TIMBER FRAMING

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TIMBER FRAMING
INCORPORATING TIMBER FRAMERS NEWS

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LETTERS

On Longevity

IT may be of interest to your readers that "On Longevity" (Topics, TF 34, January) was an edited version of a paper I presented last August in Baltimore at a conference entitled "Environmental Issues Affecting the Forestry and Forest Products Industries of the Eastern United States," sponsored by the Forest Products Society. A short report may be in order, for though the trip was self-funded, I was representing the Guild.

First, let me make it clear that if anyone ever has a doubt as to whether timber framers put on—and have a good time at—great and fun conferences, just try an FPS gathering sometime. No bridges were built, much less christened at midnight with the white behinds of skinny-dipping attenders! If the evenings were quiet, though, the talks were not. These are turbulent times for forest managers and secondary producers, and the tension was evident.

One of the goals of the organizers was to further develop consensus among those managers, producers, users and environmentalists in moving toward balance in harvests and demand. They too struggle with and frequently evoke the term *sustainability.* Were it not so applicable and crucial, we might get tired of the word, chalk it up to fad and look for something else. Instead, it is foremost on the minds of both forest economist and ecologist.

There was also a great deal of talk about ecosystems, as a better management approach than simply forests. Jack Ward Thomas, Chief of the Forest Service and keynote speaker, expressed his frustration with both the elusiveness and the importance: "When I first came to office, our priority was to manage ecosystems, and after one too many managers asked with curled lip 'Just what is an ecosystem, anyway?' I lost my temper and demanded that if they weren't smart enough to start somewhere, then they should not be in a position of authority in the service." (My paraphrase, with apologies to the speaker.)

All of these new terms combined with the pressure of a flat economy are causing fits with the industry professionals I talked to. At one lunch, a pulp manufacturer swore to me that the public was unwilling to spend one cent more on an ecologically-harvested 2x4 stud, or roll of toilet paper. The recurring theme was that professionals are being told that they had to be supplying a continually greater amount of raw material at a lower cost without cutting forests. It's a riddle that can cause cynicism.

I was present as a representative of the Guild and our industry. The paper I presented opened the discussion of resource use patterns as they relate to timber-framed structures. I am convinced that compared to the status quo in light-framed stud construction, heavy timbers can better utilize lumber in a finished home. My preliminary work on the subject supports this hypothesis, while begging for further research. In fact, it is for this reason I write: there are many stories and anecdotes, like Wil Wilkins telling us about the house that survived the San Francisco earthquake and Merle Adams discussing the results of a fire that only did superficial damage. And of course in discussing this with some of us who have more experience in the study of very old timber frames, there is often a sense of awe at the abuse they seem to live through. I am interested in working through the longevity issue with as much research as we have, anecdotal and empirical, to help move beyond our intuitive beliefs. If you have anything that can help, let me know. I'll keep compiling the data and see where it goes.

JONATHAN ORPIN — SHORTSVILLE, N.Y.
April 15, 1995

Straw-Clay

HEREWITH a few corrections to Sam Kirby's article "Natural Straw-Clay Wall Systems" (TF 35, March). Outside walls range in thickness from 8 in. for smaller or seasonal dwellings to 12 in. for primary, year-round residences. Regardless of wall thickness the straw-clay wall is constructed with integral 2x4s (not 2x6s) as it is not load bearing. Typically these "blind studs" are face-nailed to the rafter tails.

Estimated thermal performance (taking into account mass effect) for 35-50 pcf straw-clay is the equivalent of R 1.5-2 per in. and R 2.5-3 per in. for 15-20 pcf straw-clay loosely packed in roof construction.

These values are estimates requiring research to validate them. Anyone with building experience, knowledge of solid wall thermal performance and common sense

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will find these values reasonable. My own experience living in a straw-clay house for four years in Iowa validates the impressive qualities of straw-clay—my house is 1,500 sq. ft., uses three cords of wood a winter and requires no air conditioning in summer.

ROBERT LAPORTE FAIRFIELD, IOWA
April 7, 1995

CALENDAR

Conferences

Timber Framers Guild
Tenth Western Conference
November 3-5
The Inn at Semi-Ah-Moo
Blaine, Washington
Timber Framers Guild
Box 1075, Bellingham, WA 98227
360-733-4001

Workshops

Timber Framers Guild
Hand Tool and Driftwood Scribe
July 31-August 11
The Powderhole, Green's Island, Maine
French Scribe Layout
August 21-September 4
Syracuse, New York
Timber Framers Guild
Box 1075, Bellingham, WA 98227
360-733-4001

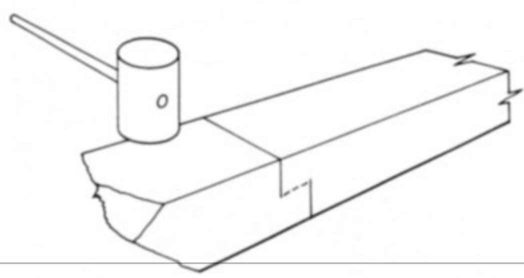
The Heartwood School
Introductory and Square Rule,
July 10-14 and August 14-18
Harvesting, Hewing, Milling, July 17-21
Traditional Layout Systems, July 24-28
Frame Design and Engineering, August 21-25
Compound Joinery, Raising and Rigging,
August 28-September 1
The Heartwood School
Johnson Hill Road
Washington, MA 01235
413-623-6677

The Natural Housebuilding Center
Straw-Clay Wall Construction
Fairfield, Iowa, June 14-18
Madison, Wisconsin, July 26-30
Warren, Vermont, August 26-September 2
The Natural Housebuilding Center
RR 1, Box 115F, Fairfield, IA 52556
515-472-7775

Dave Carlon and Jack Sobon
Traditional Timber Framing
September 20-24, Hancock, Massachusetts
Jack Sobon
Box 201, Windsor, MA 01270
413-684-3223

1995 Traditional Framing Symposium

PLIMOTH Plantation, on the bay at Plymouth, Massachusetts, and shown on the cover, provided the venue for this year's public symposium of the Guild's Traditional Timber Framing Research and Advisory Group. Some 80 visitors and speakers gathered for lectures and demonstrations over the three days February 24-26, not omitting a notably wind-chilly tour of the Plantation under a brilliant blue sky that cannot have been very different from the atmosphere in 1634, the year the Plantation aspires to recreate. Proceedings follow. Additional speakers were Dave Dauerty (Hewing), Preston Woodburn (History of Plimoth Plantation), Jan Lewandoski (see "Steeples," page 6) and James Sexton (see "Tying Joint Evolution," page 12).



FRENCH SNAP

Jack A. Sobon

INSPECTION of cut-offs found under a building indicates a time-saving way to rough out half-laps or barefaced tenons. Although likely used by all timber-framing cultures, this technique is known to at least one French framer practicing today, thus the sobriquet. Instead of sawing all the way through the timber, then laying out the tenon cheek line on the end grain, sawing the shoulder and finally sawing or chopping the cheek, this method calls for the shoulder cut, a half-depth end cut and a good blow from the mallet. If the timber is straight grained, little clean-up is necessary.

DUTCHESS COUNTY RENOVATION

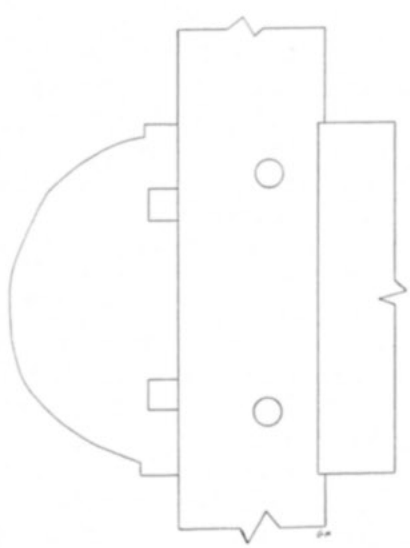
Michael Carr

THE center-entrance, story-and-a-half Greek Revival house represents a vernacular form in the Hudson Valley, built from roughly 1830 to 1850. Renovation of this one involved the marriage of new sawn oak framing to an existing hewn frame to expand the house to a full two stories and add 4 ft. of depth to the plan. All new framing was made consistent with the old in size, specie and square rule layout dimensions. Sill deterioration and missing braces required restoration work, accomplished wherever possible with timber salvaged from the original roof. Vertical bladed scarfs extend the old posts to gain the needed height.

TWO ULSTER COUNTY BARNS

Greg Huber

TWO Dutch barns standing 15 miles apart—the Nieuwkerk and Hoornbeck barns—appear to have been built in the same year, 1766, by the same builder. A dozen specific attributes occur commonly, including such critical dimensions as the *verdiepingh* (post height above the anchorbeam) and the central aisle span as well as certain signature details like marriage marks and pegging pattern—and indeed the legend AHM 1766 is carved into the face of the first interior anchor beam of each barn. The last is a particularly rare detail before 1800 and this pair of barns represents the only known instance in the region of the same builder erecting two barns in the same year. In other instances of barn provenance research we are limited to suggestive details such as the anchor beam tenon contour shown in the illustration, taken from an Albany County barn.



Two-in. tenon extends 10¼ in., anchorbeam is 22 in. high. (Coeymans Hollow, New York).

NEW JERSEY HOUSE RECONSTRUCTION

Alex Greenwood

THE house consists of a two-story side hall main section with an attached one-and-a-half story kitchen wing, a plan locally referred to as a "cow and calf." Despite renovations in the 1950s and some recent vandalism, a substantial amount of the original woodwork remained. Our expectation that the house was constructed in the late 18th century was born out by the initials and date scratched into a brick behind a bedroom mantel—"E.B. May 8 1787." Deed research documenting Edmund Burrough's ownership of the property at the time substantiated our discovery.

As we stripped away layers of the building, we grew to know the house intimately. Each piece was examined for clues. Missing details such as chair rail were discovered reused as furring strips inside the walls. Pintle holes in the door jambs established the original use of Dutch doors. The parlor mantel and cupboard with butterfly shelves and brass escutcheons survived as did the main staircase, most of the raised panel doors and a few sections of sash. The door frames, window frames, staircase and lapped oak plank interior wall sections were removed intact.

The hewn white oak house frame was in remarkably sound condition, requiring limited patching or replacement on the east wall and at the sill plates. The larger section employed framing in the English tradition with the first floor joists resting on the girts. But the attached kitchen wing was framed in the Dutch manner with a series of H-bents consisting of two posts supporting each floor joist. Original door and window sizes and locations were determined by studying the original framing members.

