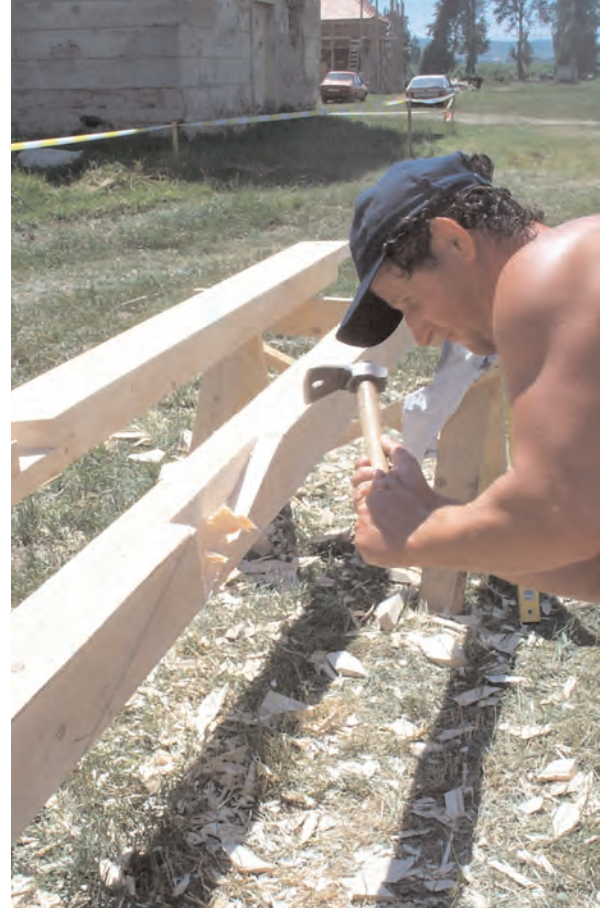


TIMBER FRAMING

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Restoration in Romania

TIMBER FRAMING

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On the cover, top left, horses and carts remain the most popular way to move materials in rural Romania; Banffy Castle, Bon-tida, in the background. Middle left, truss timbers set up over chalk-lined plywood on the grass. Bottom left, lap dovetail and clasped purlin detail of new roof frame assembled on ground. Top right, removing waste from a lap housing with hand adze made by the local blacksmith. Bottom right, Hungarian carpenter using a traditional Continental bowsaw. Photos by Daniel Addey-Jibb. Story page 7.

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1985



Keeping One's Head

I GREATLY enjoyed Doug Eaton's article on helving a broadaxe. It's impressive how he was able to laminate his own handle, especially with such tight curves. However, I'm afraid that he may soon lose his head. (The head of his axe, that is.) Almost all of the broadaxes that I've examined closely have an hourglass-shaped eye cross-section, the same as a hammer or regular axe. (The only exception that I've seen was a modern, poorly cast and improperly ground imitation of a real broadaxe head.) Having an hourglass-shaped eye allows the head to be mounted either way up, for right or left-handed hewers. When helving, these heads should be wedged the same as a regular axe, with a softwood wedge splitting the middle of the handle, and with steel wedges then splitting the softwood wedge. You also need to use a softwood wedge, not hardwood, to mate with the hardwood handle. Hardwood against hardwood loosens up too easily, since neither the handle nor the wedge will readily conform to the shape of the other. Placing wedges *between* the handle and the head, as recommended by Mr. Eaton, may be useful in adzes that have a wedge-shaped (rather than hourglass-shaped) eye cross-section, but even then they should be used only as a temporary fix to true up a poorly fitted handle.

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A Farewell to Freddie

F.W.B. CHARLES was the author of many treatises on ancient timber-framed buildings. A few are classics, including the collaborations with Walter Horn on cruck-built barns published in the prestigious English periodical *Journal of the Society of Architectural Historians*. The exposition "Medieval Cruck-Building and its Derivatives" (1967) in the *Medieval Archaeology* Monograph Series was the first article by Charles that I read, or, should I say, devoured. His monograph *The Great Barn of Bredon – Its Fire and Reconstruction* (1997) summarized his work in restoring the ca.-1345 barn. American architectural historian Abbott Lowell Cummings called it "his greatest triumph." Charles penned more than 15 other articles and books, from "Scotches, Lever Sockets and Rafter-Holes" (1974) to *The Conservation of Timber Buildings* (1984). He also contributed a section on timber-framed buildings to *The Buildings of England* by Nikolaus Pevsner. Certainly his writings ranked him as one of the great authors on early English vernacular architecture.

I visited Freddie (as everyone called him) last year in Broughton Hackett, Worcester, where he lived in a restored mill. The thought struck me that an architect with Freddie's background should live in such a place. Inside, we found Freddie, on a very old settle, and his wife Mary, on a modern chair, both covered in blankets before an open fire. After we were made to feel at home, Freddie Charles answered my questions. He was born on the Ides of March in 1912 in a house in Hoylake in the Wirral in Cheshire not far from Liverpool. His father, born about 1885, was a musician before World War I, later worked at a timber merchant's office in Liverpool and finally became a golf captain, but died prematurely at 57 in 1942. Freddie's mother, born about 1890, hailed from Birkenhead, southwest of Liverpool. Apparently there was one famous relative, Thomas Charles, who translated the Bible into Welsh. Whatever brought his parents together, Freddie believed the two sides of his family had nothing in common.

By the time he was 13 or 14, Freddie wanted to be an artist, and drawing images of buildings became somewhat of a passion. He eventually enrolled at Liverpool University, where he commenced his study of architecture under Charles Reilly. This encounter ultimately led him to the office of leading modernist E. Maxwell Fry. There he worked with Walter Gropius for two years, 1935 to 1937.

The Second World War approached. After a stint at Penang as a colonial architect, Charles found himself in Lord Holford's office preparing drawings for what he later learned were components of the Mulberry harbors used in the Normandy landings. He then taught architecture at Edinburgh for two years, where he met and married Mary. It was here also that he became a Communist, a political position he held for the rest of his life. From 1952 to 1957 he worked with Douglas Jones at Birmingham University. Here he began to pursue his specific interest in ancient timber frame buildings, particularly those with cruck frames. While recording old cottages, farms and barns, he obtained commissions to restore and modernize them. His connection to the medieval world of vernacular architecture became firmly established. Mary and Freddie went into a partnership around 1955. He was then nearly 45 years old.

In 1959, Charles did his M.A. thesis at Liverpool University on the houses of the Freckenham Forest in Worcestershire. Through the 1960s, his particular conservation philosophy of early timber-framed buildings assumed its specific form and became his trademark. He was known to have told his students and various assistants, "We must make these old buildings live again." He had a radical approach to repair and restoration—he did not follow the then predominant philosophy of "conserve as found." For this he did not receive the approbation of many of his peers and architectural conservators, including his very close friend Abbott Lowell Cummings. Nonetheless, he looked at buildings with an eye to their original disposition and layout. He became a master at working out the forms of particular structures and the joints cut by the original carpenters. He became particularly adept at discerning probable construction sequences. Apparently he gave little importance to the patina of time and the layering of history that virtually every early vernacular building is subject to. He wanted to strip back the building to what he deemed the most important point in its history. In addition to holding these generally unaccepted views, Charles was not averse to moving historic structures from their original settings. With that approach, he came into fiery relations with the Society for the Protection of Ancient Buildings, which believed firmly in protecting buildings at their original sites.

Freddie Charles was distinctly interested in the timber species that produced the structures he studied. He devoted nearly 20 pages of text to timber in his 1984 book, *Conservation of Timber Buildings*, discussing the properties of wood, the size of trees and the effects of the environment. Naturally, he placed particular importance upon oak, both its anatomy of decay and its unseasoned usage. In addi-

tion, he reviewed cruck trees and the reuse of timbers. He regularly visited Venables, the great Stafford timber merchants.

It was in 1967 that Freddie Charles's closest professional friendship began, with Abbott Lowell Cummings, who had stopped off at Birmingham while returning from a trip to Scotland, and been advised at a local art museum to get in touch with Freddie. Abbott invited Freddie and J.T. Smith, another medieval building specialist (and today Her Majesty's Chief Investigator of the Royal Commission on Historic Monuments), to come to Massachusetts to view very early houses near Boston. That fall, the threesome visited several pre-1720 houses, including the 1641 Fairbanks house. Whenever Abbott visited England to study architecture, he would stay perhaps a week with the Charleses at the mill in Broughton Hackett. Abbott found in Freddie "as great a human being as I have ever known." When I asked Abbott recently what were the most admirable professional traits he saw in Freddie, without hesitation he replied, "Two things—his analytical abilities and a masterful restoration philosophy." The second citation was all the more significant because Abbott actually did not agree with Freddie's approach to restoration. "If you could accept his philosophy," Abbott explained, "it would be very difficult to find anyone in the business who could surpass him." I mentioned to Abbott that Freddie had told me he did not consider himself an architectural historian. "Yes," replied Abbott, "that was very much something Freddie would say, something to stir the pot. He would want to get an exchange of ideas about historical restoration going. But we never confronted each other with our different political philosophies and there was never a problem." I remarked on the informality of everyone addressing F. W. B. Charles by a diminutive of his name. Abbott said, "That was because of the closeness everyone felt toward him."

England is replete with so many ancient buildings that a worker in the field could dedicate his entire life to one section of the country. This is essentially what Freddie did, working mainly in Worcestershire and Warwickshire, though occasionally he extended his efforts elsewhere. Possibly his single greatest work was the reconstruction of the manorial barn at Bredon, northeast of Tewkesbury near the River Severn, an aisled structure of nine bays, 134 ft. long and about 44 ft. wide and high, acquired by the National Trust in 1951. The barn was mostly destroyed by fire in 1980, with many of the cross-frame timbers ruined beyond repair. As fortune would have it, Freddie and Walter Horn had recorded the barn in great detail a few years earlier. The original timbers that could be saved were spliced onto new oak beams. The repair work was utterly exacting, and the fastidiousness that characterized so much of Freddie's work was seen in the fact that many complete truckloads of timbers were returned. In one case, arcade braces were sent back three times before an acceptable pair arrived. All told, 298 timbers (not including rafters) were either replaced or repaired. Most of these timbers had to be worked at both ends, with every joint cut by hand, draw-bored and pegged. The final cost of reconstructing Bredon barn was £226,000, about £24,000 under the agreed price. That Freddie worked within budget was typical of his abilities.

Freddie Charles either worked on or reported on innumerable restoration projects of all kinds, ranging from manorial and tithe barns to refectories, manor halls and inns. His energy was apparently boundless and was reflected in all of his work. He was absorbed in various jobs until 1990, only two years before his 80th birthday. He left for the ages a rare, perhaps unique, legacy. His skills as teacher, instructor, architect and historian touched many people in England and abroad. Freddie Charles died on August 10, 2002. He is survived by his wife Mary and four children. The world of early vernacular architecture will be a lonelier place without him.

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LATERALLY LOADED TIMBER FRAMES

V. Modeling the Strength and Stiffness of a 1S1B Frame

This article is last in a series to discuss the results of research conducted at the University of Wyoming on the behavior of sheathed and unsheathed timber frames subjected to an applied lateral load. Primary funding for this research was provided by the US Department of Agriculture National Research Initiative Competitive Grants Program, with additional support from the Timber Frame Business Council, the Timber Framers Guild and individual timber framing companies who contributed the test frames and structural insulated panels (SIPs). Previous articles included One-Story Frame Behavior (TF 62), Two-Story Frame Behavior (TF 63), Sheathed Frame Behavior (TF 64) and SIP Connection Behavior (TF 65).

INTRODUCTION. This article is a brief portion of the complete chapter on modeling in a dissertation to be published by Rob Erikson. Additional information can be obtained directly from the authors. Before delving deeply into structural modeling, we must first distinguish between the terms *strength* and *stiffness*. These are the two most important issues to be investigated in analyzing a structure. To investigate strength is to determine if a structure or structural element will break and no longer be able to carry any load. To investigate stiffness is to determine if a structure or structural element will deflect or displace an excessive amount, thereby creating undesirable secondary effects such as cracked dry-wall, broken windows or uncomfortable occupants. According to our research as discussed in previous articles (see especially TF 63), a typical unsheathed timber frame that relies on knee braces to resist lateral load is likely to have adequate strength but not sufficient stiffness. Analysis for strength is typically the easier of the two analyses. Although the entire frame must be analyzed to determine all forces, each individual element is then analyzed to find those that may be subject to excess stress. However, frame stiffness is based on all parts (beams, posts, braces, pegs, joint detailing) working together. The following discussion will demonstrate how the detailing of a joint will not have much effect on frame forces but will have a significant effect on frame stiffness.

