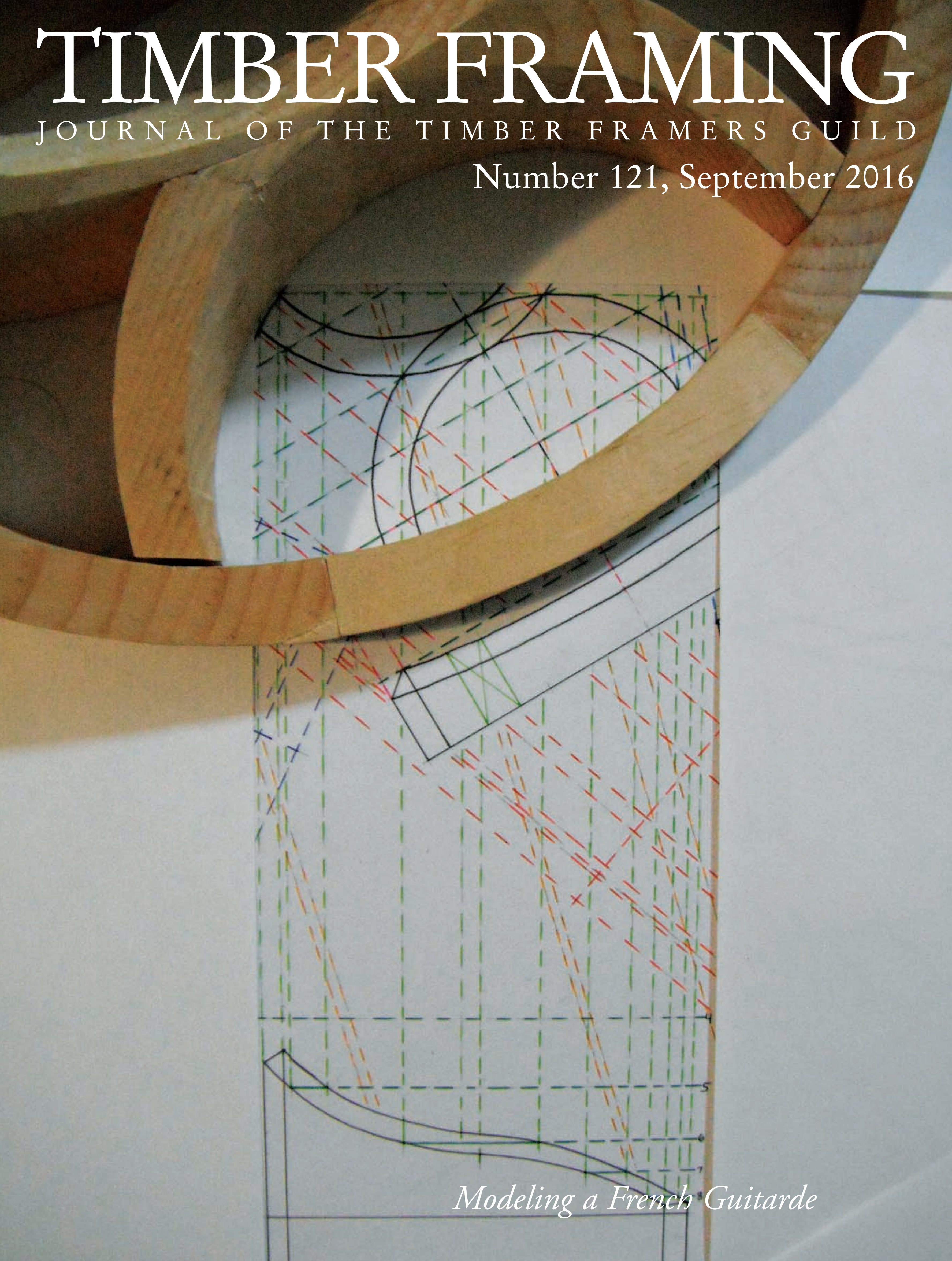
# TIMBER FRAMING

JOURNAL OF THE TIMBER FRAMERS GUILD

Number 121, September 2016



*Modeling a French Guitarde*

# TIMBER FRAMING

JOURNAL OF THE TIMBER FRAMERS GUILD

NUMBER 121 SEPTEMBER 2016


## CONTENTS



*On the cover, developed drawing of French* guitarde *dormer shows plan and elevation of secondary tie and its location in model under construction. See page 25. Drawing Adam Miller. On the back cover, Wildhof bridge, Ahrensberg, Germany, an example of Howe truss use in Europe in the latter part of the 19th century early in the 20th. Drawing Philip S. C. Caston.*