COMPOSITE MASSACHUSETTS BARN

David E. Lanoue

BERKSHIRE COUNTY in western Massachusetts accommodated early English expansion from the Connecticut River Valley to the East and an influx of Dutch settlers from the Hudson River Valley to the West, mixing two different building heritages. In Berkshire County's Monument Valley, two frames stand together as one barn 30 ft. x 76 ft.

The older four-bent barn frame (30 x 40) at the north end of this structure was framed by the scribe rule and reflects earlier English craftsmanship in a tie-beam-plate-post intersection in gable bents 1 and 4 only. The tie-beams at bents 2 and 3 are dropped from the plate level and joined to the posts with a pegged wedged dovetail assembly. The purlins are tied by beams half-dovetailed at each end and let in to the top surfaces. This frame is mostly hewn white oak with up-and-down-sawn braces, purlin ties and rafters.

The dropped tie-beams may indicate Dutch influence since they somewhat resemble anchor beams. This tying technique alleviates the problems incurred as the traditional English tie-beam dovetail shrinks in its mortise, allowing the plates to spread and place inordinate stress on the main posts. The dropped tie-beam replaces a three-member intersection and also lowers the loft, making it more accessible and allowing a man more headroom in which to work.

The second four-bent barn frame was framed by the square rule, and the tie-beams are dropped and joined to the posts with a pegged vertical tenon. The purlin plates are tied by a timber horizontally mortised into them and pegged near bents 2 and 3, but the purlin ties are dropped down onto the gable purlin posts and joined with vertical tenons at bents 1 and 4. White oak for the main posts, rails, braces and girts, hemlock and pine for the remainder, all members up-and-down sawn.

Comparison of these frames shows an early transition retaining scribe rule techniques and a mid-to-late transitional example exhibiting knowledge of the square rule and the last vestiges of English oak building traditions and plate tying joinery.

MORTISE CLUES

Rudy Christian

BY looking at tools used for boring (and their relative ages) we can establish investigative procedures. Since the end of a mortise is protected by the tenon during the life of a timber frame, the marks left by the carpenter are usually intact. In very early frames the complete process of mortising had to be done with an edge tool, leaving straight lines and wedge-shaped chips in the mortise bottom.

As early as the 17th century the idea of removing wood with a gouging tool had become well established. The spoon bit and later the nose auger were developed, to allow a carpenter to "drill" a hole. By attaching a T-handle to these cutting tools, a rocking and twisting method would bore a hole more efficiently than chopping. Since these tools required a notch to start them, often traces of the gouge mark can be found around the finished mortise. The end of the mortise itself will also show gouged markings left by the spoon bit.

The evolution of the nose auger into the twist drill was a major step in consistent hole boring. It was now possible to drill a hole of a specific diameter, and the addition of the lead screw tip allowed boring to be accomplished without a gouge. In the 18th century, mortise holes become much more well formed and the evidence of the screw tip can be seen in the bottom of the mortise.

In the mid 19th century, the boring machine could produce mortise holes square to the surface, aligned and of consistent depth. Instead of scalloped side walls, evidence of the T-auger, mortises roughed in with the boring machine show a row of circular "bit prints" with a center hole in each, from the screw tip. The use of a depth stop can be inferred from the lack of screw thread marks in the center hole.

NEW GLOBE FOR LONDON

Peter McCurdy

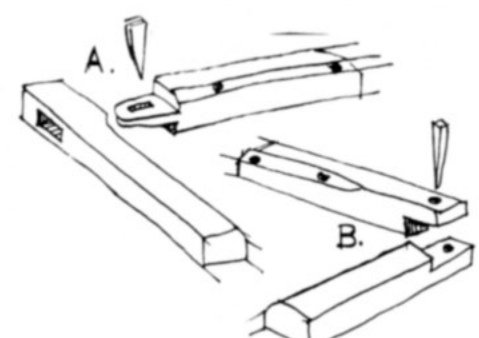
WE have now nearly completed the fabrication of the basic frame work for the reconstruction of Shakespeare's "Wooden O." The Globe Theatre will seat over 1,000 people in three covered galleries with a further 500 standing in the yard. More than 1,000 English Oak trees will have been felled to provide timber for this polygonal structure measuring 100 ft. across and 54 ft. to the top of the stage. The original Globe (1599) burned to the ground within 14 years but a similar theatre was built on the same foundations and stood until 1542. Of this second Globe we have a contemporary illustration in a view of London from the top of Southwark Cathedral drawn by Wenceslas Hollar. Working with this and other bits of evidence, and after an exhaustive examination of the stock of surviving buildings from the period, and especially polygonal buildings, dimensions, design and layout of the new Globe were agreed with the project architect, John Greenfield of Pentagram design. Twenty three-story bays would be lime-plastered and thatched with Norfolk reed. In front of the tyring (attiring) house the covered stage would project into the center of the 100-ft. circle, its canopy roof spanning 46 ft. and supported on two round timber columns. Since beginning actual construction of the bays in 1992, timbers have been joined using traditional scribe layout methods, with modern tools used for cutting and raising. Certain procedural complications have arisen because of the public and ceremonial aspect of the project. Current work proceeds on the stair towers, the stage and the tyring house. The reconstruction is expected to be complete by summer of 1996.

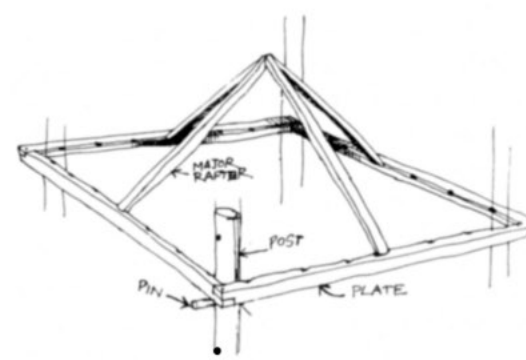
HAY BARRACKS

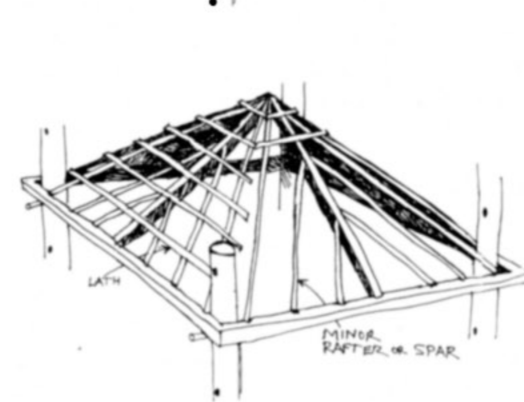
Peter Sinclair

THE barrack is a rudimentary type of pole-barn with a lightly-framed roof that can be raised and lowered. A series of holes are drilled through the corner-posts about a foot apart and the roof plates rest on iron pins inserted in these holes. A simple, versatile structure, the barrack could provide storage for loose hay or bundles of grain. The common farmer could easily build it or adapt it to shelter his livestock. The barrack served as an important structure in the establishment of many frontier farms in America.

Barracks were built by the Dutch who settled Manhattan in the early 1600s, and they remained common on the Dutch-American farms of the Hudson Valley of New York and New Jersey for 300 years. During the late 19th and early 20th centuries—long after the introduction of tractors, portable hay balers, and other more progressive ways of farming—some farmers continued to use barracks to store their hay, whether because of tradition or poverty. Today they have nearly disappeared.







The Erection of Church Steeples

CHURCH steeples, along with roof trusses and bridges, were the most ambitious timber framing projects in the towns and cities of the New World. In the 17th, 18th and 19th centuries, thousands of wooden steeples, typically 75 to 225 ft. tall, were constructed, and yet we know relatively little of how they were erected. With only one exception that I can find, and will mention, the builder's guides of the time are strangely silent on the accomplishment of this work. My experience and research indicate that height, technical complexity and restricted working space within the attic and tower rendered the mass raisings of the house and barn sort impractical for steeples, and that specialized rigging was often the solution.

In the following discussion, "steeple" refers to the entire assemblage rising above the plate and roof of a building. The steeple's lower and sturdier part is usually called the tower, and above that are found belfries, lanterns, cupolas, spires, pinnacles, finials and vanes.

Jan Lewandoski

Setting of steeple into reconstructed roof of meeting house (1826), at Weathersfield, Vermont, 1988.

Tall Scaffolding. The most low-tech, slowest and perhaps the safest method of erecting a steeple before the era of large mobile cranes was to construct scaffolding to nearly the full height of the structure, then bring up the steeple and assemble it piece by piece. Nineteenth-century photographs exist of these tall stagings. In the case of the First Congregational Church of Danbury, Connecticut (1857) "They began at the base, building solidly upward as they went" (1). However, constructing the scaffolding was almost as big a job as building the steeple and some framers had already looked for and found an easier and quicker way.

Build the Steeple on the Ground. The steeple of the 1772 Meeting House in Farmington, Connecticut, was described in 1841 as follows: "The steeple above the belfry was raised entire, where it has stood uninjured to the present day. . . The frame is of the heaviest white oak timber. . . The top of the spire is some 150 feet high, and the spire itself was completed below and lifted to its place along the tower" (2). No description is given of the rigging but it appears that approximately 75 vertical ft. of lantern, tapering spire and weathervane were finished at a more convenient elevation, then lifted atop the tower and belfry.

A very complete description of the method of lifting an 80-ft. wooden octagonal spire, completed on the ground, atop a 90-ft. stone tower is given in *The Journal of the Franklin Institute,* Vol. 39 (1845). The steeple belonged to the Church of the Nativity, Spring Garden, Pennsylvania (outside Philadelphia) and was raised, completely roofed and finished, from the ground in two hours. The printed description is very lengthy and involves two derricks atop the tower, each guyed in "three directions over the neighboring commons." The derrick feet "were made convex and fitted into corresponding concavities worked in the oak sleepers." This arrangement allowed the derricks to rotate in order to position the spire and is the only example I know of timber-framed ball and socket joints. Block and tackle joined the derricks to lashings about a third of the way up the spire (the center of gravity of a cone). Ropes from the blocks fell through the tower to "two capstans. . . placed in the main story of the church. . . each manned by 20 men." A straight lift of the spire would not bring it into place. With the spire 90 ft. in the air (with its apex 50 ft. above the tops of the derricks), the derricks must be rotated inward to position the spire properly. The account says "it was performed with the greatest ease," but the details as described or envisioned seem very intimidating (3).