Structural Models. In order to begin the analysis, a simple line diagram, generic model was developed for the 1S1B (one-story one-bay) frames. As shown in Fig. 1, the model had a center-of-beam height of 92 in. and post-to-post dimension of 144 in. Brace leg length varied with each of the three frames modeled. The Douglas fir frame had a brace leg $kb = 30$ in. while the Eastern white pine and white oak frames had brace legs $kb = 36$ in. All other dimensions and node locations were identical for all frames. The dimensions of joint end and edge distances and joint offsets vary slightly among the frame manufacturers, but these small differences were assumed to have minimal relative effect on overall frame performance. Therefore, node locations are approximate compared to actual frame dimensions, but are generally accurate to within 1 in. The structures were modeled in a relatively simple fashion with all braces pinned at

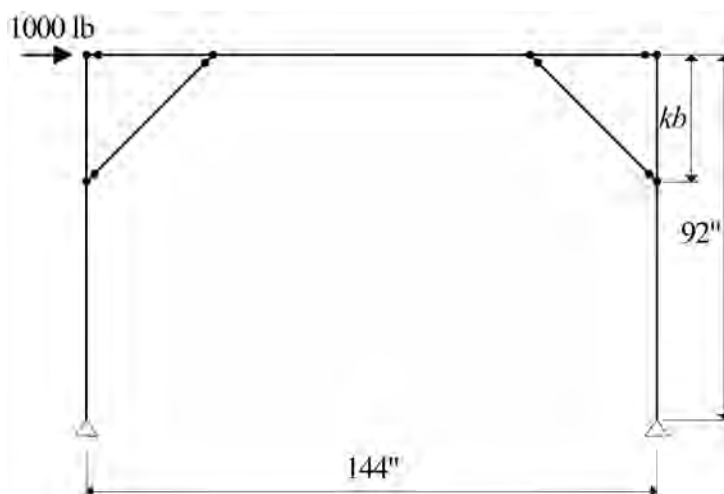


FIGURE 1. MODEL LINE DIAGRAM.

each end, thus limiting brace actions to axial force only. Beam-to-post connections were also modeled as pin connections. The frames were modeled with SAP 2000 Nonlinear, version 7.42 (Computers and Structures, Inc., 2001).

The first model to be analyzed was one that most closely represented the as-tested experimental frames described in the first article of this series (see TF 62). This model is referred to as the "As-tested SAP model." Wood-pegged joints were modeled as axial springs, and a standard frame element was used to represent the joint spring. The stiffness k_j of a joint spring is determined by Equation 1.

$$k_j = (A)(MOE) \div (L) \quad (1)$$

As shown in Fig. 2 (facing page), in order to simplify the model, the area A and length L of the joint element were both assigned unit values. Therefore, joint stiffness was equal to modulus of elasticity MOE , which was adjusted accordingly for each frame element representing a joint spring.

Model joint stiffness as shown in Table 1 was based on experimental work by Scholl (Schmidt and Scholl 2000*). These average values are derived from static tests of wood-pegged mortise and tenon joint specimens. The experimental joints were pinned with

Base Material	Peg Diameter (in)	Joint Stiffness (lb/in)
Douglas Fir	1	25,000
Eastern White Pine	3/4	18,000
Eastern White Pine	1	22,000
White Oak	1	50,000

TABLE 1. EXPERIMENTAL STIFFNESS FOR A 1-PEG JOINT
LOADED IN DOUBLE SHEAR.

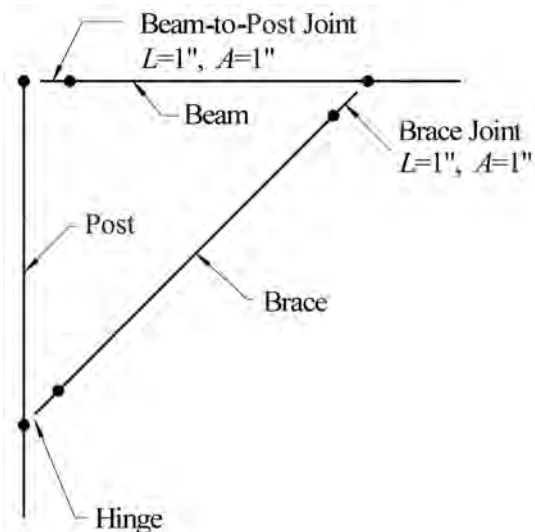


FIGURE 2. JOINT MODELING.

two white oak pegs, thus the results of the aforementioned study have been halved (and rounded to two significant digits) to provide a value for a mortise and tenon joint connected with one peg. Rotational stiffness of a pegged joint is negligibly small compared to axial stiffness.

In order to determine change in member actions if the effect of joint flexibility is ignored, a second SAP model was analyzed where the joint stiffness was increased many orders of magnitude such that joint flexibility was inconsequential compared to member flexibility. This model is labeled "Simplified SAP model."

Also, in order to demonstrate the ease with which frames with a minimal amount of redundancy can be analyzed, the frames were modeled using classical work/energy techniques to determine member actions. This model is called the Classical model and differs from the SAP models in that the beam, post, and brace material stiffness was increased several orders of magnitude, thereby negating the effects of member flexibility relative to joint flexibility. As with all models in this study, the frame was assumed symmetrical, with all joints having equal characteristics in tension and compression. Given this assumption, the frame was statically determinate with the lateral load split equally between horizontal post-base reactions. Since the model frame had nearly infinite frame element material stiffness, all deformation was assumed to have occurred at the joints. Frame stiffness k_f was calculated by Equation 2 where k_{kb} is the brace joint stiffness, k_{bc} is the beam-to-post joint stiffness, h is the frame height and kb is the brace leg dimension. A full discussion of this derivation is available from the authors.

$$k_f = \frac{1}{\frac{2}{k_{kb}} \left[\left(\frac{h}{kb} \right)^2 \right] + \frac{1}{2k_{bc}} \left[\left(\frac{h}{kb} \right)^2 + 1 \right]} \quad (2)$$

Comparison to Actual Frames. Table 2 shows the results of the As-tested SAP model analysis of three frames with comparisons to actual frame tests. Frame stiffness is based on the load applied at the top of the frame divided by horizontal deflection at the top of the frame, and was determined by the first experimental test that subjected the frame to a lateral load of 1000 lbs. As shown in the results, model predictions are quite close to actual frame stiffness.

*Schmidt, R. J. and Scholl, G. F., "Load Duration and Seasoning Effects on Mortise and Tenon Joints," research report, Department of Civil and Architectural Engineering, University of Wyoming, Laramie, Wyoming, August 2000 (available on the members-only page of the Guild Website tfguild.org).

	Douglas Fir	Eastern White Pine	White Oak
Knee brace distance (in)	30	36	36
Knee brace joint stiffness (lb/in)	25,000	18,000	100,000
Beam/column joint stiffness (lb/in)	50,000	31,000	100,000
SAP model frame stiffness (lb/in)	907	933	2683
Experimental frame stiffness (lb/in)	980	1240	3000
Percent difference	7%	25%	11%

TABLE 2. SAP MODEL AS COMPARED TO ACTUAL FRAME.

Model Comparisons. The global frame stiffness and member forces predicted by alternative models are shown in Table 3 (below) and Tables 4 and 5 (overleaf). Each table includes the results of one of the three species. All comparisons are made relative to the As-tested SAP model because it was assumed to be most accurate compared to the experimental frames.

As seen from the tabulated results, frame actions (moment, axial force and shear) are relatively insensitive to the model assumptions. Differences in frame actions were typically around 3 percent, with a high value of 8 percent occurring in the Classical model of the white oak frame. As expected, the differences in frame actions were low since the frames are nearly statically determinate. However, the predicted frame stiffness increased significantly as joint stiffness increased in the Simplified SAP model. Modeling the frame with high frame element stiffness in the Classical model also produced a slightly stiffer frame for all species of manufacturers' timber.

	As-Tested SAP Model	Simplified SAP Model		Classical Model	
	Value	Value	Diff.	Value	Diff.
Knee brace joint stiffness (lb/in)	25,000	large		25,000	
Beam/column joint stiffness (lb/in)	50,000	large		50,000	
Frame material MOE (kip/in ²)	1,600	1,600		large	
Model frame stiffness (lb/in)	907	4,044	346%	1,168	29%
Moment (lb-in)					
left column at knee brace	-30,069	-30,993	3%	-31,000	3%
right col. at knee brace	-31,931	-31,007	-3%	-31,000	-3%
beam at left knee brace	27,319	26,823	-2%	26,833	-2%
beam at right knee brace	-26,347	-26,843	2%	-26,833	2%
Axial force (lb)					
left knee brace	2,108	2,168	3%	2,168	3%
right knee brace	-2,238	-2,169	-3%	-2,168	-3%
Shear (lb)					
beam at left column	-924	-894	-3%	-894	-3%
beam at right column	-865	-895	3%	-894	3%

TABLE 3. DOUGLAS FIR 1S1B MODEL RESULTS.

	As-Tested SAP Model	Simplified SAP Model		Classical Model	
	Value	Value	Diff.	Value	Diff.
Knee brace joint stiffness (lb/in)	18,000	large		18,000	
Beam/column joint stiffness (lb/in)	31,000	large		31,000	
Frame material MOE (kip/in ²)	1,100	1,100		large	
Model frame stiffness (lb/in)	933	4,417	373%	1,180	38%
<u>Moment (lb-in)</u>					
left column at knee brace	-27,125	-27,182	0%	-28000	3%
right col. at knee brace	-28,875	-28,818	0%	-28000	-3%
beam at left knee brace	23,160	23,254	0%	23000	-1%
beam at right knee brace	-22,840	-22,746	0%	-23000	1%
<u>Axial force (lb)</u>					
left knee brace	1,754	1,758	0%	1,807	3%
right knee brace	-1,867	-1,863	0%	-1,807	-3%
<u>Shear (lb)</u>					
beam at left column	-656	-658	0%	-639	-3%
beam at right column	-622	-619	0%	-639	3%

TABLE 4. EASTERN WHITE PINE 1S1B MODEL RESULTS.

Joint Stiffness Effects. Table 6 demonstrates the effect of varying joint stiffness for the analysis model. Overall frame stiffness and frame element actions for three Douglas fir models with varied joint stiffness are compared to the Douglas fir As-tested SAP model. As shown, changes in beam-to-post and/or brace joint stiffness had

minimal effect on frame actions. Also, changing the beam-to-post joint stiffness had little effect on global frame stiffness. However, a doubling of the brace joint stiffness resulted in a 52 percent increase in frame stiffness. This indicates brace joint stiffness is the controlling factor in timber frame stiffness.

CONCLUSION. The global stiffness of a two-dimensional timber frame under lateral load is highly dependent on individual brace joint stiffness. In a case where story drift (horizontal displacement) is of interest, it is imperative that a structural model include the flexibility of wood-pegged mortise and tenon joints. Brace joint flexibility appears to have more effect on global stiffness than does beam-to-post joint stiffness. There are many methods of modeling such a spring connection, including the two discussed in this article: the stiffness-based computer model and the classical work-energy method.

The method of analyzing internal member actions requires a more subjective decision based on the level of frame redundancy. A relatively determinate frame, such as the 1S1B frames of this study, can be accurately modeled for strength without regard to joint stiffness. However, as the frame and corresponding model become more indeterminate, joint flexibility becomes increasingly important for accurate determination of frame actions. Although the results are not included in this article, a similar modeling study was performed on the 2S2B (two-story two-bay) frames.

In the 2S2B models, member actions were much more affected by changes in joint stiffness. We can also assume that a frame may be constructed such that diagonal members such as rafters contribute to frame stiffness, and, in this case as with the 2S2B frames, member reactions would be a function of joint stiffness.