1106 Harris Avenue, Bellingham, WA 98225
360-746-6571 855-598-1803
info@tfguild.org

***Editorial Correspondence***
PO Box 275, Newbury, VT 05051
802-866-5684 journal@tfguild.org

***Editor*** Kenneth Rower

***Contributing Editors***
*History* Jan Lewandoski, Jack A. Sobon
*Engineering* Ben Brungraber

*Printed on Anthem Plus, an FSC® certified paper*

*TIMBER FRAMING (ISSN 1061-9860) is published quarterly by the Timber Framers Guild, 1106 Harris Avenue, Bellingham, WA 98225. Subscription $45 annually or by membership in the Guild. Periodicals postage paid at Becket, MA 01223 and additional mailing offices. POSTMASTER: Send address changes to Timber Framers Guild, 1106 Harris Avenue, Bellingham, WA 98225.*

*TIMBER FRAMING, Journal of the Timber Framers Guild, appears in March, June, September and December. The journal is written by its readers and pays for interesting articles by experienced and novice writers alike.*

1985


# Merle Adams 1954–2016

MERLE ADAMS, cofounder and CEO of Big Timberworks in Gallatin Gateway, Montana, died August 3 of complications from a cardiac arrest. On August 15, an extraordinary celebration of his life was held at the Big Timberworks shop. The outpouring of love in surroundings so deeply imbued with Merle's essence made it impossible not to feel his presence.

The ceremony and celebration reminded me of the magnitude of the loss—to his family, his friends, and the timber framing community. He was a unique individual who captivated us with his singular sense of craft and his ability to transform discarded materials into remarkable creations. Big Timberworks, his design-build company, was responsible for some of the most original and soulful buildings I know, which his friend Kim Hoelting calls "Profoundly beautiful physical forms that will delight the Montana landscape for decades to come." Maybe centuries.

Merle was born December 23, 1954, and died at a young age. Ironically, before his death he was perhaps as happy, healthy and fulfilled as at any time in his life. His wife Tannis said something to me recently that stopped me in my tracks: "For 37 years Merle has been battling the ravages and complications of diabetes. He was worn out, with nothing left. He was just plain spent."

His time had come. His work was done.

In the last hundred years it has become normal to expect that we will all live a long life. But not all of us do. And the measure of a life, it seems to me, is not its length but its breadth. Merle's was wide, like the Missouri River he loved. He was complicated, fierce, unpredictable, funny, intense, relentlessly creative, kind-hearted, self-deprecating, loyal, affectionate, proud and difficult.

I met Merle in 1994 when I went to the Skamania Lodge in Stevenson, Washington, to give a talk at the TFG Western Conference. Jake Jacobs, who had invited me, told me that when I was there he wanted me to meet a friend of his. He said we would like each other. I drove from the airport, walked into a large hall crowded with people, and stood near the doorway looking for familiar faces. I was wearing Levis, a Patagonia shirt, and a wool vest. As I gazed, I felt a gentle poke to my ribs, and a soft voice said, "I always find that the coolest people wear vests. You?" I looked over to see a smiling guy wearing a wool vest. It was Merle.

We hit it off immediately. Although he became one of my best friends, it was not an easy friendship. We came from very different backgrounds and had highly divergent views. In fact, Merle and I disagreed about just about everything.

Except the things that really matter. When it came to those, the extent of our agreement was deep as a well.

Some years ago he came to meet me for a day of skiing in Utah. As we got on the chairlift for our first run, he said something that pushed my buttons. Riding up, I asked him, "Do you really see any point in continuing this friendship?"

He turned to me, and said, in his quiet drawl, with the usual touch of irony, "Well, good question. How would we know?"

The question, and the answer, led to an extraordinary conversation that lasted most of the day. We would talk on the way up, ski down, and continue the conversation next ride up. We covered serious terrain, navigating the intricacies of our different pasts—how we'd come to be who we are and find

Ken Rower

**Merle Adams leading a scribe workshop at the Guild's sixth Western Conference, Big Sky, Montana, 1991.**

ourselves together. By the end of the day we were laughing hilariously, mostly at our own weaknesses and vulnerabilities, and we concluded that not only was the friendship worthwhile, it had special value because of our differences. I doubt that either of us questioned the value of the friendship ever again. I know for certain I did not.

Merle's contributions to the crafts of timber framing, home design and building, and ethical business often flew beneath the radar. But they were immense. His voice—quiet, wry and insistent—gave birth to ideas and commentary without restraint. His work ethic and drive led to the creation of a large and diverse body of work. Within the timber-framing world, he was often an opposing point of view, a free-thinker who accepted no doctrine (this was true in all parts of his life, except for his deep faith in God). He was one of a small group of timber framers who, after a time, began to feel that timber frames, on their own, were only marginally valuable and that it was important to make whole buildings as well, nesting the timber frame within a well-conceived high-performance building.