Several other accounts exist of lifting the completed upper portions of steeples. The Congregational Church in Stowe, Vermont, called in a specialist in 1861: "Mr. Edgerton, of Charlotte, a master meeting house builder, will be here in a short time to aid by his greatly practised skill, and his machines which he says will move anything loose, in the erection of the belfry and the construction and raising of the spire" (4). The 1861 newspaper account continues: "The spire of the new meeting house is now in the hands of the tinman, and will be raised in the course of next week. It is about 75 feet long and will be raised by machinery from the ground. Mr. Edgerton, who superintends the thing and knows what he is about every minute, informs us that in one hour after the machinery is applied, the spire will have reached mid-air and be proudly perching in its proper place." An original member of the church, present at the raising, provides the final details: "It was made on the ground and tinned, left side of church toward Staffords. Mr. Orlo Judson brot down a very tall tree, probably 100 ft. Tree was set up and braced in front of church. Steeple was brot to front of church and by aid of one horse and a pulley was raised into its position." (5). Mr. Edgerton's "machinery" probably amounted to large treble, double and single blocks, a capstan or two, and thousands of feet of rope.

A set of 1865 photographs in a Winterthur Portfolio shows the raising by two derricks of a large spire frame to the top of a tall stone tower at Grace Methodist Church in Wilmington, Delaware (6). In this case, the tower is fully scaffolded and, since only the frame of the spire is raised entire, the scaffolding will probably continue to the top. It may be that the spire was to be clad in stone and in its completed form would be too heavy or not maneuverable enough for the derricks. The height of the steeple is 186 ft. and the spire appears to occupy a little less than half the height.

Build the Steeple Within the Church. In a number of documented instances the upper portions of the steeple were built within the tower, or the vestibule of the church, and then pulled up by block and tackle attached to the four top corners of the tower. The spire, belfry or lantern, alone or in combination, would be seen to emerge from the tower, and when it reached a tenon's length above its proper height, sleeper timbers would be lodged beneath its feet to support it. This form of raising is well adapted to the telescoping nature of most 19th-century steeple framing (stages usually start 10 or 12 ft. down within the prior stage) and to the fact that the stages are usually lodged in cribs of timber that sit upon other timbers, rather than being rigidly framed into them.

In 1812, according to an eyewitness, the spire of Ithiel Town's Center Church in New Haven, Connecticut, was "built within the tower and raised by windlass and tackle. It took about two hours and went up beautifully" (7). This steeple is 211 ft. tall.

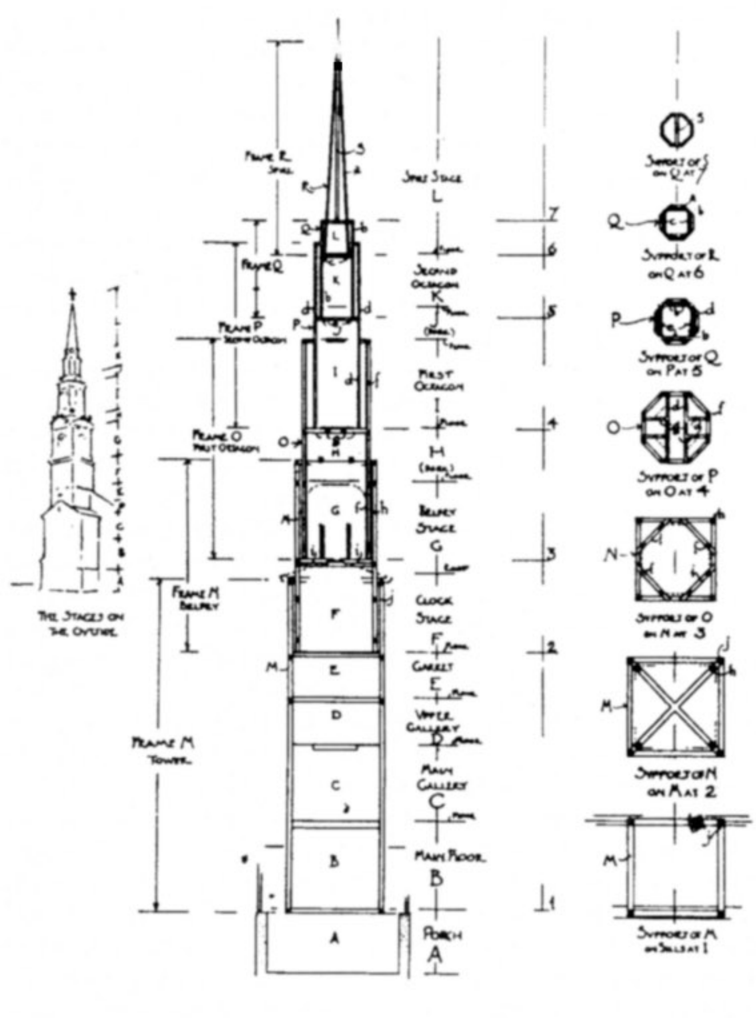
William Bell's *The Art and Science of Carpentry Made Easy* (1857) explains in Plate 28, p. 88-89, that one might "frame and raise the square portion first" and then construct a 48-ft. spire "upon the tie beam and joists of the main building. The top of the spire can, in that situation, be conveniently finished and painted, after which it can be raised halfway to its place, when the lower portion can be finished" (8). Perhaps significantly, Bell does not discuss any other methods of erecting spires in his widely-distributed book.

In addition to the concrete evidence above, a source of informed conjecture exists in Norman Isham's *The Meeting House of the First Baptist Church of Providence, A History of the Fabric* (1925). The meeting house was built in 1775 and rather complete records of its construction exist, including the information that the "house and tower" were erected by mass raising on August 29, 1774. *The Providence Gazette* for June 10, 1775, announced: "Last Tuesday the Raising of the Steeple, which lasted three days and an half, was finished" (9). The steeple, 185 ft. high, comprises five elaborate stages above the initial square tower. A piece-by-piece assembly would likely have taken more than three and a half days, and Isham offers extensive diagrams of the ability of each higher stage to rise within the previous ones, free from framed obstructions. His speculation however is that the various stages were brought up as completed walls and assembled into three-dimensional shapes at their final position. The fact that each stage fits within the next lower makes Isham's proposed scheme—or even bringing the steeple up in large completed pieces—quite plausible, since it would be safe and relatively easy to do. Using this method the previously-erected elements serve as both scaffolding and lifting apparatus.

The relative popularity of these various methods remains unknown. It isn't clear whether completion below and raising as a unit was so common as to be rarely commented upon, or so rare as to have escaped our notice. However, the following item from the *Boston Commercial Bulletin*, Sept. 15, 1860, was recently brought to my attention by Roger Reed, an architectural historian in Brookline. Under the heading "Miscellany, Church Spires," we read: "There has been a vast improvement of late years in the mode of building church spires. The old method of building them by means of staging has been found too expensive and risky. They are now for the most part, when of unusual length, built upon the ground and hoisted. Mr. George Hanson of Malden has recently achieved a success in this line at Newton Corner, near this city. The spire of the new Eliot Church at that place is 130 ft. in length; this was built inside the tower, and hoisted by means of tackles to its position at the top of the tower, a distance of over 80 feet, in less than five hours, without accident of any kind. The spire is slated, the only one we believe in this part of the country, thus giving a very large additional weight, the whole weighing not less than 30 tons."

—Jan Lewandoski

View of Providence meeting house in 1789.


Norman Isham's drawing of framing sequence.

Notes:

1. Seymour, George Dudley, *Researches of an Antiquary, Essays on Five Early New England Architects*, New Haven, 1928, p. 20.
2. Ibid., p. 5.
3. LeBrun, N., "An Account of the Raising of the Spire of the Church of the Nativity," *Journal of the Franklin Institute*, Vol. 39, 1845, pp. 368-370.
4. *Lamoille Newsdealer*, Vol. 1, No. 44, 1861, Hyde Park, Vermont, Sept. 27, 1861.
5. *History of the Community Church of Stowe, Vermont*, Stowe, 1981, p. 8.
6. Hoffecker, Carol E., *"Church Gothic: A Case Study of Revival Architecture in Wilmington, Delaware,"* Winterthur Portfolio 8, Charlottesville, 1973, p. 226.
7. Seymour, op. cit., p. 3.
8. Bell, Wm., *The Art and Science of Carpentry Made Easy*, Phila. 1857, Plate 28.
9. Isham, N. *The Meeting House of the First Baptist Church in Providence, A History of the Fabric*, Providence, 1925.

The Hanshin Earthquake

THE Great 1995 Hanshin Earthquake in Kobe, Japan, killed over 5,400 people. Of these, nearly 90 percent are reported to have been killed by the buildings in which they slept on the morning of January 17. Sixty percent of these causalities were 60 years old or older. These are numbers that should give us pause.

Furthermore, it is known that the vast majority of collapsed structures were wooden houses. Despite these figures and their obvious implications, most research following the quake has been into the failure of large, mostly commercial or transportation-related concrete structures. Only six weeks after the event did investigations begin into the causes of wooden structural failure.

The general public has access to little more than the usual mass media reports. These have focused mainly on the number of wooden structural failures and the resulting loss of life. Little light has been cast on the reasons for the failures. Many people have formed the opinion that wooden structures are by their very nature unsafe. Neither the age of the failed structures, their maintenance records nor the specific causes of failure have been mentioned or discussed in these reports.

After consulting several experts in the field, we were able to gather only the following information. Clearly a great deal more investigation is necessary.

Kyoto University's Yuzo Shinozaki reports that most wooden structural failure occurred at the foot of Mount Rokko, where the alluvial deposit sits lightly on a hard base of rock. This 20- to 30-meter-thick deposit amplified the surge of the earthquake on the foot of the mountain like a wave on a beach.

While it is reported that 30 percent of wooden buildings collapsed in the quake, Shinozaki reports that 100 percent of wood structures built along a north-south line from the foot of Mt. Rokko collapsed. Usually, only about 0.3 percent of wooden buildings suffer major failure during a strong earthquake.

Most of the wooden structures which collapsed were more than 30 years old. This suggests two possible causes of failure: they were built to insufficient standards or failed due to insufficient periodic maintenance.

Of the failed buildings, most are said to have been built just following the end of World War II. Surprisingly, until 1970 there were very few structural regulations for wooden buildings in Japan. It wasn't until 1981 that the new codes were enforced. Many of the failed structures were built without the diagonal bracing and metal reinforcement now required by local or national building codes.

Even so, many of the toppled wooden buildings were built *after* the enforcement of the wooden structural code in 1981, suggesting that even recently-built structures are often not in compliance with current codes.

Furthermore, building codes now in effect worldwide are largely based on calculations made in the aftermath of the El-Centro earthquake of 1940. The Hanshin earthquake is estimated to have been about twice as big as the El-Centro.