—ROB ERIKSON and DICK SCHMIDT

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	As-Tested SAP Model	Simplified SAP Model		Classical Model	
	Value	Value	Diff.	Value	Diff.
Knee brace joint stiffness (lb/in)	100,000	large		100,000	
Beam/column joint stiffness (lb/in)	100,000	large		100,000	
Frame material MOE (kip/in ²)	1,000	1,000		large	
Model frame stiffness (lb/in)	2,683	4,873	82%	5,942	121%
<u>Moment (lb-in)</u>					
left column at knee brace	-25,967	-25,894	0%	-28000	8%
right col. at knee brace	-30,034	-30,106	0%	-28000	-7%
beam at left knee brace	22,922	22,803	-1%	23000	0%
beam at right knee brace	-23,078	-23,197	1%	-23000	0%
<u>Axial force (lb)</u>					
left knee brace	1,686	1,681	0%	1,807	7%
right knee brace	-1,948	-1,953	0%	-1,807	-7%
<u>Shear (lb)</u>					
beam at left column	-661	-658	0%	-639	-3%
beam at right column	-617	-620	1%	-639	4%

TABLE 5. WHITE OAK 1S1B MODEL RESULTS.

	Base model	Double knee brace joint stiffness		Double beam/column joint stiffness	
	Value	Value	Diff.	Value	Diff.
Knee brace joint stiff. (k/in)	25	50	100%	25	1%
Beam/column joint stiff. (k/in)	50	50	0%	100	-2%
Global Frame Stiffness (lb/in)	907	1378	52%	952	5%
<u>Moment (kip-in)</u>					
left column at knee brace	-30.1	-29.7	-1%	-30.3	1%
right col. at knee brace	-31.9	-32.3	1%	-31.7	-1%
beam at left knee brace	27.3	26.8	-2%	27.6	1%
beam at right knee brace	-26.3	-26.9	2%	-26.0	-1%
<u>Axial Force (lb)</u>					
left knee brace	2108	2084	-1%	2124	1%
right knee brace	-2238	-2263	1%	-2223	-1%
<u>Shear (lb)</u>					
beam at left column	-924	-907	-2%	-935	1%
beam at right column	-865	-882	2%	-854	-1%

TABLE 6. EFFECTS OF VARYING JOINT STIFFNESS.

Restoration in Romania

WITH the fall of Communism in 1989-1990 and the social and political change that went with it, Romania experienced an almost immediate rebirth of interest in the conservation of its built heritage. During Nicolai Ceausescu's 25-year reign, historical and vernacular architecture was not only neglected but often razed to make way for the dictator's beloved concrete apartment blocks. As part of his "systemization" program, entire rural villages were often abandoned and their inhabitants were relocated to urban apartment blocks and given jobs in unrelated industries destined to fail. The goal was to completely sever the links between the population and its past. Maintenance of old buildings was prohibited and nearly all official historic conservation institutions were abolished by 1977.

After three decades of inactivity, Romania's building conservationists had the overwhelming, long-overdue task of taking stock of the country's built heritage and deciding on a path toward its liberation from neglect. Using Great Britain and other countries as templates, the Transylvania Trust (artnouveau.org/ttf) was established as a nonprofit organization in 1996 by various conservation groups and professionals, with the purpose of protecting, preserving and restoring the historic buildings of that region of Romania. Their aims range widely, from surveying and recording the building inventory to reintroducing and teaching traditional building skills so that local craftspeople and conservation officers are then able to carry out restoration work in their own regions.

Recognizing the need to develop a long-term conservation strategy, the Romanian Ministry of Culture, in partnership with the British Council in Bucharest, invited the Institute of Historic Building Conservation of Great Britain and Ireland (ihbc.org.uk) and the Transylvania Trust to design and develop projects that would promote building conservation in Romania. The idea was to create an exchange between conservation practitioners in both countries, the principal aim being to teach the teachers through extended workshops, formal presentations and slide shows, as well as selected ongoing conservation projects.

The first project was the restoration of the Baroque-style Bethlen Gabor College at Auid, during the summer of 1999, which involved not only carpenters, but also plasterers, renderers (exterior finishers), stonemasons, stone carvers, structural engineers, architects and site managers.

I joined the exchange while working at Rick Lewis's Traditional Oak Carpentry, in Ipswich, Suffolk, England. Rick had been asked by the IHBC's David Baxter to participate because of his experience and knowledge in conserving historic oak frames all over Suffolk. My own experience was skewed more toward new framing, so in the end the IHBC and Transylvania Trust agreed to send both of us over to teach a two-week module devoted to building a new roof over the main entrance of Banffy Castle in Bontida.

This Baroque structure is considered the Transylvanian Versailles, and is still regarded as one of the most important Renaissance-Baroque assemblages in all of Romania. It was constructed in many phases beginning in the 16th century and wasn't fully completed until the 20th. In 1944, retreating German soldiers set the castle alight; it had been decaying ever since. Last summer, the castle was set up as an International Built Heritage Conservation Training Center to provide craftspeople and professionals with classroom-style tuition and hands-on conservation experience. Because of the sheer number of buildings in the complex in need of attention, the castle will likely be providing the hands-on training for many years to come.



Photos Daniel Addey-Jibb

Rick Lewis gives a talk on laying out twisted timber using plumb and level. David Baxter (standing) of the IHBC looks on from back row.

After a long day of travel that included seven hours of harrowing overtaking maneuvers in a minibus and a two-hour delay at the Hungarian-Romanian border, we eventually made it to the castle's very sleepy town of Bontida, just north of Cluj-Napoca. We arrived on the weekend, so our first day out was to visit the National Ethnographical Park, the open-air branch of the Ethnographic Museum in Cluj. The quantity and quality of the buildings that have been re-erected there over the decades, surviving even the Ceausescu era, is outstanding, easily on a par with the famous Weald and Downland museum in West Sussex, England.

Established in 1929, the park showcases vernacular buildings from the 17th to the 20th centuries. There are agricultural buildings, along with dwellings, churches, craft workshops and mills, one housing a water-powered reciprocating saw. The saw was attributed to the 19th century, but we were told of documentary evidence dating such saws as far back as the 14th century. The steeply pitched log churches with towering spires were beautifully painted inside and had carved detailing throughout. They were reminiscent of Norwegian stave and timber churches, both in size and design. Not a bad way to spend our first day.

WORK began in earnest on Monday morning. Our main objective for the two-week module was to build a 20-ft. by 40-ft. scissors-braced roof that would cover the vaulted stone entrance to the castle. If we had time, we were also to start work on the two adjacent roofs of a similar size, using a queen strut design. The designs were the work of Dorottya Makay, a structural engineer and Technical Director of the Transylvania Trust.

The scissors and queen strut roofs fell under what the Trust called the Eclectic style, a roof type popular during the 19th and 20th centuries. These roofs were generally of modest pitch and often employed queen posts and collars. The other two stylistic terms Romanians use to categorize their roofs are the Baroque and the Gothic. The Baroque style is a double-pitched Mansard roof built anywhere between the 17th and 19th centuries, the Gothic style a steeply pitched gable roof built between the 15th and 18th centuries.

The pine for our work, previously cut and delivered to site, was fairly fast-grown stuff, but free overall of major defects and cross-grain. It had been extremely difficult to locate timber from a local



At left, students lay a scissors brace on top of two principal rafters already positioned over the chalk lines.



At right, lap joint with curved end seen in the roof framing of the ancient church at Sighisoara. Joint has remained tight for 500 years.

source, but they did find some nearby after months of searching. Funds were very stretched as it was, so importing higher quality timber from abroad wasn't an option. The pine had been roasting in the 40-degree Celsius heat (over 100 degrees F) for several weeks before we got there, so it was already checking, bowing and twisting quite nicely. Ideal for demonstrating scribe-rule carpentry, we thought.

The first day we took getting to know one another and going over basics: reading and checking drawings, determining datum lines, critical measurements and reference faces, and a delivering a quick introduction to trig (it met with a lukewarm reception). Everything we discussed was translated by Dorottya into both Romanian and Hungarian, as Transylvania is historically a Hungarian region and many of the students spoke Hungarian as their mother tongue.

Toward the end of the day, the students had cut several test joints as practice, all with hand tools. That's what they were comfortable with; besides, there weren't any power tools on hand except for a drill that had already been claimed by the mortar-mixing crew and a chainsaw being used exclusively on the wooden centering for the brick vaults in the gatehouse. So we had a 1-in. auger bit (which made pegging decisions easy) and a hand brace, as well as the kit Rick and I brought over and the hand tools the students owned. This tooling didn't affect their efficiency at all. If anything, we had to keep telling the students to slow down and take more time with their cuts.

In the meantime, Rick and I had chalked out three of the principal truss triangles full-scale on the ground, with the help of Florin Candea, a local carpenter who would be helping to teach the next modules. There wasn't any flat asphalt available (they wouldn't let us use the basketball court), but we did manage to squeeze one of the trusses onto a bit of flat concrete below some brick vaulting with a rather large hole in it—not necessarily from collapse, but from the “recycling” of brick and stone by locals in need of building materials. The other two trusses were set up outside on grass, with corner datum lines clearly chalked out onto plywood sheets staked in the ground with bits of rebar.

We went through the method of scribing and made sure everyone was armed with a plumb bob and a pair of dividers. Since they were carpenters already, the students took to scribing very quickly, and immediately saw its benefits when using irregular and twisted timber. Workmanship ranged from average to excellent, as you might expect, and Rick and I made a point of not cutting any of the joints so as to give them the practice, except when a demonstration was required. We would stop at various points throughout the week and gather everyone around for a mini-module on subjects ranging from tool sharpening to plumbing and leveling, from peg-making to cutting scarf joints in severely twisted timber. The most frequent discussions centered on joint detailing. We talked about peg sizing, peg location, tenon sizing, dovetail sizing and relish. For the scissors braces, we chose to use the lapped dovetail, the granddaddy of joints in vernacular Romanian buildings. It would also help assembly and would be easy to cut given our tool arsenal. The majority of joints used in Gothic structures were lapped dovetails secured with oak dowels, even for members in passing joints or clearly in compression. Mortise and tenon joints (often cut quite short and not pegged) were used less frequently in old work. As in other European countries, the Romanian builder's material of choice in the Gothic period was oak, readily available in the region. Later Baroque structures made increasing use of softwoods, including larch, as oak became harder to find. Mortise and tenon joints also started to appear more often in the roof framing of the period.

The Trust's engineers were just as interested as the students in the discussions we had about joint detailing, and they were impressed by the Guild's *Joinery and Design Handbook*. They've since been turned onto the Guild Website for further reading. At some point in the future, the Transylvania Trust would like to conduct its own joint research—especially on historical joinery used in the region. The research they've done in other areas is impressive, and they were kind enough to give us both a copy of a 120-page report they compiled on historic Romanian-Hungarian roof structures, presented at the Third International Conference on Historic Structures held in



At left, ambitious oriel corner window reveals quality of masonry at Banffy Castle as well as extent of dilapidation.



At right, skillfully carved gates and doors are seen frequently in rural Romania.

Cluj in 1999. The report records and categorizes the different roof types in the country and examines how they hold up under modern engineering computer analysis. The report also includes lectures on decay and insect attack in old roofs and modern approaches to conservation and maintenance.

WEEK one ended with a nearly completed scissors roof. For our two days off, our host, Csilla Hegedus, had rented a minibus and took us on a trip around the countryside visiting various churches and timber structures, stopping over in spectacular Sighisoara. Perched beautifully on a hill, this medieval town is one of Romania's best preserved, known as the birthplace of Vlad Tepes, whose impaling exploits later became the inspiration for Bram Stoker's *Dracula*.

A highlight of the tour was getting into the roof above the church atop the hill in Sighisoara. Built in the Gothic style in oak, this roof is massive at over 17m high and one of the country's earliest at over 500 years old. We found lots of Roman numeral assembly marks in the frame, as we had with some of the log structures in the open-air museum. This was a good indication that the framing had been done on the ground before being lifted into place. We couldn't find anything resembling plumb and level marks during our limited time in the roof, but nearly every lapped dovetail we saw had a curious but beautiful curve defining the end of the dovetail. We couldn't come up with a reason for this technique, other than aesthetics, yet who but the carpenters would see it in the high roof? As we were coming back down the belfry, the bells started to ring. The sounds of the timbers groaning and creaking from the motion of the bells, combined with their ringing, was awesome.

Back at the castle, work progressed nicely, and the first roof was finished by Wednesday of the second week. Because the stone work on the gatehouse wasn't going to be ready in time, we erected the roof on the ground. This gave the students who wouldn't be back again the chance to see their work in 3D, and allowed us the chance to offer up the purlins and double-cut them into place, as some were

bowed in both directions. A trenched purlin roof on the backs of the principal rafters would have made a lot more sense with wiggly timber, but we made do with the clasped system.

