the ca.-1785 Single Sisters' House at Old Salem consists of principal and common A-frames with both collar

Ken Rower

Fig. 1. Covered pedestrian bridge at Old Salem, N.C.

David C. Fischetti above and below

Fig. 2. Repairs to a principal frame at the Single Sisters' House, Old Salem.

Fig. 3. A pair of light steel trusses now support the steeple in the attic of St. Philip's Moravian Church. Main roof trusses are composite vernacular queenrods.

Old Salem Museums & Gardens

Fig. 4. Reconstruction of the 1823 Moravian Log Church.

beams supporting the upper attic and tie joists supporting the third floor. Timber frame work required traditional timber repairs to the ends of the floor joists and to the lower portions of principal and common rafters (Fig. 2).

OFTEN a building is placed on marginally adequate soils without benefit of a deep foundation. Consolidation can produce quite dramatic amounts of differential settlement. The 1890 addition to the 1860 St. Philip's Moravian Church in Salem was constructed on a portion of a preexisting cemetery. The underpinning of St. Philip's Church provided an opportunity to repair the large cracks in the addition by pulling sections of the wall together. Once the gaps were closed, the cracks could be repaired by a combination of masonry rebuilding and stitching. By necessity, the masonry repairs had to occur after the walls were fully supported by the underpinning system consisting of grade beams and pin piles.

The roof of the 1860 church is framed with "queenrod trusses" consisting of 5x8 timber top chords, double ⅞-in. square iron queenrods, 2¾x3½-in. braces (webs) and a bottom chord of doubled 4x10 timbers spliced together and fastened with trunnels (wood pegs). Properly, these members together constitute an assembly better described as tied and braced principal rafters with sag rods. We added two light steel trusses to replace remnants of steeple supports (Fig. 3).

Work at St. Philip's also included construction of a replica of the 1823 Log Church based on photographic and archaeological evidence. Structural design issues at the Log Church included the A-frame roof structure, support of the false chimney clad with brick veneer, bracing of the gable endwalls, support of the open belfry, porch and balcony details and tiedown details connecting the log structure to the foundation (Fig. 4).

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Photos P. Smith

Fig. 1. The Brethren's Shop at Hancock Shaker Village repaired, with scarfed-in sills and posts, woven-in exterior finish and a new pentice roof to protect the entry. The iron platform on posts in the foreground is a carriage mount.

The Brethren's Shop

David E. Lanoue

THE Brethren's Shop at Hancock, Massachusetts, Shaker Village was used by Shaker brothers until 1958 for a variety of small manufactures and trades and was designed specifically for their hand labor. Analysis of the five different styles of wrought nails, tools and wooden joints used in this scribe rule timber frame workshop places its construction date ca. 1813 (Fig. 1).

Sill and foundation problems as a result of roof runoff, poor surface drainage and backsplash from the entry steps led to door, sidewall trim and flooring disintegration as the structure settled (Fig. 2).

Careful documentation as the south side of the building was shored and disassembled provided new evidence of previous repair efforts, including old pentice-roof mortises. Traditional timber frame repairs were made and a new pentice roof was added for protection over the entry steps (Figs. 3–6 overleaf).

Fig. 2. Years of backsplash from broad unsheltered stone steps had led to significant decay in the doorways and the building's sill beneath.

Photos P. Smith

Fig. 3. Reconstruction of pentice roof followed discovery of telltale mortises in building. Temporary roof over work area allowed unhindered progress.

Fig. 4. Sill and foundation stone removed, repairs advanced on girder and post ends.

Fig. 5. Scarfed-in sill in place, Matt Duffin drives in free tenon to secure floor beam meeting sill. To his left, a second free tenon remains proud.

Fig. 6. Persuading a granite foundation stone to enter under the sill. The late Ed Mottarella chamfers the arris to ease the way.


Port Orford cedar, Curry County, Oregon

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Mikkel Johansen

Flying in one of four decorative double roof trusses for a great room in Stubbegaarden, Denmark, in Northern Zeeland about 40 miles from Copenhagen. Trusses were designed and built by Mikkel Johansen and Timber Solutions ApS in Græsted, of Danish-grown Douglas fir, and will sit on plates atop new lime-mortared brick walls.