Many of the toppled buildings failed at the connection between the wooden ground sill and the concrete foundation. With Japan's high rainfall this is a frequent site of wood rot. The problem of wood rot could be practically eliminated during the normal life of the building by placing a vapor barrier and spacers between the sill and foundation. These encourage greater air circulation and provide a nonporous break between the wood and highly moisture-absorbing concrete. The use of vapor barriers is now fairly common practice in Western wooden architecture. Though several Japanese manufacturers market materials to accomplish this, they are not yet widely used.

NEARLY all collapsed wooden buildings failed in a similar way, that is, the first floor collapsed, generally by "folding" over to one side, while the second floor descended as is to ground level. In many cases, the second floors survived nearly intact. In all such cases, it was necessary for the *toshi-bashira*, the longest structural posts, running a full two floors from ground sill to roof, to fail completely before the second floor could descend. In all the cases we were able to investigate, this occurred at a point just below where the beams and girders join the column. This is a particularly weak point in all Japanese traditionally-wood-framed structures because of the large amount of wood that must be removed from the post to house the beam tenons. Redesigning this particular joint at the *toshi-bashira* would significantly strengthen wooden buildings against lateral forces.

The majority of houses built by prefabrication techniques or 2x4 construction did not collapse. While it is not necessary to entirely abandon "traditional" Japanese construction, it might be wise in the interests of seismic design to begin incorporating aspects of 2x4 construction within the traditional methods of building. On a more general level, it is necessary for architects and structural engineers to approach the seismic design of wooden buildings as seriously as they do that of high-rises.

All shrines in the earthquake area collapsed, including the most famous, Ikuta Jinja, near Sannomiya station. Lacking side walls for support against horizontal racking, vertical supports toppled leaving little more than a massive roof resting on the ground. In one exceptional case, a wooden *sanmon* gate remained standing by "walking" away from its base. Since the shrines must remain open on three or more sides for everyday activities of worship, it is likely that these collapsed traditional structures will be replaced by ferro-concrete, or retrofitted on a base-isolated structure.

At present, most investigations have been planned only by those with vested financial or administrative interests. The government, for instance, will soon begin an investigation of *only* those homes built to their Housing Loan Corporation specifications.

We believe that soil surveying should be carried out even for smaller wooden buildings, where it is not required under current regulations. Swedish sounding methods already exist to accomplish soil surveying at two points on the site. Based on this information, soil improvement or piles could be specified according to ground conditions.

It is also possible to build on base-isolated foundation systems, thus allowing the building to "slide" relatively independently of the earth movement beneath it. Osaka's Chuo City Hall, built in 1918, will be rebuilt on a base-isolated structure in the next few years.

A somewhat similar technique has existed in traditional architecture for hundreds of years. This involves building up a multi-layered ground beneath the foundation, thus isolating the foundation from ground movement in its immediate vicinity.

Greater public education is necessary in the area of building maintenance. Known as *mente* in its shortened Japanese form, the concept is generally limited to the cosmetic rather than structural aspects of buildings. Wooden buildings need to be looked after. How, where and why, must be clearly explained so that wooden house owners can ensure the safety and longevity of their dwellings. What is needed is a sort of coroner of buildings to tell the reasons for failures in traditional and contemporary structures. —MICHAEL ANDERSON AND KIMIHIRO MIYASAKA

The authors practice architecture in Japan, Anderson in Osaka and Miyasaka in Tokyo. This article in somewhat different form appears concurrently in YANCHA, JOURNAL OF THE A+E FORUM (Osaka).

At right, remains of a beautiful house in Ashiya, with unscathed concrete structure behind. Below, second floor on the ground and failed toshi-bashira joint. Below right, a joiner's damnation.

Photos Michael Anderson

A Gazebo in Philadelphia

EARLY last year we were asked to design and construct a gazebo for a garden near downtown Philadelphia. The owner, Jim Kanagy wrote: "The gazebo would be placed in among several cedar trees and against a backdrop of open woodland that is starting to regrow. Two wild cherry trees would form the back boundary of this space. I wish to. . . incorporate Chinese pagoda and certain Japanese garden structure elements into the design. . . I plan to thatch the roof if I can make connections with a fellow in Ohio who has brought his skills over from Ireland."

We quickly agreed on a plan of action and proposed that one of our timber framers, Ryosei Kaneko—a highly-skilled craftsman trained by Japanese master carpenters—act as consultant on design. Assisted by Kurt Doolittle, Ryosei also led the framing effort using traditional Japanese joinery methods.

Designer Randall Walter first produced pencil renderings and computer models of several proposals, synthesizing Chinese and Japanese timber building styles. A site visit helped in determining the gazebo's placement, size and orientation, and Ryosei authenticated the chosen design in the Japanese tradition. Japanese tea garden structures are primarily rectilinear, emphasize simplicity, use timbers in their natural round form and often are roofed with thatch. Chinese pagodas tend to be constructed of stacked rectilinear or square timbers, with heavily-ornamented end cuts, and are often multi-sided (up to 12 sides).

The final plan shows a square unfloored structure 10 ft. 6 in. on a side, with log posts, 5x8 eaves, 4x6 hip rafters, an 8x8 kingpost and two crossed *taiko* for strength. The naturally-arched *taiko* beam resembles the curved side of the drum from which it takes its name. The gazebo rests on round river rocks and eventually will be surrounded by a Japanese garden.

William Cahill of Cincinnati, via County Galway, Ireland, thatched the gazebo using water reeds gathered from several farms in New Jersey. He says, "Thatching is basically the same the world over, it being one of the first ways used to cover a building." Thatched roofs can withstand winds of up to 110 m.p.h. and may last for as long as 60 years. After consulting with Cahill, we applied the batten framework that supports the gazebo's thatch. Tied down with long metal hooks, the 12-in. thatch coat near the base thickens to about 20 in. at the peak where it is covered by a copper cap.

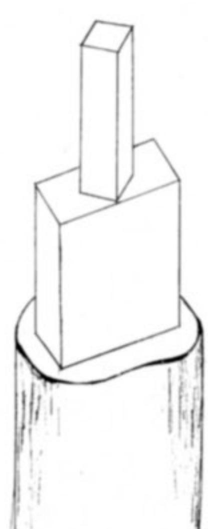
Posts and *taikos* are hand-peeled Atlantic cedar logs, chosen for rot-resistance and to blend with the woodland setting, while all other frame members are Port Orford cedar. Pegs and wedges are ash. After the logs were peeled they were washed with water and lightly scrubbed with a natural-fiber brush to leave the surface perfectly smooth. Log ends were hand-planed and sealed with wax. All the squared timbers were hand-planed. As Ryosei explains, the fine planing slices and seals the cedar fibers so that no finish will penetrate.

Since the cedar logs were fresh-cut, steps were taken to control checking. A sawcut to the heart, or *sewari*, was made along the length of the log and wedged. Periodically, as the log shrinks, the wedges are driven deeper so that pressure is maintained, thus preventing major splits elsewhere on the surface. Eventually, as the logs reach equilibrium in the standing gazebo, the wedges will fall out or may be removed.

Drawings Ryosei Kaneko

Ryosei applied his training in both Eastern and Western framing traditions to invent the joinery for the gazebo. He used the same rules of layout employed by Japanese temple builders (but in a looser manner as is the custom when constructing tea houses), where a known log's proportions determine the sizing of all other pieces.

In Western joinery, mortise and tenon work is generally blind, whereas in Eastern joinery, the tenon often runs right through and is outside wedged. The gazebo contains wedged through-tenons for the girts near the bases of the four posts, and blind tenons for the short tie-posts under the eaves. In addition, Ryosei devised several other unusual and intricate joints. At each corner of the gazebo a hand-cut stacked tenon from the post ties it to the *taiko* and eaves resting above. The top stage, or "diamond end," of this tenon is cut at a 45° angle to the lower stage to minimize the weakness inherent in the stack. This joint is further strengthened with an imbedded, threaded metal rod.



The kingpost joins two crossed *taiko* with the central peak of the roof. To accommodate the *taiko* mortises, which of course lie at right angles to each other, the tenon at the bottom of the kingpost is cut to correspond. ("Very uncommon," says Ryo.)

Where the eight rafters converge at the top of the kingpost, stub tenons enter the octagonal cap. In addition, two metal rods cross within the cap and run through to the ends of the four principal rafters. "There were too many tenons for the size of the joint," Ryosei says.

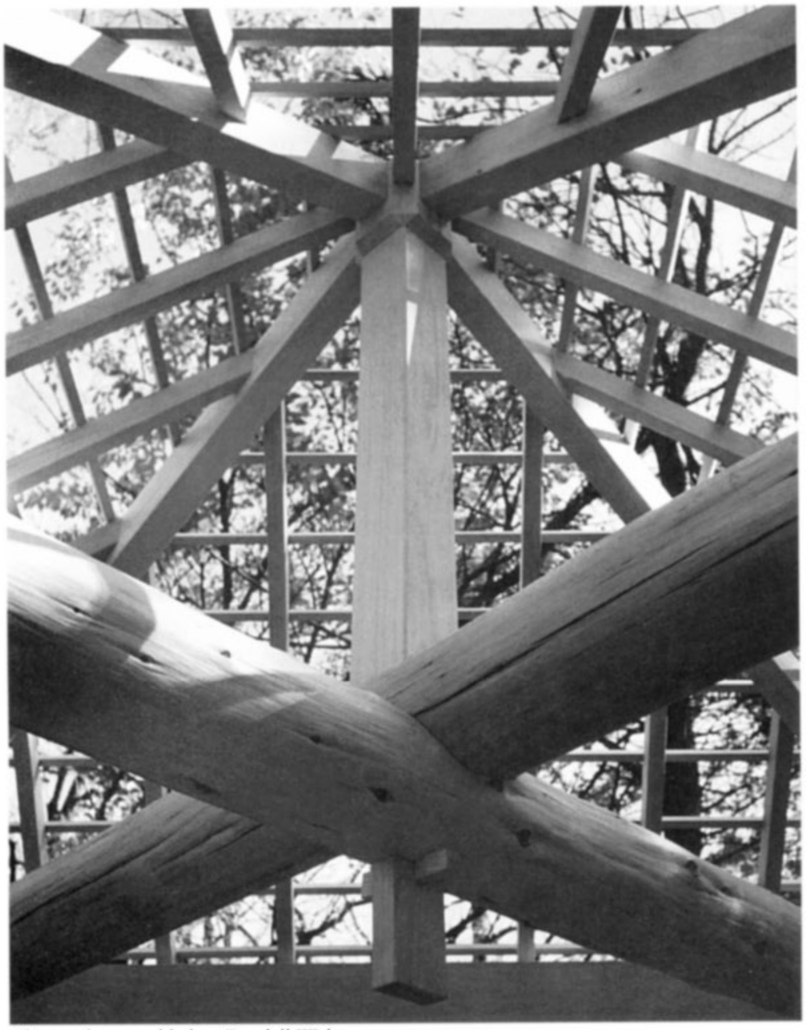
"There's nothing wrong with using metal: it's *how* it's used. A thousand-year-old tree should last a thousand years as a structure. Primary focus should be respect for trees, knowing their character, to give them a second life in a different form. You see, for longevity there are certain rules to follow. Metal won't last as long, and it's of secondary importance, but it can help."