After a quick group photo with the assembled roof, work began on the second roof, this time using a tie beam, collar and queen struts. This vaulting was lower, so the scissors truss wasn't required. Assistant instructor Florin led the charge and had the first truss together in about a day, using a multi-layered stacked scribe. All six elements of the truss were laid in level planes on top of one another in a total of four different layers. The other students followed suit, and by the end of our stay, we had half the second roof completed, ready for whoever would be taking the reins in the next module. (I later found out that Adam Whittle, a former co-worker from Carpenter Oak & Woodland in Wiltshire, took over the scribe instruction duties and did a great job pushing the project forward. With his help, the students finished the two other entrance roofs and also managed to complete the round bastion tower roof, which put the project ahead of schedule.)

During the second week of our stay, Rick and I were able to see a bit more of the other work going on around us. It felt like a medieval jobsite as the brick vaults were being completed and the stone carvers' work started to take shape. The last night we spent celebrating and sampling the local plum brandy, which starts to taste good after about the sixth shot. And, amazingly for a town with no paved roads, there were two dance clubs!

The entire experience was unforgettable. Not only did Rick and I learn about vernacular timberwork in Eastern Europe, we also met people doing admirable things with minimal resources. The program has recently won European awards for its conservation work, as well as the praise and support of the Prince of Wales, whose interest in historic architecture will help draw further attention to this worthy cause.

—DANIEL ADDEY-JIBB

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TIMBER FRAMING FOR BEGINNERS

IV. When the Chips Fly

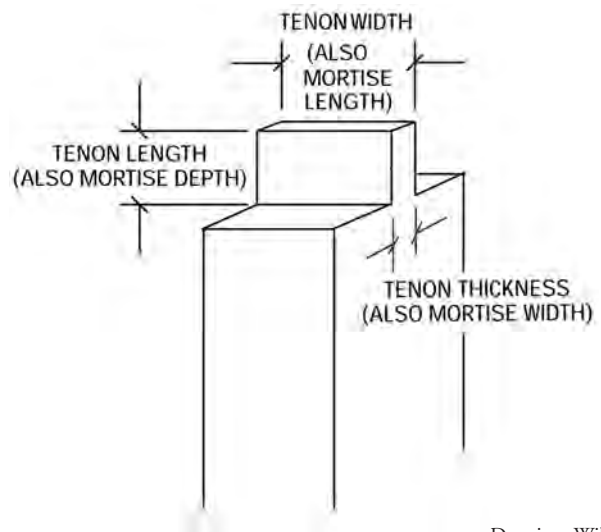
IN the last article of this series (see TF 63), we covered layout, the locating and marking of joinery. Joinery design is beyond the scope of this series, but it has been discussed in past issues of this journal (and in the Guild's *Joinery and Design Workbook*). But in both layout and cutting, the joiner must understand the nature of wood in order for the joint to be cut efficiently and perform soundly.

Wood is *anisotropic*; because of its long, thin cells and fiber bundles, it behaves differently in different orientations. Wood's directional grain affects structural characteristics as well as the way the material can be efficiently shaped. Different tools and techniques are used to make cuts appropriate to the grain.

By far the most common joint in the timber framing repertory is the mortise and tenon, and both parts of this joint should be laid out parallel to the grain. The length of a tenon should be of continuous long grain, for strength; this orientation also allows the joiner to form the wide faces, or *cheeks*, by splitting out large chunks of waste after severing the fibers at the shoulder line. Mortises should have their long dimension (as laid out on the face of the timber) running parallel to the grain and their short dimension running across the grain because this orientation weakens the mortised timber the least. It also eases the removal of material in the mortise since you have relatively less end grain to sever. Efficiently cutting joinery involves understanding the behavior of wood and applying these principles in the proper sequence.

In a timber framing company, the design or engineering office will often show the arrangement of the timbers in the frame and specify their proper sizes, leaving the joinery design to the people on the shop floor who actually do the cutting, and who often work to standard designs if their joinery is repetitive from frame to frame. Alternatively, the design office may produce shop drawings (sometimes called "stick drawings") that show all four sides of each timber in complete detail. Information about how a joint is to be cut and its finished dimensions, if not provided by a stick drawing, must be communicated on the framing plans or on the stick itself, especially in shops where one person may lay out the joinery and another will actually cut the piece. But even if the layout and cutting are to be done by the same person, it's helpful to make certain notations on the timber to denote different depths, angles, and the like, especially if there are a lot of different joints on the same timber.

MARKING. Let's look at various marking conventions used by layout people to communicate joint dimensions to the cutting crew. First, we should agree on some definitions. A tenon has length, width and thickness, while mortises and housings have depth, length and width. The length of the tenon corresponds to the depth of the mortise, the width of the tenon to the length of the mortise and the thickness of the tenon to the width of the mortise (Fig. 1). One way to specify how a joint is to be cut is with joinery bubbles or "takeouts" shown on the plans or elevations (Fig. 2). Here we see indicated the location of the mortise and the tenon from the layout face; only one number will be given if the lay-



Drawings Will Beemer

FIG. 1. TERMS OF DISCUSSION FOR MORTISE AND TENON WORK.

out faces of both timbers are flush (in plane) to each other. The next number down indicates the depth of the housing or gain. In the lowest part of the bubble are shown the mortise width and depth; tenons will correspond, respectively, in thickness and in length, except that there must be clearance between the end of the tenon and the bottom of the mortise. Shops will typically cut the tenon $\frac{1}{8}$ to $\frac{1}{4}$ in. shorter than nominal, or make the mortise that much deeper, to prevent the tenon from bottoming out and to allow for shrinkage of the mortised piece. Tenon width (mortise length) usually need not be specified as it's normally the full width or depth of the

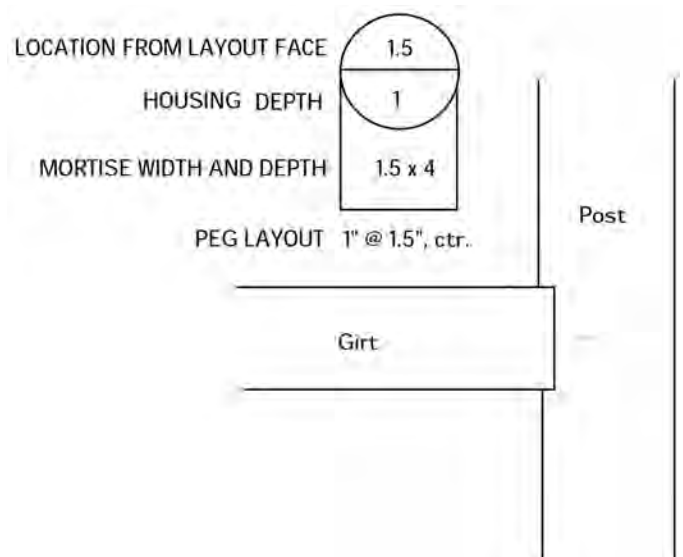


FIG. 2. JOINERY "TAKEOUT" FOR STANDARD DESIGN.

tenoned timber where it meets the mortised member. But tenon width may be reduced in some cases, such as where sill timbers meet in a corner. A full-width tenon here would require an open mortise on the end of one timber, exposing the tenon edge and end, and depriving the joint of mechanical strength apart from its peg. Stopping the mortise a few inches in from the end of its timber provides some relish and protects the joint. Reduced-width tenons require shoulders on three or four sides, more difficult to cut than two.

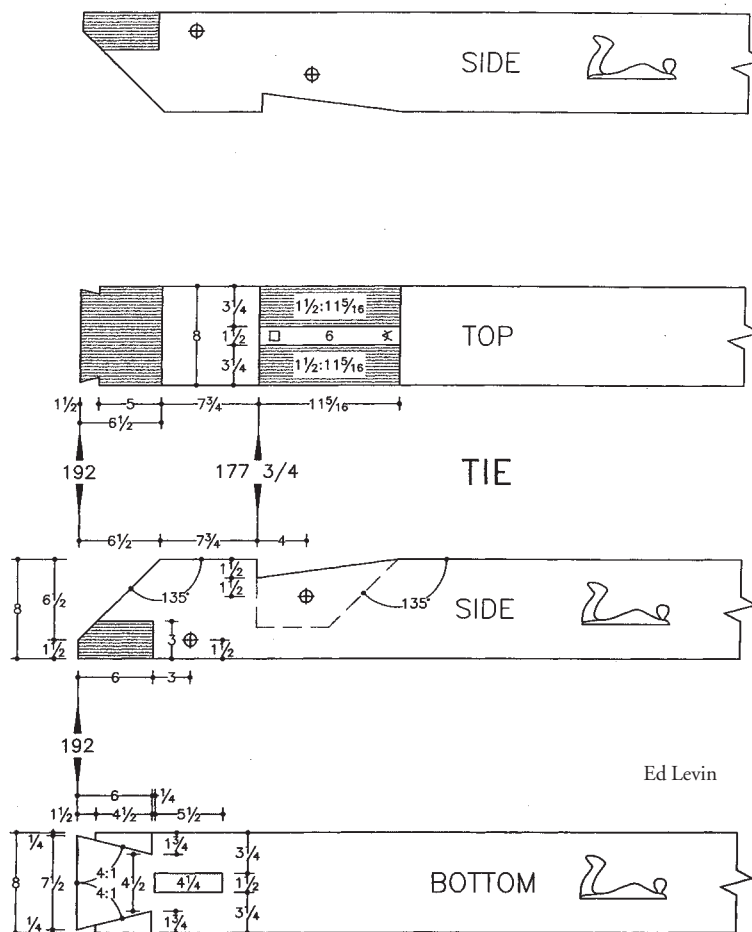


FIG. 3. DETAIL OF FULLY SPECIFIED STICK DRAWING FOR SPECIALIZED JOINERY DESIGN.

Stick drawings will include all the information necessary to cut the joinery, and the symbols used can also be applied to the timber itself during layout to aid in cutting. In Fig. 3, we see one end of a tie beam drawn in all four face views. On three of the views we see the icon of a steel plane, indicating a visible surface (that hence may need to be finish planed). In the top view we see the housing and mortise for the principal rafter foot. The large black dimension arrow at $177 \frac{3}{4}$ in. shows the control point (or station) that locates the joint with respect to one end of the timber. The shaded areas in the top view shows that the diminished haunch in the housing, as well as most of the end cut, are sloping surfaces relative to the viewer; the housing is the full width of the timber and is $1 \frac{1}{2}$ in. at its deepest by $11 \frac{5}{16}$ in. long. The number between the mortise lines indicates a depth of 6 in. as measured from the original surface, and the square at one end of the mortise shows the bearing end is to be cut at 90 degrees to the face, the norm in mortises, while the symbol at the other end tells the joiner to slope that end of the mortise. The pitch is given in elevation on the side view beneath. (Mortises with one end sloped to accommodate the entry of an angled piece such as a brace or rafter are called *chase* mortises; in all but the most refined work, chases are avoided in favor of square ends.) All other dimensions necessary to cut the timber are given, including peg layout.

Carpenters have their own systems for marking what is to be cut and how. In the US, we often use a large X to indicate the waste side of a cut line. In France it's the opposite: X means "leave this piece" and O shows what to take away when cutting a tenon. The French use closely spaced diagonal lines (hatching) to indicate a mortise. No matter what system you use, try to make it logical and consistent. One rule I always follow during layout is to use solid pencil lines only for lines that are to be cut; other lines are lightly dashed and dimensions are indicated by tick marks. Once layout is complete, a different timber framer ought to be able to come to that timber and know how to cut it by looking at the markings.

Where on a timber you start layout does not make much difference. Some workers cut one end first to get a clean shoulder from which to lay out the rest of the joinery, but defects in the timber will often require a start elsewhere. I prefer to lay out the entire stick before cutting, so I can spot the defects that conflict with joinery, giving me a chance to move things. As a rule of thumb, cut the most difficult joinery first. If you make a mistake or aren't happy with the results, you still may have a chance to remark the stick or get another before you have spent a lot of time on it. Don't make both end cuts first; by leaving one end long for a while, you may also have a way to save the stick if you make an error.

Ideally, your layout has avoided most knots and other defects that may cause you difficulty or cause the wood to behave unpredictably when you start cutting. A proper cutting sequence starts by severing the long wood fibers to a certain depth, by crosscutting with a saw or chisel or by drilling, and continues by splitting out large hunks of wood parallel to the grain to the cross-cut depth. Certain tools do this more easily than others, and some even combine the crosscutting and splitting operations in one go (see my article on tools in TF 61). Here, I'm just going to discuss simple and traditional methods with tools commonly available to most timber framers.