I once asked Merle's mother how he came to be such a creative guy. She said he was a very quiet kid and didn't say much, so she figured he was busy dreaming up all those wild ideas. She said he always knew that he wanted to do something different with his life. His dad wanted him to go into the building business with him in North Dakota but Merle didn't want to build "just plain vanilla buildings."

So, without forsaking his deeply religious upbringing, he grew his hair long and hit the road with his wife Tannis. They lived for a bit at a beautiful place in the Colorado high country, and moved on to Bozeman to start Big Timberworks. In the early days they lived in a crummy basement apartment they called the Mole Hole and scraped by, sometimes having to take money out of their savings just to meet payroll.

According to the company website, at first Big Timberworks was "a coalition of log-building gypsies," practicing a traditional building method using humble materials to make functional structures.

In the learning process, Merle and his then partner John Palmer moved around the country mastering new techniques. By 1985, they had transitioned from logs to timber framing.

In search of dry timber, they came across a load of reclaimed lumber from an old industrial building on the West Coast. It became a passion. A decade later, Big Timberworks was said to be the largest end user of reclaimed timber in the US.

Today Big Timberworks is one of the most diverse companies in the timber-framing world. Along with their bread-and-butter timber-framing shop, they have a busy sawmill, a huge inventory of reclaimed wood, a thriving metalworking shop, a custom woodworking business and one of the most distinctive design-build practices I've encountered.

By all accounts, Merle left the company in great shape to continue and prosper. In 1999 he restructured it as a worker co-op. After early trials and tribulations, the co-op found its legs, the company found its right size (about 25 people) and the result is a group of dedicated, engaged employee-owners. The business has no debt and fine prospects. The employee-owners I have spoken to are devastated by the loss but committed to the company's future.

Merle lived for road trips, especially when they involved the search for unique wood or metal or stone. He loved the stories embodied in those materials and the opportunity to make them into surprising expressions of what they could be.

Like the handrail in his "Alley House," crafted from a piece of discarded chairlift cable. The sweeping bend and perfect form make you feel like you are running your hand along a hallowed artifact—the work of an artist no longer with us.

Merle leaves behind his beloved wife Tannis, with whom he would have celebrated their 40th anniversary on the day of the service, and his son Seth, a Montana state trooper who says about his work, "it's really not work." The apple doesn't fall far. Seth's remarks and slideshow were the highlights of the memorial service.

Emblematic of Merle was his love for the Blue Heeler dogs that have been by his side for three decades (Zach, Hank and finally Ruby). In Merle's words: "I first got a Blue Heeler because they're like me: scary at first, hard to get to know, but loyal to the end." He was, indeed, loyal. To his family, to his friends, to his craft, to truth. And to chasing the beauty of imperfection by giving life to and making art from materials that others saw no use for.

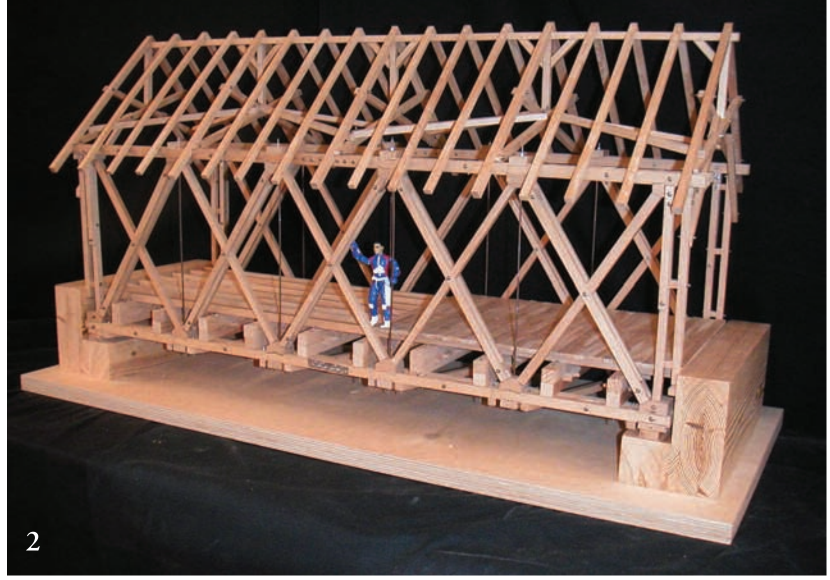
When he died, Merle was partway through a blog post called "The Tyranny of the Straight Line." In life, he constantly disrupted that tyranny.