Ryosei and Kurt undertook the task of fitting posts to rounded river rocks using the scribe fit technique *hikarikata*. After establishing a level line and center on the post, a compass is used to match and plot the rock's uneven surface along the circumference of the post. A gouge is then used to hollow out the bottom surface of the post. This method was also used to fit the *taiko* to each other and to the corner posts.

It was important that the construction of the gazebo on site do as little damage as possible to the tree roots and surroundings. Log and timber sizes were designed small enough to permit a hand-raising, which was accomplished in two and a half days.

The natural clearing with filtered sunlight playing on the gazebo presents a delight to the eye. Other senses are also stimulated through the structure's fragrant cedar and the earthy scent of the thatch. The gazebo contains beautiful natural materials crafted by intelligent artisans, whose expertise is derived from quite different cultures. But the confluence of their labors stands gracefully in the woods, an invitation to peacefulness. —Randy Miller

Randy Miller handles communications for Benson Woodworking, Alstead, New Hampshire.



Photos above and below Randall Walter

Jim Kanagy

Tying Joint Evolution 1690-1790

GUILFORD, Connecticut, lies between New Haven and New London, on Long Island Sound. It was founded in 1639 by a group from Kent and Surrey, England, led by clergyman Henry Whitfield. The town and its 18th-century east parish, now the town of Madison, contain 200 extant examples of pre-1790 buildings. A survey of approximately one-quarter of these buildings has revealed a variety of framing techniques from the period 1690-1790.

The oldest houses, those built before 1740, are framed consistently with many practices of traditional English-influenced construction, such as the first-period buildings of the Massachusetts Bay Colony. While the era 1690-1740 includes many changes in the appearance of houses, such as the acceptance of integral leanto construction, the falling out of favor of exposed and decorated frames and the introduction of new and varied styles of interior trim, the buildings from this period all share two key structural elements.

Each building is composed of a box frame divided into bays that establish the plan of the building, and each uses the same post-head joint (The English Tying Joint) to connect the post, plate and tie-beam together (Fig. 1). Every carpenter built with these common elements, and the buildings that resulted are therefore structurally similar. While the decorative elements, the construction of the roof and smaller constructional details vary, these two key elements remain the same throughout the years before the 1740s.

Drawings
Bryan Green

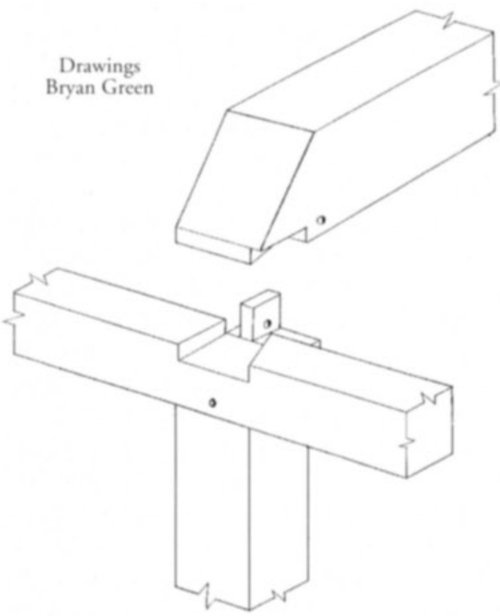


Fig. 1. English Tying Joint
(after A. L. Cummings)

Beginning in the 1740s the defining uniformity of framing techniques of the previous years becomes fragmented. Three separate approaches, each violating at least one aspect of the logic of the previous generation, are introduced at this time: one a technique for framing buildings without leantos, the other a pair of approaches to framing integral leanto buildings.

The first variation uses a post-head joint constructed without the lap dovetail that formed an integral part of the previous generation's approach to framing (Fig. 2). The dovetail is replaced by a horizontal tenon joining the beam to the plate, and held in place by pins. The traditional orientation of the post, with its flair perpendicular to the ridgeline, is also changed. The post is rotated 90 degrees so that it flairs along the long axis of the house. Finally, the framing sequence is changed. Instead of the tie-beam being placed on the already-joined post and plate, the order of erection becomes post, beam, plate, with an appropriate blocking arrangement to allow the plate to clear its post tenon while being offered to the tie-beam tenon.

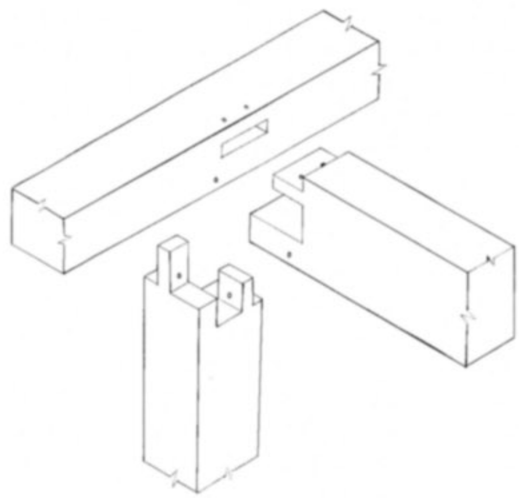


Fig. 2. Triple-Tenon Tying Joint

The second variation demonstrates a different approach to framing a leanto. The most dramatic change is that the rear posts extend above the attic floor (Fig. 3) and are capped by a raised plate, creating a steeply-pitched roof over an integral leanto. (The most common previous method for framing an integral leanto was to extend the tie beams past the interior wall to support the roof over the leanto, without increasing the height of the posts above the attic floor.) The new approach also removes the necessity of a complicated post-head joint in the rear, as tie-beam and plate do not meet the post at the same level. Instead, the tie-beam is tenoned to the post in a joint similar to the one used for the girts at the first floor level. The raised rear plate sits on shoulders of tenons at the tops of the posts.

The front post-head joint also differs from what had previously been the norm in Guilford. Now there are two plates: an inner one which caps the front wall and an outer one supporting the feet of the rafters (Fig. 4). The inner plate is discontinuous, and each section is joined to the tie-beams with dovetail joints. The exterior plate fits over the horizontal tenons at the ends of the tie-beams. Again, the order of framing is changed: pairs of posts are first joined by beams and raised into place, the inner plates are then dropped into place to link the bents at the front while the raised rear plate caps the posts at the rear, and then the exterior plate is placed on the ends of the tie-beams.

The third new style of framing uses a series of fairly heavy (about 8x8) timbers running from front plate to rear plate to cap the frame (Fig. 5). While the post-head joints present a version of traditional construction, the use of many tie-beams to link the front and rear plates is far from conventional. The pairing of beams and rafters also harkens back to the principal rafter systems which had been employed in Guilford at the end of the 17th century, but the elements are used many more times than pre-

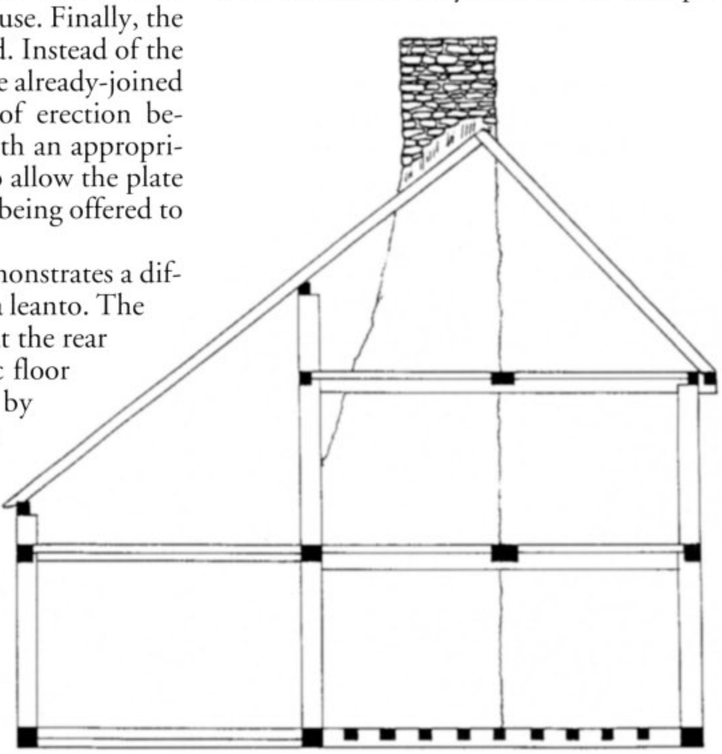
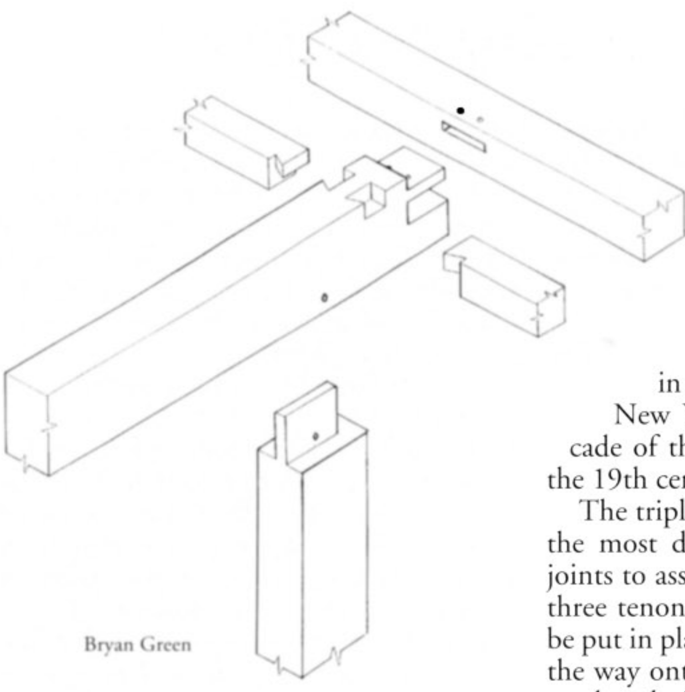


Fig. 3. Raised Rear Plate with Separate Front Cornice



Bryan Green

Fig. 4. Doubled Front Plate System

viously had been the norm. The hierarchical system of beams and joists is removed from this part of the frame, and the bay system established by the posts and girts is much less evident at this level.