Proper setup for cutting is important for accuracy, comfort and safety. Since it's a natural tendency to drill plumb, your timber supports should be set level and not follow sloping ground. If you are going to be climbing onto the timber to ride a hand-operated boring machine, you may want to use low sawhorses (28 in. tall works best for me). Some framers like to work their timbers on the ground for drilling operations. In any case, make sure you are in a comfortable stance, not off balance, when using power tools, and be sure that the timber is well supported so it can't fall unexpectedly.

In general, you will probably start by cutting one end of a timber. If this surface is to be the end of a tenon, the cut does not have to be perfect. You may cut all your tenons a bit short anyway to keep them from bottoming out in the mortise. But if a mortise lies near the end of a timber, you should finish the mortise before making the timber end cut to avoid risk of blowout while you work on the mortise. Always be aware which sides of the timber will be visible so that you can take extra care while cutting a joint on an exposed face.

When cutting the end of a timber, if a large or long piece of waste is going to be released, make sure that it's supported or that someone is ready to catch it to avoid torn grain as the piece pulls away under its own weight. When catching a waste piece, keep your feet out from under the fall line and direct the weight down and away from the sawyer as the cut is completed to keep the offcut from binding the sawblade.

TENONS. After making the end cut on the timber, crosscut the shoulder line down to the cheek of the tenon. Start on the layout surface side of the tenon and finish this side before rolling the timber. This face of the tenon is parallel to the layout face and offset a standard distance, usually $1 \frac{1}{2}$ in. or 2 in. (See my "Introduction to Layout" in TF 63.) The shoulder can thus be cut with a circular saw set to this depth; accuracy now becomes very important since the shoulder-to-shoulder length of the timber is a critical

dimension in the structure. Some workers think it's safer to keep the circular saw away from the shoulder line $\frac{1}{16}$ in. or more and then pare down to the line. But, if you've got hundreds of shoulders to cut, you'll soon learn to cut accurately enough to make the first shoulder cut the finished one.



Photos Will Beemer

Starting a shoulder cut on the arris of the timber.

Here are a few tips for cutting accurately with a saw. Novices can often make a better cut with a hand saw than a portable circular saw; because the former is slower, you have more time to correct any error as you go. One rule with any saw is not to cut a line you can't see. Start at the arris on the far side of the timber as shown above, and place the saw just to the waste side of the pencil line. Saw teeth are bent slightly outward from the body, or *set*, alternating left and right, so that the *kerf* or groove the saw makes is wider than the body of the saw, thus allowing the saw to drop through the cut.

You want those teeth whose set is toward the pencil line to remove about half of it, so most of the saw should be outside the line. Draw backward lightly on the saw to get it started at the corner, using your thumb as a fence to keep the saw from jumping around. By starting at the corner, you remove only a small amount of wood, and the cutting is easy as you get the kerf started. Don't try to cut across the whole face of the piece at once at the beginning. As you cut, lower the handle of the saw to cut across the top face without



Saw only the lines you can see.

going down the far side, which you can't see. When you reach the upper corner nearer you, keep to the line you have just made across the top as you saw down the vertical line facing you.

Once you reach the depth on the front, you will have made half the desired cut. To continue cutting down the back vertical line, stop and go around to the other side of the timber in order to watch that line as you cut it. The kerf you made on the first side will help guide your saw. Simply by seeing what you are doing and paying attention, you can cut very accurately instead of hoping that the saw is cutting true on a blind side. Of course, all this advice assumes that your saw is correctly sharpened and set.

Some workers prefer to lay out with a knife rather than a pencil. The saw is then kept entirely on the waste side of the knifed line.

The main advantage of a portable electric circular saw is that it's much quicker, and experienced timber framers can be just as accurate as with a hand saw. The saw kerf is wider (usually about $\frac{1}{8}$ in.) than with a hand saw, but otherwise the principle of leaving half the pencil line is the same. In the case of a knifed line, the saw cuts exactly to the line.



Shoulder cut is finished from the other side of the timber.

Once the critical shoulder cut on the reference surface is made, then you can remove the rest of the waste above the cheek of the tenon a number of ways. If the tenon is large, or if there is a great depth of material to remove, an axe can be used efficiently for the bulk of it. If there is a knot or wild grain involved, you could take a rip saw or circular saw to cut along the cheek line. (The difference between crosscut and rip handsaws is explained in TF 63.)

Ripping the tenon cheeks with a circular saw, a routine technique used by experienced joiners, requires placing the plate of your saw on the end grain of the timber to execute a dive (or drop) cut. Make sure your sawblade is square to the plate, set the depth of cut nearly to the length of the tenon and then cut downhill, using gravity as an aid and keeping the blade on the waste side of the line. To cut the other cheek, you may find it easiest to roll the timber 180 degrees. When one cheek has already been removed, as in the photo on the facing page, the plate of the saw is not fully supported and you'll have to be extra careful to cut square.

One warning: holding the saw up high to start the cut is often awkward and hence unsafe. Lower the timber to a height you're comfortable with and use a familiar saw when making this cut. Being comfortable and balanced improves your accuracy as well as your safety. Some people using circular saws prefer to cut tenon cheeks upward, or to roll the timber once and then cut horizontally. Such techniques, if more laborious, may offer better control.



The dive or drop cut is an efficient method to remove waste in one step.



In straight grain, most waste can be quickly removed with a chisel.

A second caution: if you have the habit of starting a cut with the blade guard raised, always be aware of where the saw cord is and keep clothing and tool belts way from the blade. If you're starting high, the blade may be somewhere in the vicinity of your armpit.

In most cases, the full depth of cut of the sawblade will not be enough to reach all the way to the tenon shoulder. This limitation has the advantage of keeping the end of the workpiece intact for the second cheek cut, but it does require a technique to remove the partly severed waste from both cheeks. Sharply striking the end grain or prying in the saw kerf will snap off the waste piece if the grain is straight. If the grain isn't straight, it's quick work to dice up and chip away the material remaining toward the shoulder.

Another method of cutting tenon cheeks is to crosscut multiple kerfs parallel to the shoulder, $\frac{1}{4}$ in. to $\frac{1}{2}$ in. apart, with a circular saw set to the depth of the cheek. The material left will chisel off easily. Note that if the face of the timber is not square to a reference face, this depth will be different on each side, and the saw should be set to the shallower depth. If the wood is clear, the tenon small or there are only a few inches of material to remove, I just use my chisel, since I'll soon be using it anyway to pare the tenon to its finished dimensions. (After some years of practice, economy of movement becomes very important to a timber framer; it becomes habitual to perform all similar operations on a given timber face before changing tools.)



Kerfing the waste on a tenon cheek. Many kerfs make for easy chipping.

To use the chisel, place it bevel side down at an angle across a corner on the end grain of the waste to be removed. Since you've severed the grain at the shoulder, driving in the chisel should remove a chunk of wood all the way to the shoulder cut. But now look at the way the grain slopes. If it rises toward the shoulder, you can be pretty confident you can continue to remove material without splitting down into the tenon. If the grain goes down, you'll have to be more careful and switch directions, or go cross-grain, or start paring as you get close to the tenon cheek. As you remove large pieces, each time go halfway down to the cheek line; when you get to within $\frac{1}{8}$ in. of the line, you can start paring.

Orient your chisel according to what you want to accomplish with it. To remove a large amount of material, go bevel down and strike the chisel with your mallet. Placing the bevel down causes the chisel to rise up in the cut or keeps it from diving down into the material. (But when it comes time to pare or finely trim the surface, flip the chisel over so its flat bottom acts as a guide.)



First step in trimming the cheek is to establish the edges.

To pare the tenon to its finished surface, chamfer the edges of the tenon down to the cheek line, again leaving half the line. This chamfering removes just a bit of material at a time, so you have more control in getting the perimeter of the tenon perfect. Then you can work the main part of the tenon, staying away from the finished edges and using the chamfer as a guide for depth. Be careful not to push your chisel all the way across the tenon; you could tear out the

other side and lose your cheek line. Always work from the edges in toward the center. When paring, keep both hands behind the cutting edge by gripping the blade with the forward hand and using it to brace against the side of the timber as you steer and push with the rear hand on the end of the handle.



Cross-grain paring levels the surface between the prepared edges.

For finer shavings, try a slicing cut by pivoting the chisel in your forward hand as you push with the rear hand. For more aggressive action (but less control), move both hands to the end of the handle. Avoid letting your forward hand move out in front to hold the timber; if you're having to push so hard that the timber is moving, you probably need to sharpen your chisel. You can also trim tenon cheeks with a hand plane (though it must be a rabbet plane to work right up to a tenon shoulder) or with a slick if it's a very large tenon or a scarf joint.



Bench rabbet plane will work the cheek right up to the shoulder (and will trim the shoulder square if necessary).

Check the cheek surface with your square(s) to verify its finished distance down from the reference face, and then you can flip the timber over and finish the other cheek of the tenon in the same way. Once the cheeks are finished and you no longer need the working lines on the edges, you can trim the tenon to width if required.

How tight should a finished mortise and tenon joint be? Both the mortise and tenon will shrink somewhat, but it's hard to predict



Checking for flat across the cheek.

how much or if it will be the same amount. Too tight a fit can cause a joint to split during assembly, raising or seasoning; too loose is, well, sloppy, and can result in stepped surfaces where timbers should be flush. Meanwhile, plenty of clearance is helpful and sometimes essential during raising when many joints must be made up at once.



Tenon thickness checker made from cut-down framing squares and adjustable for 1½-in. and 2-in. tenons. Temporary checker can be made from full-size squares clamped by stair gauge fixtures.

You should strive for a perfect, sliding fit at least over the last inch or two as the joint is pulled together. After the two cheeks of the tenon are finished, it should be checked for thickness, then tapered. A tenon checker can be made from ¼-in. plywood with a very accurate slot cut out to slip over the tenon; or a mock mortise, long enough to clear the widest tenon on the job, can be fabricated in dry hardwood. You can also join together two steel framing squares (aluminum ones are too thick) with stair gauges, the buttons that clamp onto squares for stair layout. Once the tenon is trimmed to thickness, you can taper the outer end of it ⅛ in. on all sides except the bearing surface (if there is one). This taper allows the tenon to slip into the mortise easily during assembly, but do keep the last 1½ to 2 in. toward the shoulder at full thickness so the joint snugs up nicely. As a last refinement, chamfer lightly the edges that will first enter the mortise, so a chip isn't pulled up if a corner catches.



Chamfering the tenon arris for easy assembly.

PEGGING is the subject of lively debate among timber framers. Some workers drawbore the joints, offsetting the holes in the mortise and tenon slightly to cause the joint to draw up tight; others avoid drawboring. If drawboring, it's foolproof to assemble the bents and walls with the mortises bored for pegs, lightly prick the tenons with the drill bit, then take the assembly apart and drill a hole in the tenon slightly offset toward the shoulder. This is a lot of work, however, and I usually prefer to pre-drill the tenon, locating the hole by measure, right after I've finished cutting it. The principle of drawboring is the same, however, and worthy of serious consideration since it's well established by tradition and intrigues so many people new to the craft.

Drawboring causes the peg to bend slightly as it goes through the tenon, pulling the joint tight as it is driven through. As the timbers shrink, the peg then acts as a spring to keep the joint tight. Assemblies pulled together with comealongs and then drilled without drawboring will never get any tighter, and the joints are free to open up with shrinkage of the mortised piece. To achieve a kind of drawbore without taking the assembly apart, some framers put the drill bit in the pre-bored mortised timber and "point to the joint" as they drill through the tenon from each side. This technique may work satisfactorily as long as the drill bit is pulled back before it creates much of a hole in the mortise wall beyond the tenon. When driven,



To draw and keep a simple mortise and tenon joint together, the peg hole for the tenon is deliberately offset toward the shoulder of the joint.

the peg has to be able to make the turn back into the pre-bored hole in the far-side mortise wall without being sidetracked.

Pegs for any kind of drawboring are heavily tapered so the point can catch the far-side hole after diversion by the offset hole in the tenon. While some peg holes are blind for aesthetic or other reasons, most are bored right through to allow the tapered end of a peg to be driven far enough to yield full or nearly full diameter at the exit side.