There will never be another Merle Adams.

—John Abrams

*John Abrams, Merle's lefty pal, is president and CEO of South Mountain Company, a worker co-op that practices integrated architecture, engineering and building in West Tisbury, Mass.*


1


2

Photos Philip S. C. Caston

# An American in Europe

SOME 70 historical covered bridges still stand in Germany today. The majority are in the south of the country, some are in the east, but just one is in the north—and by chance less than an hour's drive from my office in Neubrandenburg at the University of Applied Sciences. Naturally, the bridge became the focus of my attention, especially when I discovered that its truss design was a Howe. Erected in the summer of 1928, the bridge spans the Kammerkanal on the road to a wild game farm (Wildhof) near the village of Ahrensberg, Mecklenburg-Vorpommerania (N53° 14.881′ E013° 1.722′).

The concrete abutments are just over 45 ft. apart, the trusses just short of 52 ft. long and a little over 16 ft. 6 in. high. The road surface lies over 3 ft. 6 in. up from the underside of the framing, such is the combined depth of underslung X-braces, lower chords, deep keyed-beam joists, lengthwise stringers and transverse decking. Properly called the Wildhof bridge, the boarded sides and tiled roof give the bridge its nickname "Housebridge" (Figs. 1–3).

Many of the original documents, including correspondence from the planning stage through to final costing, design drawings, tenders and technical details, as well as structural calculations, have survived and are stored in the Mecklenburg State Archives in Schwerin. So far I have not been able to locate historical photos or details concerning the erection itself, other than that local master carpenter Paul Reinke in nearby Neustrelitz was given the contract.

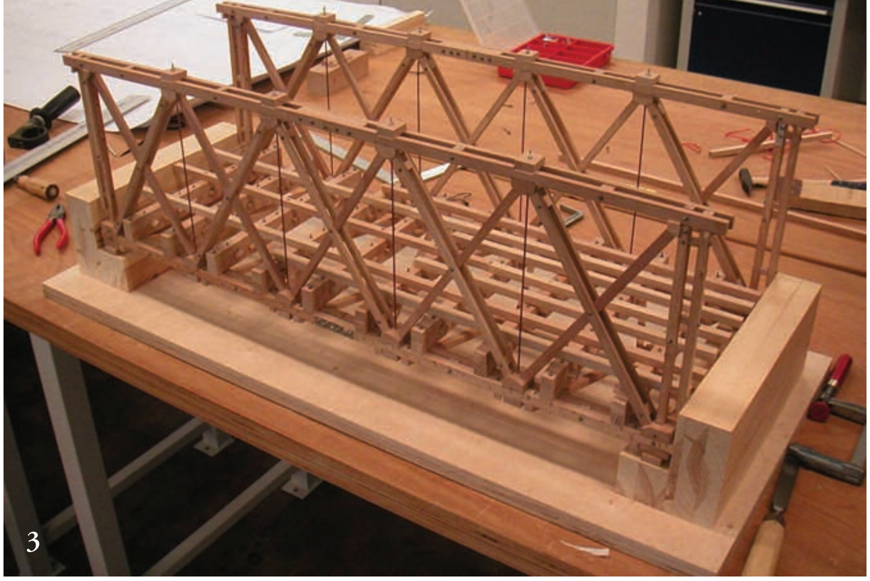
Eyewitnesses reported that in the 1970s Soviet T-55 tanks (weighing 35 metric tons or more) regularly passed over the bridge. Until a recent restoration, the trusses were visibly deformed. In 1993 a bus hit the bridge. A temporary repair followed two years later, by hanging the deck from two large steel I-beams over the roadway, relieving the two trusses of all but their own weight. The bridge was then rated at 5 metric tons. In 2013 the bridge was refurbished and the trusses rebuilt and straightened with the help of European Union regional development funding.

**Why the Howe truss?** By 1928 bridge design in Germany had long moved away from master craftsmen and their teams of framers building traditional queenpost or polygonal framed trusses using massive members and requiring hand-cut joints and surfaces. Truss design was now firmly in the hands of civil engineers, and they were publishing their latest developments and exchanging information at an international level. The extent of this exchange still has to be quantified, but it is well known that European engineers came to America to study what was going on and that American engineers exported their designs abroad. The vast engineering requirements of building railways around the world in the first half of the 19th century spurred new designs for bridge trusses. Scottish engineer and lighthouse builder David Stevenson (1815–1886) reported on what he saw on a three-month tour of the United States and Canada in 1837, publishing the results in his 1838 book *Sketch of the Civil Engineering of North America*. The section on bridges was translated into German and appeared in 1839 under the title of "Nordamerikanische Brücken" in the Austrian *Allgemeine Bauzeitung* (*ABZ*), a leading architectural magazine read by civil servants and engineers all over the German-speaking world.