Each of these new approaches shows a shift from the framing logic employed by the builders in the previous years. The triple-tenon post-head joint is constructed without dovetail joints, and changes the order of construction. The raised rear plate frame removes the tie-beam from the post-head in the rear, simplifying it, and alters the front post-head joint by moving the dovetail from the tie beam to the discontinuous inner plates. The third approach replaces the complicated, hierarchical framing of the garret floor with a simpler, more homogeneous structure.

Why did the craftsmen of Guilford deviate from a centuries-long tradition? Why did these construction methods appeal to the builders, leading to their adoption not only in Guilford, but throughout Connecticut, and not simply for a generation but, in the case of the triple-tenon post-head joint, for nearly a century? (The first instance of this method was found in Bridgeport in a building from the 1720s and the latest found so far are in three buildings in East Durham, New York, dating from the last decade of the 18th and the first decade of the 19th centuries.)

The triple-tenon construction is perhaps the most difficult of the three post-head joints to assemble. The arrangement of the three tenons is such that the plate can not be put in place if the tie-beam has settled all the way onto its tenon, and the beam cannot be admitted if the plate has settled onto *its* tenon. It is necessary to block up all the tie-beams part way over the post tenons before the plates are slipped onto the beams. The assembly can then be lowered the final few inches into place. If the process is complicated, it does yield a frame where the upper surfaces of the plates and beams are all at the same level. Rafters can then all be cut to the same length and framing the attic floor is an easier process than it is when the upper faces of the tie-beams are higher than the tops of the plates, as they are when the English Tying Joint is used. (Height differences in the upper faces of tie-beams and plates can also lead to the intrusion of rafter feet into the chambers below.)

The innovations of the raised rear plate construction would appear to make construction easier. The raising sequence appropriate to this framing style allows for the joining of posts and beams into bents on the ground, saving the raising crew the trouble and danger of trying to maneuver large beams into place over their heads while standing on a partially completed frame. The breaking of the inner front plate into several shorter pieces allows these timbers to be put into place by fewer men. This method of framing shares with the triple-tenon approach the advantages of level upper faces for the attic floor timbers.

Coll. Guilford Keeping Society

Fig. 5. Multiple Tie Beams

The multiple tie-beam approach to framing an integral leanto provides a different way to make the construction process simpler. Granted, the large timbers running from plate to plate require more men to place them than simple joists, and there are almost twice as many of these beams as there are major timbers (summer and tie beams) required in a traditional frame. However, they do allow for a dramatic savings of time and labor in the preparation of the frame. Since the 12 tie-beams are the only timbers to be placed above the plates, only 24 mortises need to be cut. This is fewer than half the number of mortises required for a conventionally-framed attic floor containing summer beams and a traditional joist system. The tie-beams, because of their greater cross-section, are spaced much wider apart than joists and consequently fewer timbers and mortises are need.

Dovetail joints shrink as a frame dries, allowing tie-beams to withdraw from their housings if not otherwise restrained. The English Tying Joint provides such a restraint, the jowl tenon shown in Fig. 1, but the pressure of common rafters (if combined with this arrangement) thrusting against the plate can split a post away from its jowl. In Guilford this problem may have been exacerbated by a move in the first decades of the 18th century away from principal-rafter roofs, which transmit most roof forces directly to the tie-beams without thrusting on the plates, and toward common rafter roofs, which on the contrary transmit their roof forces to the tie-beams by pushing outward on the plates.

The new framing approaches address the shortcoming of the housed dovetail. The triple-tenon assembly avoids the withdrawal problem of the dovetail, maintaining or perhaps strengthening its grip as the frame dries, since mortises and tenons shrink together. The multiple tie-beam system eliminates all thrust on the plates since each rafter pair is footed directly in the top of a tie-beam—achieving a kind of all-principal-rafter effect—and all roof weight is conveniently placed over the joints between ties and plates. The raised rear plate, doubled front plate system offers the same advantage at the front as the triple-tenon system, and at the rear again replaces the dovetail with a vertical tenon pinned directly to the post.

While explaining their appeal to 1740s craftsmen may challenge us, the development of three alternative construction techniques shows us that timber framing in the mid-18th century was not a static craft. Framers were experimenting and modifying their techniques with the hope of finding simpler, more effective methods of constructing houses. —James Sexton

James Sexton is an historian studying at Yale University.

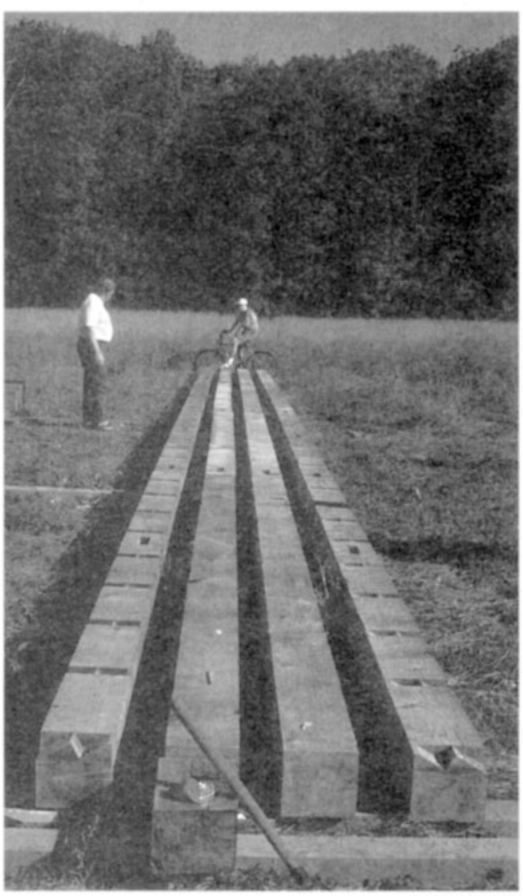
Malabar Memories

MALABAR FARM State Park near Mansfield, Ohio, was once the home of author and screen writer Louis Bromfield. Bromfield grew up in the Mansfield area but moved to France to live the Bohemian life-style of writers and artists of the 20s and 30s. World War II caused him to return home in 1939. While in France he became greatly interested in sustainable farming practices. When he returned home he bought a ruined farm in a beautiful area known as Pleasant Valley, and named it after the Malabar Coast of India. He spent the rest of his life at Malabar practicing the farming he had learned in France. When he died his family was unable to bear the expense of maintaining the farm and in 1976 it became a state park.

Early in the morning of April 4, 1993, Palm Sunday, a fire started in the main dairy barn. It appears to have been of electrical origin. The barn itself was very dry and full of straw and farming debris, causing the fire to grow rapidly. When the volunteer fire department arrived on the scene the barn was fully involved in flames and their efforts were focused on saving the surrounding farm buildings. Within two hours the century-old timber frame barn was reduced to a smoldering disheveled mass.

The working farm status of Malabar Farm State Park meant the barn would have to be replaced as a functioning dairy barn. Given the historical significance of the farm buildings and Louis Bromfield's "Big House" at Malabar Farm, the decision was made to try to replicate the barn as nearly as practical. Creating a building that looked just like the old barn was not as difficult as the decision how to frame it. State of Ohio engineer Ralph Roberts knew the barn had been framed with heavy timbers. He was also quite aware of the potential difficulty in locating a contractor who had access to the massive timbers (some were 10x10 36 ft. long) and the ability to cut the mortise and tenon joints to connect them. The final decision was to write the specifications for the new barn as design-build.

Since there was no architectural record of the big barn at Malabar Farm the information needed to specify the bent typology, roof frame type and building layout had to be extrapolated from photographs and the memories of the park staff. The video that had been shot by a member of the sheriff's department the day of the fire turned out to be very useful, since the frame was easily viewed as the roofing and siding burned away. The main barn itself was 36x72 and had been built by a qualified barn framing crew around 1890. When the 52x60 straw shed was added on around 1930, it would appear no carpenters were available who understood timber framing. The straw shed was a hodge-podge of stick framing, crudely-effected mortise and tenon joinery and wishful thinking. The tie-beams had been cut out for a hay track and the swaybacked roof had blown off more than once. The decision was made to forgo the historic fabric and rebuild the straw shed also as a well-designed frame.



Laura Saeger

The very long plates await raising day.

The large oak timbers needed to rebuild the frames were available from local sources. The presence of saw mills in late 19th century Ohio meant that most barns used sawn timber in lengths up to 24 ft. Although our milling marks would be those of a circular saw, rather than those of an up-and-down mill, the use of sawn timber would be historically accurate for the majority of the material in the frames. The 36-ft. tie beams would have been hewn, so the search was on for six 36-ft. oak logs straight and sound. The only real problem in building the frames with indigenous materials came in specifying the rafters. The fact that they needed to be 24 ft. long, combined with their relatively small 3x6 cross-section would make them nearly impossible to cut from oak. It would be more practical to order them in West Coast Douglas fir.

Once the decision had been made to

rebuild the barn as a timber frame, the concept of a community hand-raising was proposed. Although it would add a great deal of work to the planning process, the temptation to create a community event of such scale and so much historic importance seemed too great to resist. The idea was presented to the board of directors of the Guild at the Nacogdoches conference in March of 1994. The board's decision was unanimous and the call went out for volunteers. The Guild's endorsement was all the stimulus the Ohio Department of Natural Resources needed to set their well-staffed publicity department into high gear. The fact that the state park system could receive some much-needed positive publicity from the raising, which could be aligned with the kick-off of the 1994 gubernatorial campaign, was reason enough to make this a front-page event.

The response to the extensive publicity indicated that attendance and media coverage were likely to be great. Planning for as many as 50,000 spectators would present the park staff with a real challenge. Not only would it be important to ensure that the onlookers had a chance to get a real feeling for what a barn raising was, the plans to ensure their comfort and safety would also have to work without a hitch. Strategies for allowing crowd contact with the volunteers would have to be carefully interlaced with a system to keep the crowd from impeding progress. It soon became obvious that the park staff and state employees were up to the challenge. Arrangements were made for sponsors, then cooking, dining and camping facilities appeared as if by magic, and a real community happening seemed imminent.