Sometimes a drawbored peg hole should be offset in two directions, for example in sloped members such as braces and rafters. One way to think about it is to visualize which ways you want the mortised timber to be drawn, and then offset the hole in the tenon in the resultant direction, as in Fig. 4 below.

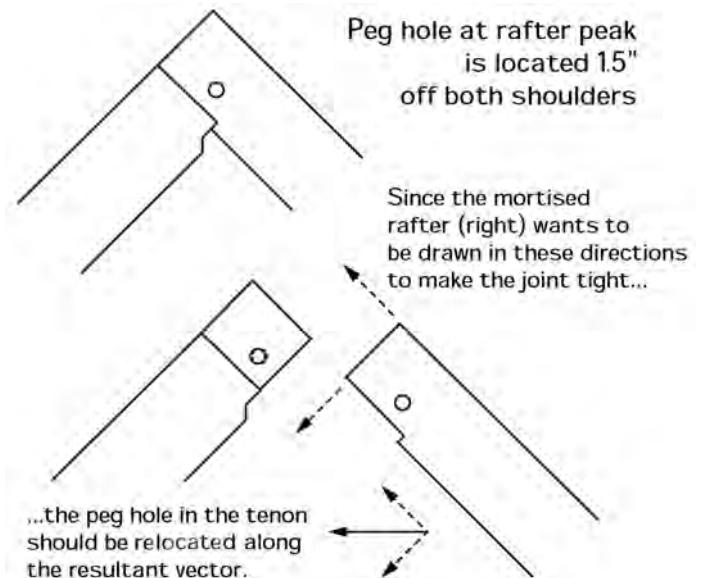


FIG. 4. RELOCATING THE PEG HOLE FOR A COMPOUND DRAWBORE.



Framing square yields traditional peg center distances from shoulder.

I measure for the peg layout and drawbore using the framing square. Traditionally, peg holes in American square rule layout are centered 1½ in. or 2 in. from the shoulder of the joint. The amount of offset for the drawbore in softwoods should be a heavy ⅛ in. for ¾-in. pegs, less (a scant ⅛ in.) for 1-in. pegs, which can't bend as much. Tenons with lots of relish beyond the peg hole (more than 3 in.) can be drawbored more than shorter tenons. Hardwoods should be drawbored a bit less than softwoods.

MORTISES. A little New England ditty goes: “Sawr it, score it, bore it.” In square rule joinery, or if the tenoned member carries significant load, there will typically be a *housing* or *gain* flanking the mortise. This housing is normally the same length as the mortise. If you started by boring the mortise, you could tear out the grain beyond the housing line. It’s a good idea, then, to cut the top and bottom housing shoulder lines first, sawing or chiseling down to the housing depth. After that, score the sides of the mortise with your chisel to give yourself clean edges. Then you’re ready to bore out the mortise and finish it completely before attacking the housing.



First steps for a housed mortise are to sever the ends and score the sides.

The mortise is cut first for a couple of reasons: you need a good surface to bear on when checking its depth and squareness (the housing surface may be sloped or hollowed out a bit—more on this later) and you also need a surface to rest your boring tool on. If you’re boring into a surface that you know is square to the reference planes of the building, the sides of the mortise should be perpendicular to it if the tenoned piece is coming in normally. You can set a portable boring or mortising machine with a base right on that surface and it will drill plumb. If you’re using an electric drill, you can also set up a guide and a depth stop on this surface. A nonreference surface, however, may not be square, and you should be aware of the need to shim or guide the boring tool so that it forms the walls of the mortise properly.



Drilling out for a mortise using aids to keep square to good top surface.

When roughing out the mortise with a round bit, you’re following the principle of severing the grain so you can remove the rest of the material easily. Thus you should drill a hole at each end of the mortise (with a bit the same diameter as the mortise or slightly smaller), and then fill in with other holes if you can. If you are using auger bits, don’t overlap your holes too much, since the bit will want to wander into a previous hole; with an antique hand-cranked boring machine this could actually crack the cast housing.

Chain mortisers (or Forstner-type bits in a drill) can overlap holes with no problem, but you should still do the mortise ends first to make them clean and precise. *Through-mortises*, which go all the way through a timber, should be worked halfway from each side. If you’re using an electric drill, make sure it’s heavy-duty, low-speed and rated to take the bit diameter you’re using. While most of us probably started our careers mortising with portable drills, the advantages of powered mortisers or boring machines are overwhelming. Although drills are affordable, they must be constantly guided for plumb, may require frequent removal for chip cleanout and can take you for a ride if they get stuck.



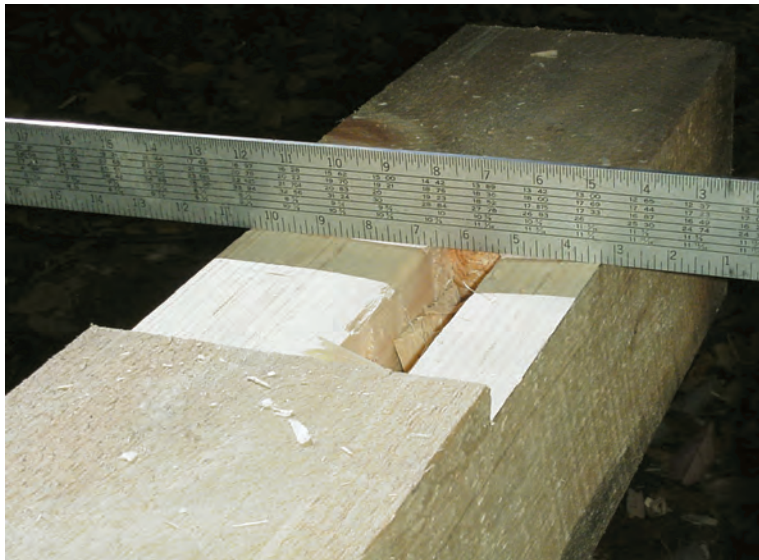
Squaring up the end of the mortise after boring out waste. Full depth is achieved incrementally by alternating between mortise ends and sides.

Chain and chisel mortisers give you a clean hole requiring little clean-up. If you’re using an auger bit in a hand or power tool, you’ll have to square up the holes with your chisel. Using your mallet, drive the chisel down the ends of the mortise (bevel toward the inside of the mortise), severing the grain, then set the mallet down and, using hand power and a little upper body weight, pare down the sides. Alternate between cutting the end grain and paring down to the depth you’ve severed the grain, always keeping the bevel toward the inside of the mortise. This is where having your timber level becomes important, because the tendency is to cut plumb and, when positioning the long framing chisel for a cut, it’s possible to judge that it’s standing plumb. If the chisel gets stuck, pry it firmly back toward the center of the mortise; don’t use the side or end of the mortise as a fulcrum or you’ll crush it. If the sides of the mortise flare out a little bit ($\frac{1}{16}$ to $\frac{1}{8}$ in.), it’s not a catastrophe, but remember that the tenon is already tapered, bearing surfaces must have full contact and thus shouldn’t be tapered, and any extra material you’re removing from the mortise only weakens the timber. (This last point can be an argument against setting the chain mortiser extra deep to clear the curve of the bar.) Since most mortises are either $1\frac{1}{2}$ in. or 2 in. wide, you can use the blade or tongue of your framing square as a go, no-go gauge to check for width. To make sure the sides and ends of the mortise are plumb, use your combination

square on the surface (if it's the reference face or square to it) or "in combination" with the framing square set to the reference face.



Checking for plumb mortise sides when top surface is not square to adjacent reference surface.



Hollowed housing helps keep joint looking tight after seasoning, which tends to reshape timber back to round.



Removing housing waste with an axe.

When the mortise is completely done, you can cut the housing. Remove material with successive dicing cuts of a circular saw followed by a chisel or plane, or even an axe, or use a router (perhaps with a guide template), but beware of any difference in depth across the housing in case the original surface is not a reference. Pare down the housing to finish it using the same techniques as shaping a tenon, carefully establishing your lines at the edges of the timber and using them to guide the removal of the larger amount of material inside the housing. On large housings, you can hollow out the face so that you keep a good, tight meeting at the visible surfaces. (When green, boxed-heart timber dries, the outside shrinks the most.)



Peg hole drilling plumb, with timber on its side. Some workers find it easier to hold the long drill level, with the timber right-way-up and the mortise in view.

Drilling the peg hole can be done as the last operation in mortising, allowing you to re-plumb or re-level the drill on a second mark after it goes through the first wall of the mortise. (But some workers prefer to drill the peg hole as the first operation so they don't get any tearout in the finished mortise.) Because the mortise and tenon joint is often closer to one timber face than the other, you will usually drill from that face to minimize any drift off your measured point before you reach the mortise. Watch for the feed screw of the bit when it exits the other side and pull back on the drill so as not to blow out the grain. Withdraw the bit and finish the hole from the other side. Except for this final step, peg holes should be drilled all from one side to ensure that they're straight.

There are lots of other tools and techniques for shaping and finishing timbers. Here we have discussed only the common methods and tools to cut the basic mortise and tenon, of which most other timber frame joinery is a variation. For books with more tips and techniques on cutting joinery, see Tedd Benson with James Gruber, *Building the Timber Frame House* (Charles Scribner's Sons, New York, 1980) as well as Jack Sobon's *Timber Frame Construction*, (Garden Way, Pownal, Vt., 1984) and *Build a Classic Timber Frame Home* (Garden Way, 1993). Magazine articles offering help with cutting include Ed Levin's "Tools for Timber Framing" in *Fine Homebuilding* 4 and Tedd Benson's "An Introduction to Timber Framing" in *Fine Homebuilding* 12, both reprinted in *Timber-Frame Houses* (Taunton Press, Newtown, Ct., 1992).

—WILL BEEMER
Will Beemer is co-executive director of the Guild in charge of workshops.

Kenozero and Timber Buildings in Northwest Russia



The isolated rural landscape at Kenozero in northwest Russia. Motor vehicles play a minor role.

Photos Jan Lewandoski

IN late September, I traveled to the Archangel District of northwest Russia for the ICOMOS International Wood Committee Annual Symposium at Kenozero. Kenozero (*ozero* is the Russian for lake) is a large body of water surrounded by an ancient and largely intact cultural landscape. ICOMOS is the International Council on Monuments and Sites, affiliated with the United Nations Educational, Scientific and Cultural Organization, the sponsor of this meeting. I traveled to Kenozero with 36 other wood conservation specialists from around the world to determine whether the cultural landscape around the lake was eligible to be designated as a UNESCO World Heritage Site. The group was long on historical architects from Russia, England, Scandinavia and Japan, but also included wood technologists from England and Italy, a chief preservation carpenter from Parks Canada and an icon restorer from Cyprus. Kenozero is not easy to get to, and I think that all of us would agree to the use of the word “suffering” to describe some of our travel experiences.

Imagine a 100-sq.-mile lake situated in rolling, forested hills, near the Arctic Circle but blessed with a climate no more severe than central Quebec. Around this lake lie subsistence farming settlements of great antiquity, perhaps originating in the 11th century and today still composed entirely of log structures dating from the 16th to the 20th centuries. Serfdom never reached here; the people were free peasants, and the land, of which there was a great abundance, was owned by the community. War never reached here, and the temperatures are such that wood can rot only during a few months of the year, leaving historic buildings largely intact. The lake is full of islands and peninsulas, almost every one supporting a tiny village of seven to 20 farmsteads, with pasturage, grain fields and vegetable gardens. Horses and dairy cows are everywhere and not fenced.

Each household grows cabbages, cucumbers, potatoes and other root crops. There are no fruit trees, not even apples, but the forest is full of mushrooms and lingonberries, which are eaten in great quantities. The lake is full of fish, and thousands of square miles of uninhabited forest, full of game, surround it. The residents have succeeded in reconciling their devout Russian Orthodox Christianity with a pre-Christian nature religion, in a beautiful way. Soviet Communism reached here briefly, then went away, its large sawmill and collective farm falling to ruins among the still robust buildings of earlier centuries. Travel is by footpath and boat. Though a gravel road reaches a few of the larger lakeside villages, the personal car is unknown; there are a few motorcycles, trucks and tractors. This sounds like an idyllic setting, but the people are running away from it as fast as they can, seduced by the appeal of paying jobs, shopping malls and education. In the past 20 years the population has dropped from 6000 to around 2000 souls and, as it gets smaller, a sort of cultural critical mass is lost, making it even less appealing for young persons to stay.