Stevenson reported on the widespread use of "Town's patent lattice bridge" and "Long's patent frame bridge" trusses in the design of railway bridges, but he was a few years too early to have seen the Howe truss. In 1845 the *ABZ* reported on the topic again, including a plan, cross-section and elevation of Howe's patented design. By now Howe had erected a large number of railroad bridges with his design, and these were inspected in 1842 by Austrian railroad engineer Carl von Gehga. Very likely his findings influenced the design, around 1845 or 1846, of the first German wooden Howe truss bridge over the river Iller near Kempten (N47° 42.934′ E010° 19.314′ ), the so-called King-Ludwig-bridge, which can be assumed to have been completed in 1848 and is probably the oldest extant wooden Howe truss in the world.

As iron became a cheap mass-produced commodity in the 19th century its strength and incombustibility usurped wood in truss design, but large wooden Howe trusses continued to be erected in the mountainous areas of Central Europe into the 1920s. Altogether over 25 examples are standing today, and drawings and photos of many others since removed are located in archives. Perhaps more than these built examples themselves, it was the dissemination of the design idea through technical journals, patents, published technical reports and textbooks that helped the wood-framed Howe truss live on parallel to the engineer's preference for iron and, later, reinforced concrete. Another factor was war and its preparations, which required the construction of replacement or temporary bridges quick and easy to build, and that used local or standardized materials and parts.

During World War I, a sapper company of the Swiss army erected several Howe truss bridges. The Heiligholz bridge at



3

4

Münchenstein, Switzerland (N47° 30.801′ E007° 36.894′), built in 1915, is 138 ft. long and still standing (Fig. 4). It found its way into several influential textbooks including August Laskus's *Hölzerne Brücken* (Wooden Bridges) in 1922 and Theodore Gesteschi's *Der Holzbau* (Wood Construction) in 1926.

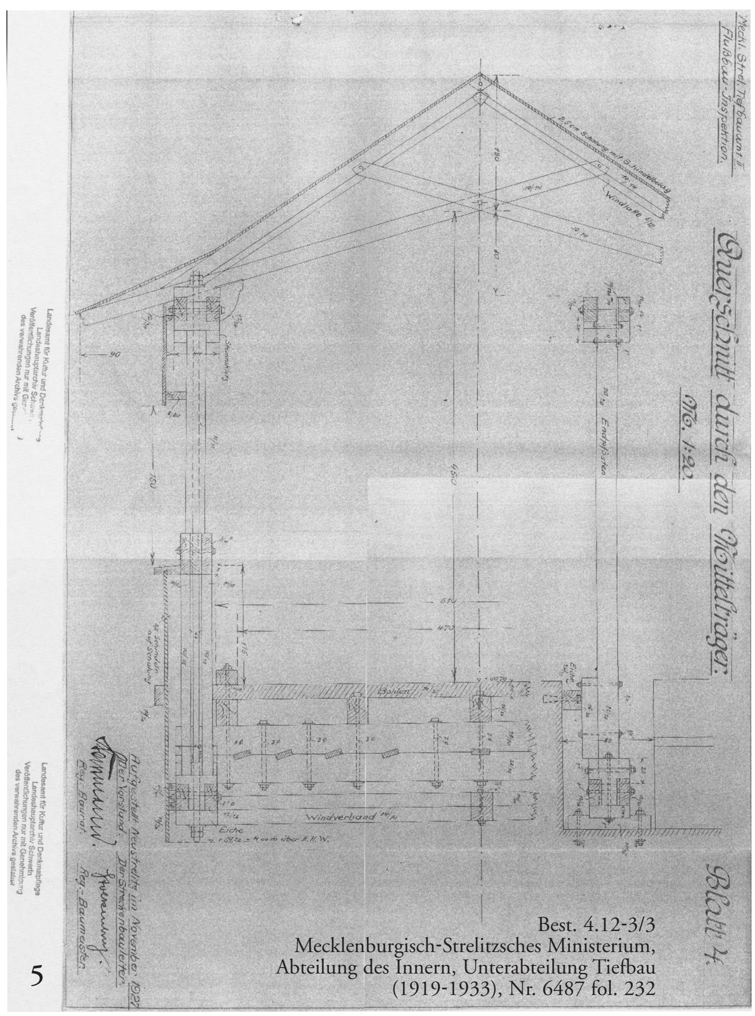
Given the information circulating in Germanic engineering circles in the early to mid-1920s, the post–World War I depression and the need for economy, the Howe truss would seem to have been a logical engineering solution for the location, but there may have been other supporting factors such as availability of materials and framers.