While the publicity staff was busy arranging the event, the general contractor was on schedule with the site preparation and foundation construction. The support by the state engineer's office, combined with the unusually dry summer, meant the work at the site was not going to cause any delays. The dry weather also helped in acquiring the timber needed for the crew of itinerant framers who had settled in central Ohio for a summer of joinery and tomfoolery. The frame was cut from computer-generated stick drawings based on the same square rule layout system used to mark the joinery 100 years ago—with modern (that is cryptic) numerology and a dimensioning system designed to challenge the crew. Nevertheless, they soon turned several truckloads of timber into a frame anyone would be proud to have cut.

Because of the number of visitors expected, and the fact that 25,000 board feet of timber were to be raised in bents, the decision was made to spread the event out over the three-day Labor Day Weekend.

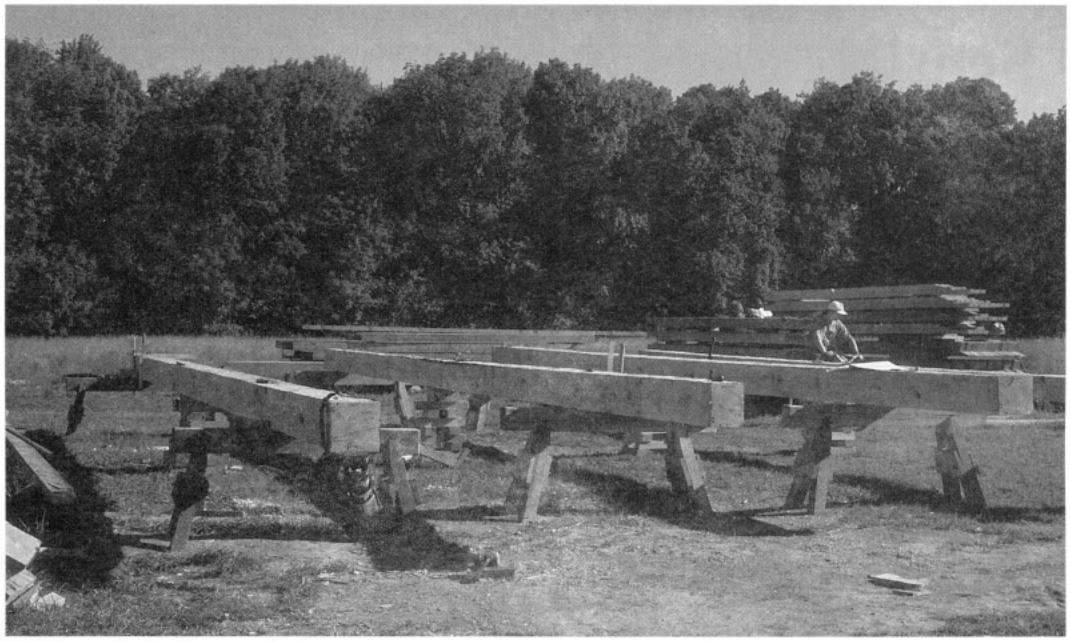
Since there were actually two completely independent timber frames, on the same foundation, two separate raising bosses were assigned. Most of Saturday was spent organizing teams, getting to know the frames, reviewing the raising plans, meeting new friends, enjoying the company of old ones and preassembling the bents. By supper the frame was ready to raise and the volunteers migrated to the makeshift tent city, complete with camp fire, set up in one of the picnic grounds. Folk songs and tales lasted on into the night.

Sunday morning greeted Governor Voinovich and the gathering crowd with brilliant sunshine and no wind. The hills at Malabar seemed to be quietly waiting for the new barn raising to begin. A few political affirmations were included with the obligatory gratitudes and presentations, and it was time to raise up a frame. Ellen Geld, Louis Bromfield's eldest daughter, flew up from her farm in Brazil to join the festivities. She as well as many local and state dignitaries were invited to pound some trunnels and grab a pike pole for the first lift. Because of the weight of the first bent, and the desire to make the first lift as one great team, over 100 volunteers heaved and pushed, wove in and out with pike poles, manned tag lines and aligned post tenons. Thunderous applause from the crowd greeted the first part of the new timber frame as it came to rest strong and proud on a hill in Pleasant Valley. The rest of the day went equally well. Good conversation with onlookers, tremendous teamwork and no injuries made for the raising of both frames by sundown. The teams' hard work was rewarded with a harvest dinner, square dance and fireworks. This was a day to remember.

Monday broke bright and warm, although the previous night's revelry made the sunrise a little hard to look at for some. As the teams were reorganized to accommodate the smaller crowd of hardy volunteers, the morning light on the new barn frames helped confirm the reality of the Sunday's accomplishment. The day would be dominated by the sound of hammers spiking the step-lapped rafter seats into the principal plates and purlins. The soft pink tones of the Douglas fir rafters and the gentle sweep of the adzed reductions made a fitting compliment to the massive geometric shape, the backbone of Malabar's newest architectural treasure. By early afternoon the rafters were complete, the wetting bush was in place and the crowds of onlookers were allowed into the new building for photographs and congratulations.

—Rudy Christian

As subcontractors to the R. G. Beer Corporation in Mansfield, Ohio, Christian and Son of Burbank built the timber frames for Malabar Farm, with extra crew for the job.



White oak timbers at the layout stage.

Photos Laura Saeger

Above, a team of 100, mostly Guild volunteers, hand-raised the two frames working in front of a very large crowd. Below, the completed barn and straw shed await the 21st century.

French Scribe Layout III

IN our first two articles (TF 34 and 35) we demonstrated methods of geometric drawing, explained the making of a ground plan and surveyed issues in choosing timber. In this article we look at the lining and gauging of timbers and the aligning and marking of timbers in accordance with the ground plan.

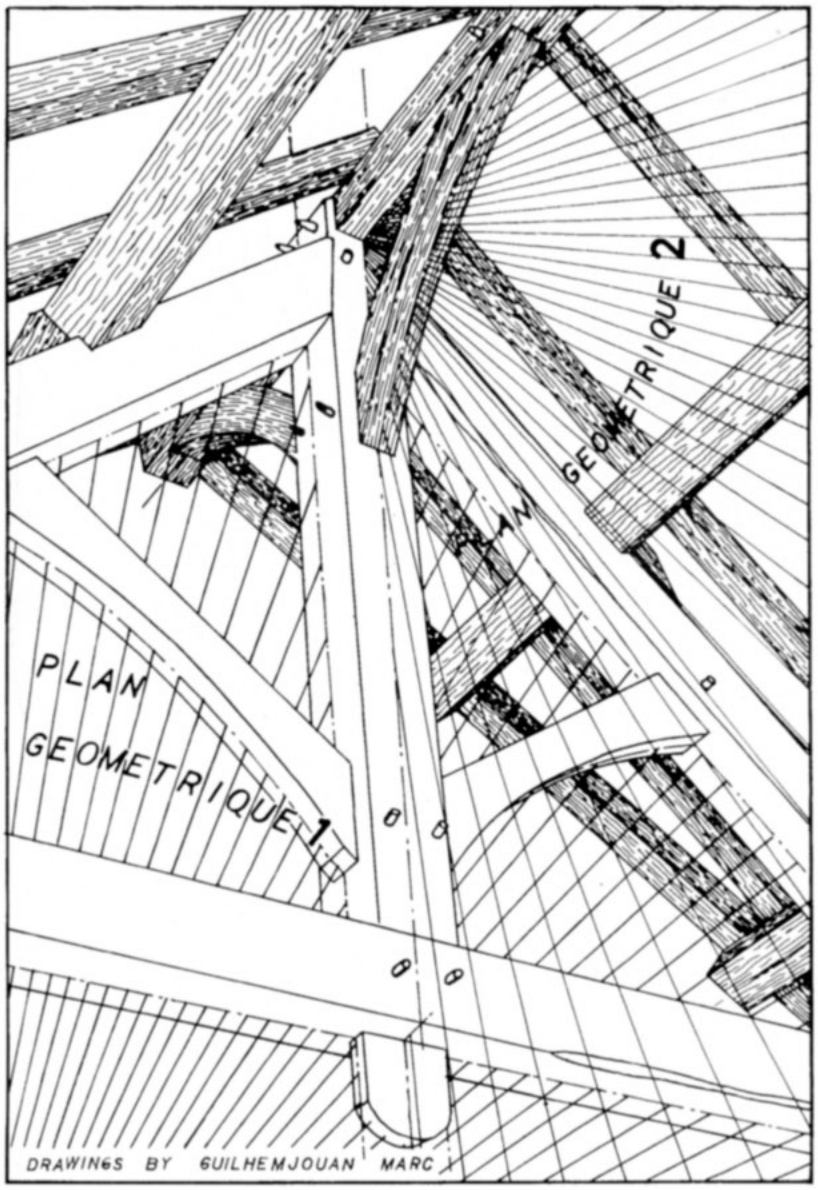


Fig. 1. Perspective View of Bent.

Lining and Gauging the Timbers (for Irregular Pieces of Wood). In the past, beams were rarely straight, square or of uniform section. To solve the resulting problems and to have the joinery fit well, the *Compagnon* carpenters devised an original technique. Abbé Soubise's *descriptif-géométrique* was developed and is still used today in France.

First we must establish one or two geometric planes through the length of each piece of wood. These planes form the axes of all joints and, very important, are parallel or perpendicular to each other (Fig. 1). All tenons and mortises in the frame lie on these axes.

We proceed as shown in Fig. 2. After putting the timber on sawhorses (for convenience) we mark the *plumée de devers,* at 1, a reference surface so that we can reestablish the correct geometric plane when the beam is later aligned to the ground plan. At this stage we level the timber, flattening as necessary across the grain to get a good bearing for the spirit level. It may be necessary to stabilize the timber with small wedges (2).

Without moving the balanced timber, join the corners at each end with diagonals (3) to establish centers. Still being careful not to move the timber, position the level at the centers and draw level lines across each end of the timber. (On a timber designated as a post or kingpost, it may be necessary in some cases to draw plumb lines as well through the centers.) Now join the level lines at each end with snapped lines along the edges of the timber.

These latest lines are called the *lignes des assemblages* and mark the axes for the joinery. With these references we need not consider the irregularities of the wood. We can now imagine the geometric plane travelling through the timber and indicated by the lines at the edges.

Aligning Timbers to the Ground Plan. With the beams marked and oriented and the ground plan marked on the ground ("French Scribe II," TF 35), we can now align the timbers to the ground plan as shown in Fig. 3.

Before moving timbers, set out 2-in. to 3-in. blocks (A) on the line of reference. These are necessary to allow the plumb bob space to drop once timbers are placed. For the same reason it is absolutely necessary to avoid placing blocks under intersections where beams cross.