WE were there to look at historic wooden buildings, and there were plenty, almost all log-built, with rarely a mortise or tenon to be seen. Typical of what I have seen previously in northern Russia, the logs are round on the exterior and hewn flat on the interior. An old form we see all over the US, the house-barn combination, is common there, as are detached barns and smaller outbuildings and plenty of *banya*, or saunas. Most remarkable is the great number of churches and chapels; even the smallest village supports one. Around the lake are 12 churches and 35 chapels. The churches are larger, contain altars and occasionally enjoy visits by priests. The chapels are smaller (one is so small that it holds only one kneeling person), lack altars and do not offer sacra-



Scots pine may be 300 years old. Trees grow slowly at these latitudes.

ments performed by priests, but rather encourage the unmediated conversation between the believer and God. The chapels are also the focus of the sacrificial offerings of embroidered tea towels; some chapels contain hundreds.

The construction of chapels was discouraged by the Orthodox Church, but they proliferated at Kenozero. To make them more interesting, most of the chapels are located in sacred groves, impressive and distinct copses of ancient trees, where pre-Christian, nature-centered religion was once practiced. I don't believe that any of the trees in the sacred groves I visited predates the arrival of Christianity, but some may be 300 years old and the groves have a longer contin-



Sacred groves frequently contain small chapels.

uous life than any individual tree. The other pagan influence, pervasive over a large part of the globe, is Classicism. Greek and Roman architectural motifs show up even at this sub-Arctic lake, mixed in with onion-shaped domes and the vernacular detailing of the local carpenters.

KENOZERO is a wooden world. Trees grow better here than any other crop, but it is so far north that very few species are present: two of spruce, both looking like what we call Norway; the pine we call Scots (growing as a beautiful, straight tree); and two poplars, white birch, alder, mountain ash, willow and a lit-

Small farmsteads fit the landscape and, together with forestland, produce most of what is consumed by the populace. Open meadow and pasture surround the farmsteads; a chapel is often nearby.



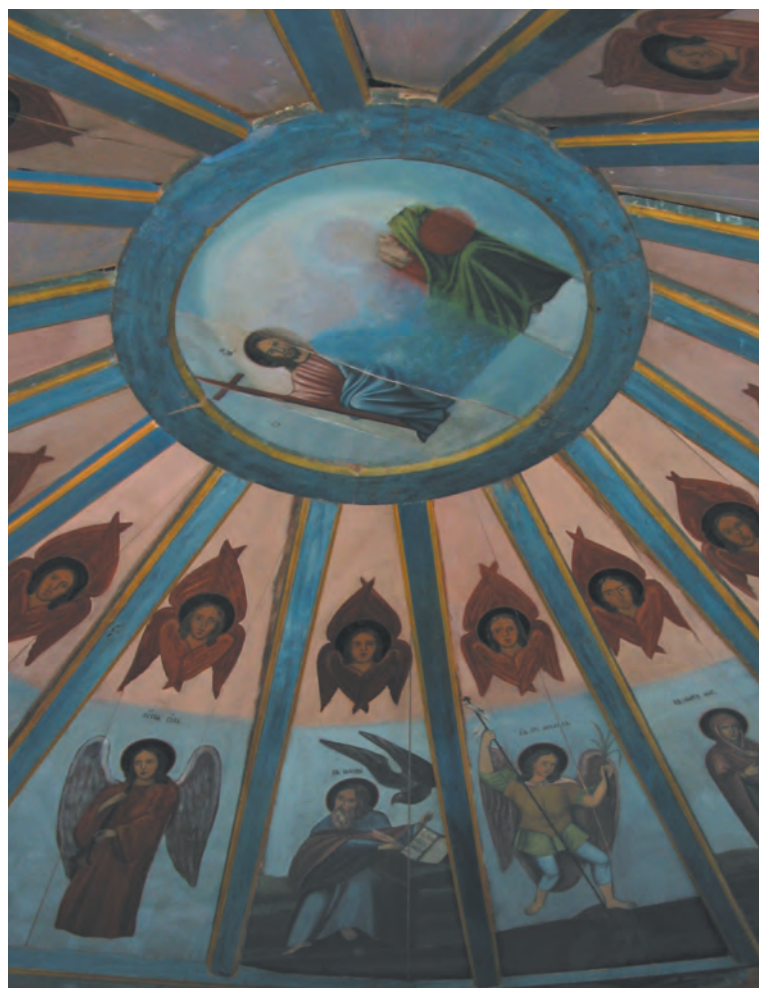
Sunset at Filipovskaya puts a rosy glow on the octagonal Church of Christ's Holy Tree. So-called tent-roof is covered by six double-courses of riven boards made concave across the grain and laid hollow-up. Photo below, superb painted ceiling in a chapel. Painted wooden panels are joined up of boards restrained by concealed cross-grain dove-tailed battens. Photo below right, the 19th-century Chapel of St. Andrew, quite near the edge of the lake. Chapels with semi-engaged porches, small octagonal towers and onion domes are a regular feature of the landscape, usually found in the company of old trees.



tle bit of larch. Almost all construction is of spruce and pine, and they are also the dominant trees in the sacred groves, where they often approach 100 ft. in height. Some of the experts on this trip (myself included) were partly engaged in tree tourism. Brian Rid-

out, a well-known British wood technologist, was there particularly trying to track down the factors in what he assured me is the scientifically verified resistance to rot found in pine grown slowly or at far northern latitudes.

We toured the lake largely by boat, studying the landscape and visiting log churches. The landscape and the buildings seemed perfectly integrated: little log farmsteads (photo previous page) surrounded by fenced-in gardens and open meadow and pasture, with a chapel, on a small prominence usually among some old trees, always in view. The chapels were often smaller than the houses. They were also architecturally distinct, with steeply pitched roofs,



Jacking the Church of Christ's Holy Tree in Filipovskaya. A dozen jacking rigs surround the building and can lift it entire to allow the removal of logs. Below right, detail of the jacking rig showing refined clamping system of bolt pairs and steel angle, as well as rollers to allow easy movement of the upper (moving) half of the system. Hydraulic jack, leaving fluid behind, has been removed after upper tube has been safely pinned in place.



onion domes, spires and crosses. Under the Classical influence, the plan of some of these chapels was not unlike that of an Asher Benjamin church in New England: a gable-roofed structure with semi-engaged porch that carries a square or octagonal tower, with a telescoping octagonal colonnade rising from it, capped with spire or dome (photo facing page). One of the few places I observed mortise and tenon timber work was in the tenoning of the telescoping belfry columns into sleepers concealed within the towers.

Larger churches, however, were particularly Russian in inspiration, with tall, stacked octagons of logs crowned by multiple onion-shaped forms or a wide spire called a tent roof. Even the spires were usually built of horizontal logs, sheathed in vertical boards.

Inside many of the churches and chapels were so-called sky ceilings: joined-up, large-scale wood paneling producing a sort of pointed dome over the entire interior (photo facing page). The panels were painted with religious scenes and figures. The painting was polychrome, iconic and probably done professionally by itinerant artists of great skill, judging by their ability to produce a spiritual impact and to get paint to adhere to wood for hundreds of years. Tapered, dovetail-slotted battens were fitted across the grain on the backs of the boards to restrain each wedge-shaped panel.

Norwegian preservation organizations have been helping with the work on some of the structures at Kenozero, and, with their Russian colleagues, have pioneered some techniques to deal with the difficulties of changing entire logs in large buildings. When we visited the Church of Christ's Holy Tree, built at Filipovskaya in 1700, its lower logs were being replaced. A dozen steel-tube jacking rigs stood upright on flanged bases, surrounding the church. Each rig used a central square-tube post with a pair of short, slightly larger square tubes able to slide over it; all three tubes were drilled for the locating pins hanging on light chain attached to the movable tubes. Welded I-beam brackets projected from the short tubes to permit hydraulic jacks to spread the tubes apart. The upper tubes were bolted via welded flanges to the log walls at desired points while the lower tubes could be slid up to them and pinned in place to provide jacking platforms. With sufficient purchase to lift the entire church,





Russian logbuilders preparing corner notches for replacement logs at the Church of Christ's Holy Tree in Filipovskaya. Axe is used to remove nearly all the waste after kerfing with chainsaw. In a separate operation, logs are full-scribed in length on their lower surfaces.

the jacks could make enough space to change a log or a course of logs anywhere on the building. In fact, an entire course of good logs had already been removed to be used as a pattern, and a crew of young Russian axemen were recreating the bottom four courses in

the yard next to the church before installing them in the correct order. Their technique for producing the notches required few tools: axe, hollow adze, scribing dividers, drawknife, inshave and chainsaw. First they laid out the shape and diameter any given log



Completed corner notch housing tools of the trade except for the timesaving chainsaw. Bluestain in pine appears to be a problem even at far northern latitudes.

Reportedly the longest wooden bridge in Russia, some two hours' drive from Kenozero, with five spans totaling 300 ft. Log-cribbed piers, cutwaters and abutments are filled with boulders. The deep beams visible on the longest spans are modern glulam timber.



should have at its corner notch, then reduced the log to that diameter in the area of the notch, using an axe. They then scribed the shape of the notch itself, cut to its depth several times with a chainsaw and then cleaned and shaped it with the axe (mostly) and adze. Meanwhile, each log was also full-scribed to fit the one below by hollowing the length of its bottom side into a v-notch whose walls neatly fitted the contour of the log below. This joint was then packed with moss before assembly.

Preservation work carried out at Kenozero to date seems to be more replacement in kind than preservation of the maximum historic fabric (to use the academic terms). Perhaps the idea is that if one goes to all the trouble to rig and partially dismantle a log building, one ought to change every log that has a problem. Since most logs in these buildings have a large measure of excess capacity, there is no structural justification for this approach, and sometimes a chapel presented as 18th century looked distressingly new, though the quality and historic faithfulness of the work were high.

Pains are taken to use historic systems such as birch-bark flashing, but it's possible that no real masters of this art exist any more. Bell decks I examined in several churches had two layers of a sort of grooved boarding that was expected to divert water to the eaves, but generally they were not detailed correctly to do so. Likewise, the birch-bark flashing where belfry posts penetrated floor levels appeared little more than collars, not able to stop moisture running down the posts into the mortises in the supporting sleepers. Historic flashing systems, without lead or other metal, undoubtedly existed everywhere in the world, and I have seen successful surviving examples, but little is known of them today, in Russia or elsewhere.

Almost all roofs I saw were boarded, not shingled. Envision perfect boards pried off a log along the growth rings. The boards will retain some degree of cross-grain curvature from their position in the log. (Some readers may remember the Finnish preservationist Maia Kairamo's presentation at the 1999 Auburn, N.Y., TTRAG conference.) Then envision adzing or planing these boards until

they have a pronounced concave section, and, finally, double-boarding the roof with all the hollows upward. The good condition of the painted sky ceilings indicates that this technique has worked well over the long haul.

THE wooden truss did not seem to be in use either at Kenozero or in the larger churches we visited in Kargopol (an ancient, now bypassed and impoverished city four hours' drive from Kenozero), nor was it evident at other historic wooden structures I've visited previously in Russia. Halfway between Kenozero and Kargopol, we visited the longest wooden bridge in Russia, a five-span cantilever-beam structure nearly 300 ft. long. The log cribs are filled with boulders, and the shorter spans are made of built-up log beams. The two longer middle spans now have glulam stringers. Since this bridge and the others we saw are uncovered bridges, the material in them, with the possible exception of what's down in the mud and water, likely all dates from the 20th century, though the crossing sites may have had bridges from remote antiquity.

We spent a day in the Kargopol region, 250 km to the southeast. Kargopol had seen better times. The square in the center of town contained three huge brick churches from the 17th and 18th centuries, as well as a 100-ft. free-standing bell tower funded by Catherine the Great. Elsewhere in town was a large Greek Revival church from 1819 (overleaf) showing that identical design inspirations were at work at the same time in upstate New York, Vermont, and Kargopol, except that Kargopol had more up-to-date information and capital, a situation that is now reversed.

As with most churches one sees in Russia (and they are everywhere), most of the churches of Kargopol and the surrounding district were scaffolded (with 2x6s nailed together to reach any height) and undergoing restoration, as if trying to make amends for the Soviet period of ecclesiastical neglect. Most of the work, perhaps because of the buildings' independent status as churches and perhaps because of a lack of funds, escapes the building code and mod-



Large Greek Revival-style church (1819) in Kargopol, 250 km southeast of Kenozero. Like most churches to be seen in Russia today, it is scaffolded for repairs after the passing of the Soviet era.