**Preparing for the new bridge** For a public road bridge, the financing, design and supervision of the works fell principally in the domain of two state government authorities: the ministerial Department of the Interior and, at a lower hierarchical level, the Highways and Rivers Department. The latter was primarily responsible for the technical side of building the bridge, Interior for financing. This led to a continuing exchange of correspondence that generated plans and estimates and allows the historian to follow the project in some detail.

The first indication of any activity is recorded in an internal Highways and Rivers report dated October 1921 that the wooden pile bridge on the site, about 100 years old, had to be closed as it was dangerous and, further, that it could not be repaired as it was no longer suitable for the contemporary river traffic beneath. The report lists four different design solutions for a new bridge and their respective projected costs.

The project proceeded briefly but was abandoned during the period of German currency hyperinflation (ultimately the currency was revalued at one trillion old marks to one new Reichsmark in 1925). In 1926, with the economy sufficiently stabilized, planning resumed and a temporary bridge of wood piling and steel beams was quickly thrown across the river. The site plan for the temporary structure also showed the position of a projected new bridge set slightly farther to the north, with new approach ramps leading to it.

In November 1927, Highways and Rivers produces a set of four drawings that show the bridge at a scale of 1:100 and include construction details of the Howe truss at a scale of 1:20 (Fig. 5).




5

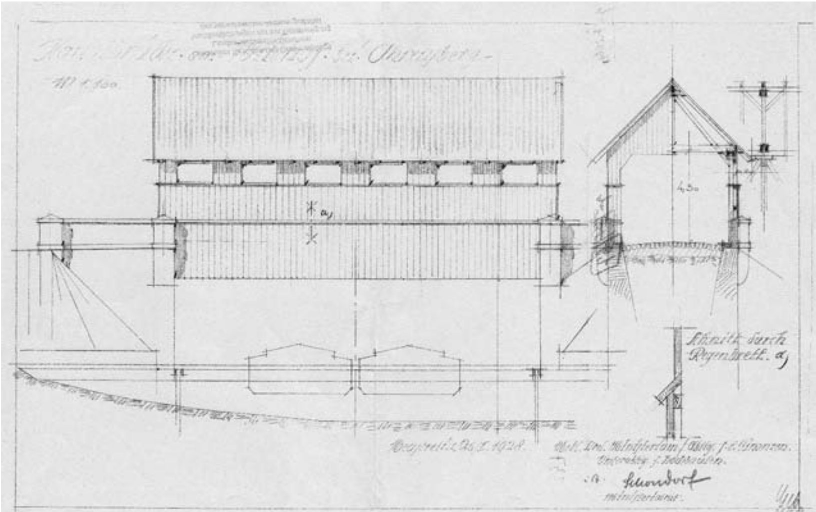
**1 Wildhof Bridge, Ahrensberg, Germany, 2007. Sagging has been arrested by suspending floor deck from I-beams inside running from abutment to abutment.**

**2 Model at 1:25 of the Wildhof bridge made by author's students shows finished structure with coverings removed. While still a wooden bridge with many timber joints, engineers have rationalized and calculated away much of the handcraft.**

**3 Model showing Howe trusses, key-laminated floor beams, stringers and underslung X-braces, all bolted together, preparatory to adding scissor-braced roof trusses and common rafters.**

**4 Heiligholz bridge, Münchenstein, Canton Basel-Land, Switzerland, a century old, now only used as a footbridge. Howe trusses still functional.**

**5 Mecklenburg-Strelitz Highways and Rivers Department's first set of construction drawings, Sheet 4, cross-section, dated November 1927, with roof design probably inspired by that of Heiligholz bridge, published in various textbooks of the time. Note keyed beams and liberal use of bolts. Plan reproduced with permission of the Landeshauptarchiv in Schwerin, Germany.**



Best. 4.12-3/3
Mecklenburgisch-Strelitzsches Ministerium,
Abteilung des Innern, Unterabteilung Tiefbau
(1919-1933), Nr. 6487 fol. 337

6

7

**6 Free State of Mecklenburg-Strelitz Department of the Interior's design "corrections" changed Ahrensberg bridge roof framing, rationalized external appearance of bridge and significantly reduced window openings in size. Drawing reproduced with kind permission of the Landeshauptarchiv in Schwerin.**

**7 Straightened trusses, fresh siding and roof tiles give the bridge a new lease on life. Trusses have been returned to their original function of supporting the bridge.**

**8 Double-web Howe truss with braces and counterbraces over two panels, from William Howe's Patent 1711 of August 3, 1840.**

The bridgeworks are altogether over 130 ft. long, including a 20-ft. abutment at each end, followed by a 22-ft. concrete deck span on each side resting on the abutment and a pier, leaving 47 ft. to be spanned by a covered bridge using Howe trusses. Further designs are submitted, with additional wooden bridge structures replacing concrete for significant cost savings.