The first timber is now placed on the ground plan. In the case of our model truss, this would be the tie-beam at B. When placing the timber on the line of reference, align the edge of the beam as nearly as you are able using the plumb bob to check and adjust position. Place a long level (N) lengthwise on the beam and if necessary set wedges under the beam until it is level.

Next place a short level across the beam on the *plumée de devers* and again set wedges until the beam is level cross-wise. This repeats the function performed when we first marked the *plumée.*

Additional timbers—in our case the two principal rafters—are now placed on the ground plan. It is advisable to consider the height of the finished assembly and, accordingly, select in which order beams will be placed on the ground plan.

With this in mind, we trim the top ends of our principal rafters before placing them over the ground plan, using the angle of the roof slope and the kingpost (CA).

Having made these cuts, it is now possible to place both principal rafters at the same height within the assembly. On the ground it will be necessary to block (2, 3) under the tops of the principal rafters because the base of the beams will be resting on the tie-beam and will, therefore, be higher. As with the tie-beam, use the plumb bob and make any necessary adjustments to ensure the rafters are aligned to their lines of reference.

Our kingpost is now placed on the principal rafters and the tie-beam. As with the principal rafters, it is necessary to block up the base of the kingpost to allow for the additional height the tie-beam has added to the base of the assembly. As always, check with the plumb bob.

To complete the assembly, follow the same procedures for the two braces.

It is very important to check that timbers are long enough before they are placed within the assembly. Additionally, extreme care must be taken to not move beams already aligned to the ground plan when new beams are being positioned.

Picage (Marking Points) of the Joinery with a Plumb Bob in Accordance with the Ground Plan. This procedure enables us, with great precision, to find where the joinery begins and where all cuts are to be made (despite

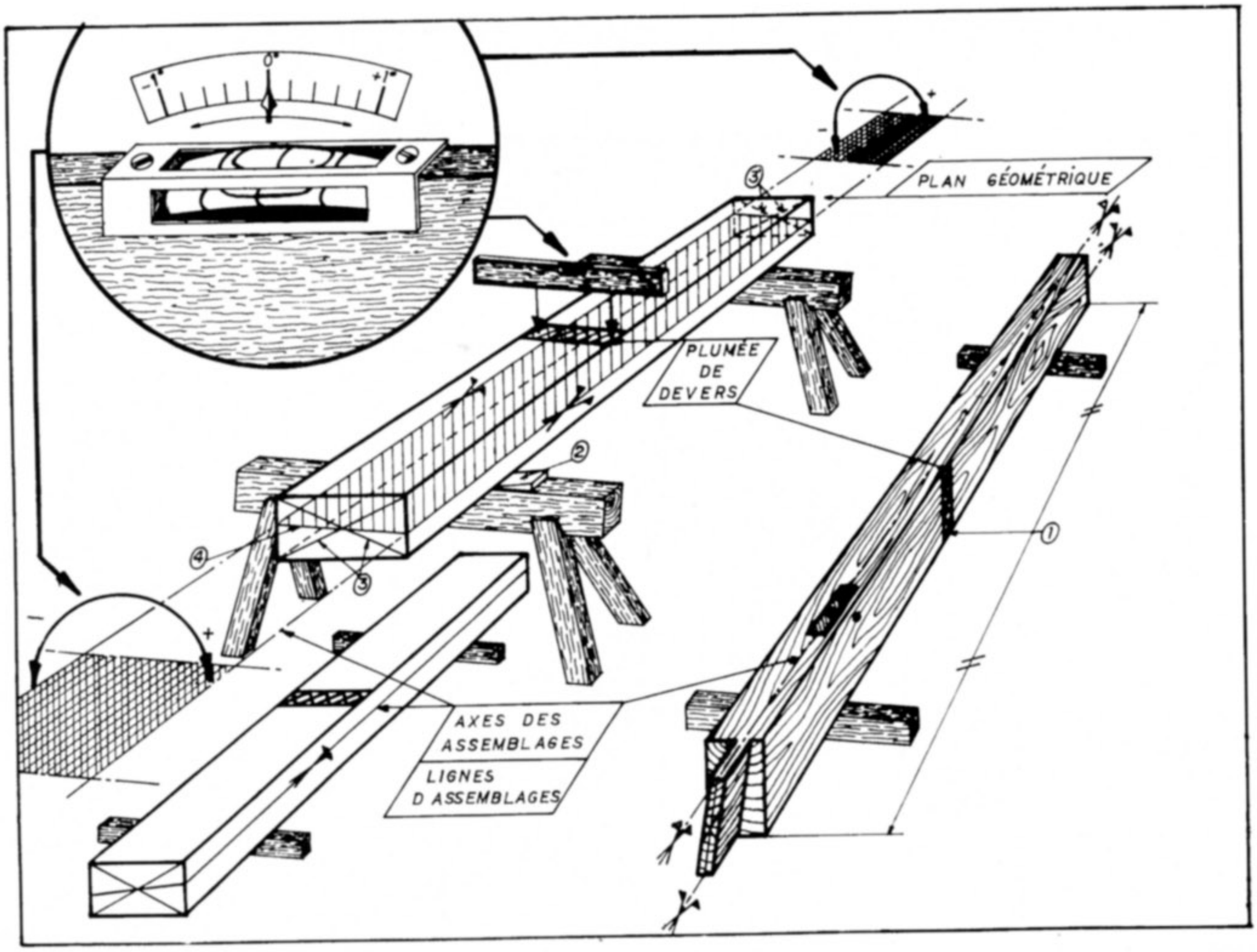
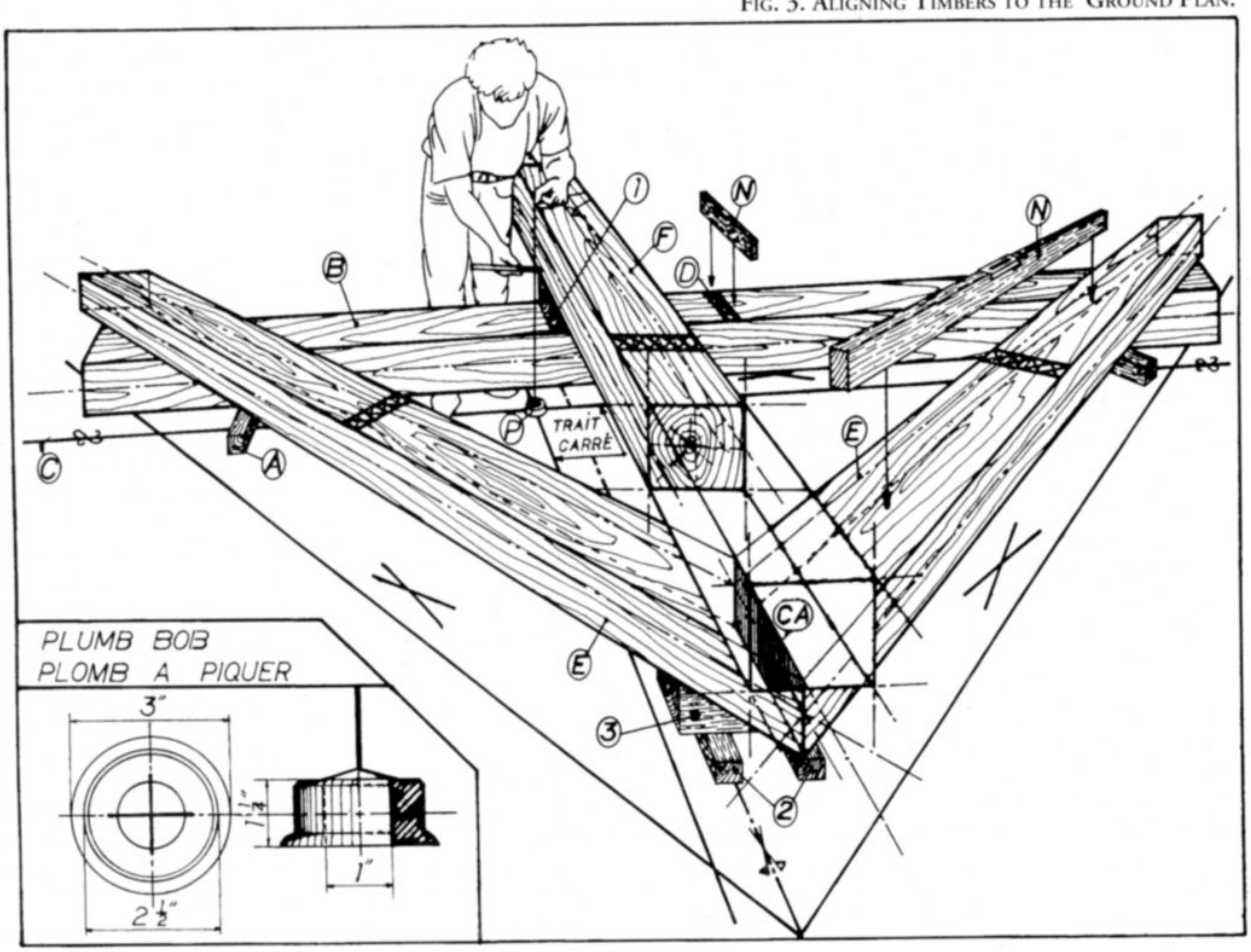


FIG. 2. LEVELING THE TIMBERS.

FIG. 3. ALIGNING TIMBERS TO THE GROUND PLAN.



irregularities and defects in the wood) and permits us to commence the marking process, as shown in Fig. 4.

Picage ("jabbing") is a process of picking points which we call *piqures* and *queues* ("tails") *de piqure* (at A and enlarged). The addition of the tail makes it easier to spot the mark.

A plumb bob (3) and a long, sharp carpenter's pencil (2) are required to make a *piqure.* The pencil is held level with the line of reference and the corresponding face of the beam (4). This process is exceptionally important when working in traditional carpentry. Each carpenter's skill and ability with this process is as varied and personal as handwriting.

After the timbers have been aligned on the ground plan, we drop the string of the plumb bob. The string needs to touch a minimum of one corner on each beam (5, 5'). Avoid having the plumb bob rest on the ground as this will effect the angle of the string. In this way we are easily able to see the irregularities between the beams.

With your well-sharpened pencil, make a *piqure* (A), taking into consideration the eventual difference between the plumb bob string and the corresponding corners (B, B'). These differences are called *la polen* (C).

When all jabbing is completed draw a line across the beam to mark the points (D, D'). These lines will be the junction lines of the joinery on the beam. When marking the *piqures,* always try to imagine the finished assembly.

Although not everyone will at first have success with this method, persevering will bring the true rewards of traditional carpentry.

—Marc Guilhemjouan

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Fig. 4. *Picage,* Marking the Joints.