Church of the Protection of the Virgin (1743), near Kargopol. Onion domes of separate winter church are just visible behind main building, adjacent to octagonal bell tower.



Large (18-in.-dia.) interior columns at the Church of the Protection of the Virgin near Kargopol. Ceiling above is framed with closely spaced joists grooved to receive plank infill; surface texture echoes the log walls. Bulbous turnings, possibly shaved, are unusual. The three laces of rope at each neck are carved. On the story above, columns in corresponding positions are cased as paneled pilasters, in a style more appropriate to the mid-18th-century period of the building.

ern engineering requirements that plague much restoration in Europe and the US; thus it can be carried out in very traditional fashion. In addition, indigenous organizations such as The Foundation for Preservation of Wooden Heritage Buildings are active in the Kargopol region, their stated goal to “restore wooden architectural monuments using historical carpenters’ technologies including traditional ways of timber laying-in and dressing.”

In truth, the restoration challenges are not overwhelming at Kenozero, in terms of number of structures, condition or even money. Few trades are involved. Carpenters produce the structural work, roof and roofing, interior and exterior finish and even hinges and hardware. Masonry is restricted to Russian stoves, while the foundations of buildings are just stones laid on well-drained ground. Ironwork is limited to nails and occasional hardware. The sky ceilings and icons need a specialized paint conservator.

In a minute village 37 km west of Kargopol stand the Church of the Protection of the Virgin (1743) and its ensemble of buildings, including a slightly smaller winter church and a large bell tower, all of log and timber construction (facing page). At first the floor system baffled me: what appeared to be joistless plank floors and ceilings were actually very closely spaced joists with rabbets for planks parallel to the joists, so they all looked like planks. In this building were large interior timber columns, bulbous with thick rope-carving constricting their waists, that seemed to have no relation to the

Classically inspired Christian architecture elsewhere in Russia. These unusual columns supported exposed beams carrying the curiously joisted floors. On the floor above, in a more formal room, the same columns had been boxed with finish lumber to become paneled pilasters, probably in the early 19th century, the same time that late medieval architectural elements such as exposed framing were being concealed or destroyed in New England, to be replaced with white-painted, molded trim.

At our meeting to draft conclusions about Kenozero, all of us spoke, as did Russian National Park leadership and representatives of the Russian Ministry of Culture and UNESCO. We concluded that the cultural landscape is remarkable, complete and well preserved. Its restoration problems are not great. The real problem is socio-economic dislocation and the actual abandonment of the landscape. Unless this can be reversed, the marvelous buildings and setting of Kenozero will become a collection of mossy ruins surrounded by overgrown fields and forest. Wooden churches, just as lovely, stand elsewhere in northern Russia. It’s their existence in a community and a local economy that makes Kenozero so exceptional, and that context may be lost. Some residents of Kenozero believe that tourism may yet preserve it.

HOW does one get to Kenozero? It’s not easy. I flew for 13 hours overnight from Boston to Moscow. When I got there, I wandered around town for some hours, being refused entry to museums until I found out that my rubles from a previous trip were almost worthless because of currency devaluation. When the experts met, we found out who spoke which languages (English became the common denominator) and then we got on an average sort of bus. We traveled overnight for 16 hours on increasingly poorer roads, stopping periodically so that the Russians could smoke and others could relieve themselves in the bushes. By 11 the next morning we arrived in autumnal Kargopol.

We were greeted by the local dignitaries, who gave us an excellent lunch and asked if we, as representatives of a world full of well-to-do foreign lands, could please do something to improve their economically marginalized condition. The best hotel in town, where we stopped for lunch, had only one bathroom, and its running water was the last we saw for days. After lunch, our bus embarked upon a sort of highway I’d never experienced before, pre-cast concrete slabs about 20 ft. long, which meant the bus tires crashed into a displaced joint approximately once a second, and it was worse on curves where the joints became pie shaped. It was a relief to get onto potholed gravel. After about 100 miles, we came to an ingenious cable ferry powered entirely by the current of the river, and on the other side switched to smaller buses for another 80 miles to the park. Going home three days later involved four hours on the small buses, one and a half hours in a car and 15 comfortable hours on the overnight train from Archangel to Moscow, followed by flying to Boston.

The food at Kenozero was good but limited in variety. It was fresh and appeared to have sprung right out of the local ground. The people know a good potato when they see one, and potatoes are served at every meal, along with fish from the lake, pork sausage, pastries, good bread, and cabbage, cucumbers and tomatoes. At breakfast there were pots of sour cream and fresh heavy cream not long from the barn, bowls of lingonberries and pancakes called *blini*. Coffee was instant and infrequent, but the tea was good. Kenozero is one of the few inhabited places in the world where you can’t buy a Coke. In fact, if you had a million dollars and lived at this lake, it would do you no good. No one has anything to sell you. —JAN LEWANDOSKI
Jan Lewandoski (janlrt@sover.net) runs Restoration and Traditional Building in Stannard, Vermont, specializing in large timber structures including barns, steeples and bridges. His visit to Russia was supported by the Guild to increase its presence in international discussion of the conservation of historic wooden structures.



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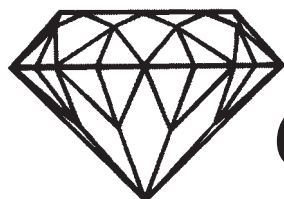
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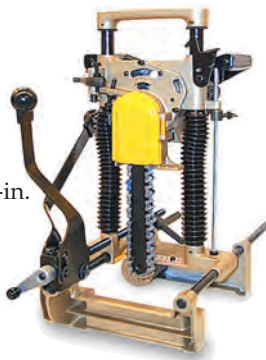
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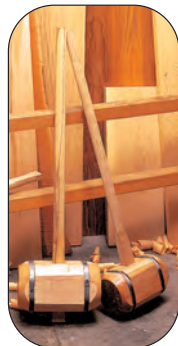
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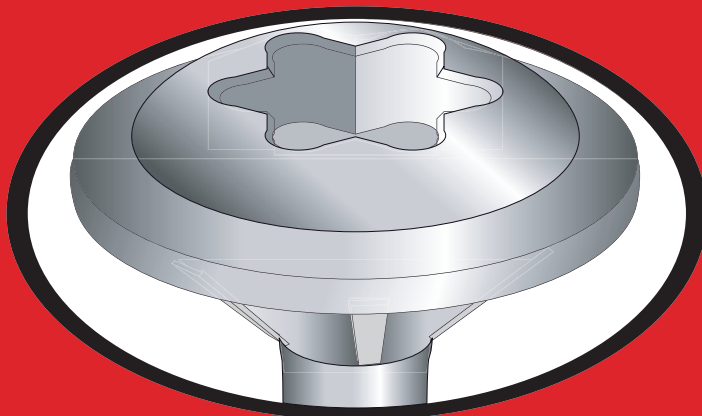
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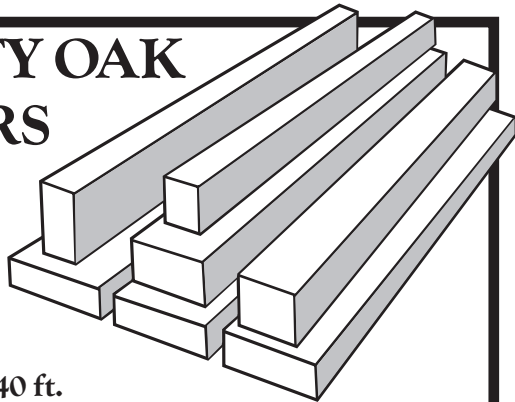
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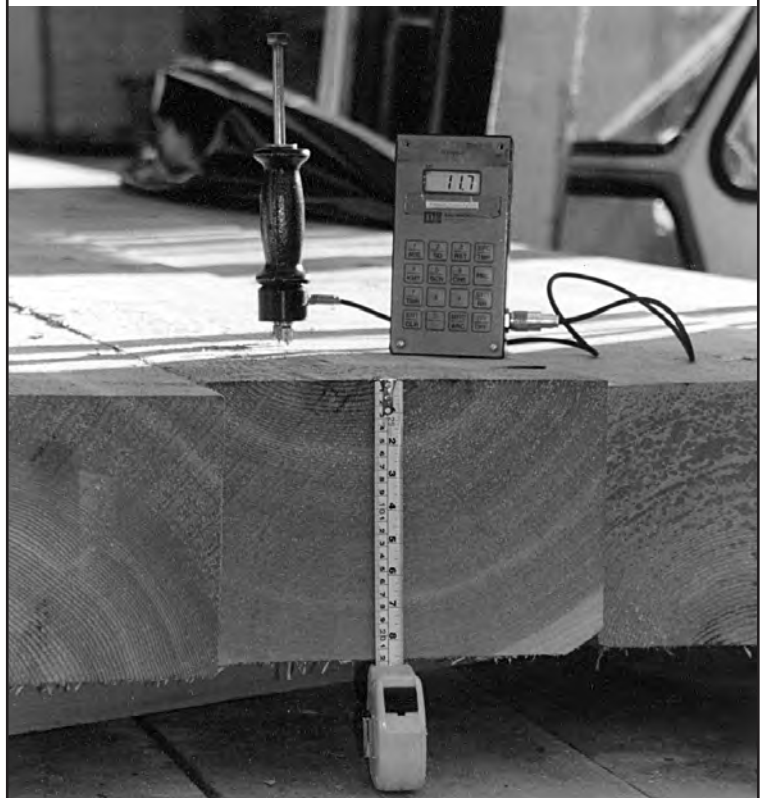
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OVER a campfire beer the last evening of a timber framing workshop led by Joel McCarty in 2000 in Järna, Sweden (TF 59), I spoke with Joel about building a frame upon my return to Norway. I had never built a frame of my own and was really keen to learn more. A pavilion seemed like the optimal choice. Said and done: on my return to Trondheim, I looked for a place to work. By chance I came in touch with a new Waldorf School that was converting an old farm to a school (lower photos). After explaining the non-profit project to the city of Trondheim, I was offered the necessary timber (pine) for a symbolic sum of \$150. A friend, Håkon Rueslåtten, became interested in helping. Together we went to the pile of logs in the forest and marked what we would use. This was during the last days before Christmas.

In parallel with the millwork, I emailed and called Joel about various modifications to the original Nacogdoches pavilion designed by Ed Levin. Ours was to be a little smaller. A number of the intricate angles of the original frame I judged to be beyond my capabilities, and I simplified the design. Making the roof drawings was difficult. When the trigonometry became too tricky, I resorted to a stereonet, a device used in structural geology to calculate the angles of intersecting planes and lines in space. To be on the safe side, I made a 1:10 scale model.

In early February, sounds of chopping and sawing could be heard through the closed doors of our "shop," an unheated concrete garage (photo top right). Luckily the head-scratching was muffled, but there certainly was a bit of that, too. I had had some trouble in the model with the large diagonal braces, but I thought it had come from minute cutting errors. During test assembly of the first full-size bent, we arrived at the truth of the matter—the plans were in error. As a result, the diagonal brace mortises had to be lowered 1 cm on the kingpost.

By April most of the joinery was completed, but the school had not applied for a building permit, and a sequence of unfortunate events caused the project to be postponed for a year. To learn by firsthand experience may be good, but when it comes to learning the effect of postponing raising until finished timbers have dried, I would prefer to have found that out from the literature. Our local pine has a strong spiral grain, and consequently many timbers twisted and some bent as well. One rafter we recut, but for the remaining timbers we had to be content with adjustments. We simply did not have material to start over, nor time.

By now, another friend, Jan Tommy Kirkholt, had come to help, and that was lucky for the completion of the job. I had been worrying myself sick about fitting the last ring girt during the raising, and I had hoped it would be possible to push the last two posts apart, permitting the girt to be lowered down from above. That proved impossible, and we had to cut a notch into the side of the rafters first (photo top left). Seeing this ring girt come home was probably the high point of the project.

In hindsight, I view the project as a great pioneering effort—and the whole affair had been carried out in spare time—but I will gladly admit that it was too difficult. While my goal of learning more about timber framing has been met, I probably value even more the friendship of people I have become acquainted with. I am especially grateful to Joel and Ed for professional advice, and to Håkon and Jan Tommy for help during the project. —Erik Lundin



Erik Lundin