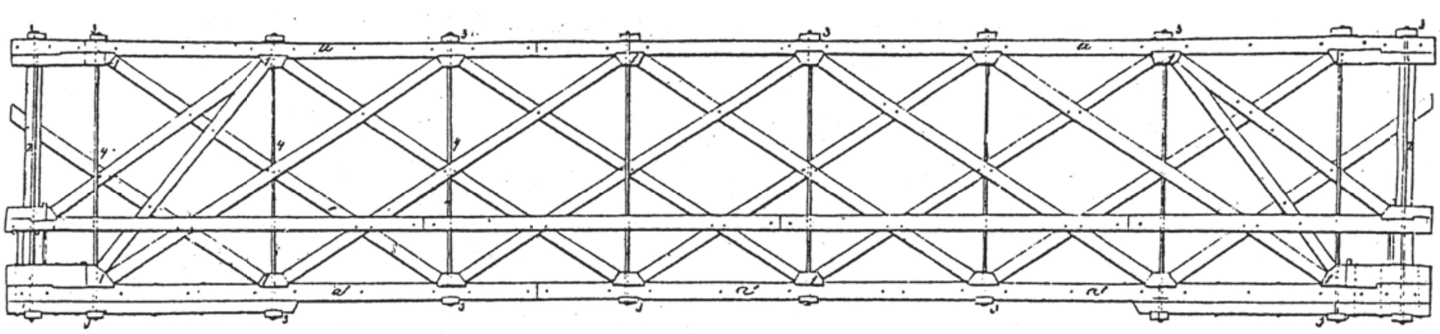
Despite submitting a detailed design for the wooden trusses, Highways and Rivers are clearly not in favor of a wooden bridge. They list the technical disadvantages of building with wood and, while admitting that the longest covered wooden bridge design is the cheapest to build, they point out that even with a covering the trusses will still be susceptible to damp rising from the river and that even minor repairs to the complicated arrangement of parts will be expensive, plus the fact that even in other heavily forested parts of the world, wood is in short supply and designs in concrete are preferred. Finally, Highways recommend an iron structure that could be painted to blend in with the countryside.

The reply from Interior is swift. They want to take the cheapest option, a single wooden span between two concrete abutments, as the maintenance costs for a wooden bridge would be no higher than for an iron construction and the bridge form would be more appealing. Someone at Interior liked wooden covered bridges!

In January 1928, Interior returns the design drawings to Highways for amendment and includes a sketch showing changes (Fig. 6)—the hipped ends gone, the half-open sides reduced to a series of small windows and the capped abutment balustrade at both ends optically continued into the vertical side boarding giving the bridge its appearance as can be seen today (Fig. 7). Interior also stipulated who should supply roof tiles and that the whole external cladding be painted light gray or red-brown.

Three months later, Interior informs Highways that local master carpenter Paul Reinke is to be awarded the framing contract on condition that he finishes the work within a 10-week period. Work on the bridge must have proceeded without any serious complications as there is little correspondence during this time. A Highways and Rivers report in May describes how the trusses will be erected. They are to be assembled in advance, then put on arks or rafts that bring them into the opening between the abutments. No more is said, and it must be assumed that either one or two cranes on the banks will lift them and swing them into place.

**The final stages** Another document of the same date calculates (somewhat late) that a change of less than 2 in. of flood-stage water rise will be caused by the abutments' narrowing of the canal. A third and final document is an in-depth breakdown of the costs, of extraordinary interest to anyone studying historic project management. To us, however, it confirms that pine was used for the main truss members and oak for the blocks and bed timbers. As the Wildhof bridge approached completion, Interior submitted



8 HOWE'S BRIDGE. US Patent Office

the designs to the Reichsminister for Transportation in Berlin in December 1928. He dryly replied that as the bridge had already been built he was prepared to overlook the design approval, and then firmly divorced himself from any responsibility for the safety of the bridge. Most important, though, he agreed that the ministry would pay half the construction costs, as had been the practice on other bridgeworks in the vicinity.

**A look at some details** Designs similar to or based on Howe's second (single panel) and third (overlapping panels) patents (Fig. 8) and the use of either oak angled blocks or cast-iron moldings as well as the end-post detailing, were well documented and illustrated in contemporary books by such authors as the eminent Austrian engineer Josef Melan (1853–1941). Although internationally famous for his work on steel and concrete bridge construction (so much so in the US that he was asked to verify the calculations on the Williamsburg and the Hell Gate bridges in New York), Melan's theoretical repertoire also extended to wooden bridge construction. In 1910 he began publishing his lectures; in his first volume, on wooden bridges, *Der Brückenbau, 1. Band, Einleitung und hölzerne Brücken* (*Bridge Construction, Vol. 1, Introduction and Wooden Bridges*), there is clear reference to Howe bridge trusses, including the Heiligholz bridge in Switzerland mentioned earlier. Published details, however, were not slavishly followed in the Wildhof truss design. Melan states, for example, that braces need not be sized according to position. This advice was clearly ignored as the cross-section of each of the Wildhof braces increases from the middle out toward each end.

Melan also makes reference to the ends of the trusses and cites several examples of how to integrate an end-post or posts and remarks that through bridges (where the passageway runs between the trusses) do not necessarily require end-posts as they are not in compression. This idea was adopted in the Wildhof bridge, and no rods were used to tie the upper and lower terminal angled blocks together. Instead, a single post at each end of the truss is bolted to the upper and lower chords. At the upper chord, the post sits behind the angled block and passes through to the space between the paired upper chords, where it is bolted (Figs. 9, 10). The upper half of the post is also strengthened by a member attached to the outer face by two bolts passing through to a plate at the top inside. The bottom end of the post passes through the terminal angled block into the space between the paired lower chords and is bolted through the chords and angled block.

Another modification to the design is harder to explain. Melan's and other contemporary works show the angled blocks in various configurations, but always with the long grain at right angles to the length of the truss, spanning the gap between the paired chord members. In the original Wildhof bridge, the angled blocks were inserted with their grain running parallel to the truss. As these blocks were almost square there would have been no financial advantage in cutting them to fit in any particular direction, but the result of setting them parallel to the chords was to expose them to splitting where the blocks spanned the open space between the chord members (Fig. 11).

Melan and the original static calculations show the grain crossing from one chord member to the other, so the decision to change direction must have been made on-site. As it turns out, it was the wrong decision and the forces induced by the braces caused nearly all of the upper angle-blocks to crack where the open space was the widest.

9

10

11

**9 Roof structure complete with cladding and upper chords temporarily raised onto steel framing, replacement angled blocks, braces and rods then inserted, chords and roof jacked down to corrected position.**

**10 Details of end joint revealed, with angled blocks recessed into chord and post and iron plate extended up into chord.**

**11 Collection of damaged original angled blocks. Blocks oriented lengthwise on paired upper chords and set over fairly wide gap tended to split in half.**

**12 Lower gantry outside trusses with simple boarded walkways on long baulks of timber resting on lower chords. Until trusses were competed, lower chords were suspended from floor beams.**

**13 Nets, guardrails and all-weather tarpaulins made site safe and a joy to work on. Gantries were designed to accommodate mobile scaffolding (at right in picture).**

**14 Bridge in May 2013 during repair work, still in use for smaller vehicles (and canal traffic beneath) by clever design of steel frame within.**

**15 In planning restoration, designers used what they found in place. Deep green I-beams, originally part of earlier stabilization measures, supported new temporary steel framing.**

**16 One bridge corner had suffered quite a lot of damage over the years but its upper chord was still intact. With bracing removed, state of joint surfaces could be assessed and showed no signs of serious deterioration.**

**17 Although open space between lower chord members is minimal and original angled bocks were well supported, they were replaced with blocks running transversely, consistent with new blocks at more widely spaced upper chords.**

**18 Wildhof bridge, Ahrensberg, interior of bridge today. New sidewalks and rub-rails adorn deck and trusses respectively.**

In the spring of 2013, the bridge underwent restoration, a good opportunity to look at more details. The siding was removed to reveal the framing, but otherwise the trusses and roof structure were kept in place (Figs. 12–14). The I-beams, soon to be made redundant, were integrated into the restoration procedure to support a steel frame erected inside the bridge, a fairly simple system of I-beam posts, horizontals and diagonal braces bolted together and perched on top of the two main I-beams (Fig. 15). This support structure was used to lift the deformed lower chords and also to provide a raised surface from which the upper chords could be jacked up, allowing replacement of braces and counter braces (Fig. 16). Many original bolts were reused, but all the iron rods were replaced with newer material. New angled blocks were inserted, this time with their grain at right angles to the truss (Fig. 17). The original timber, treated with a preservative on many occasions in the past and almost black in color, is in complete contrast to the light-colored replacement timber. This striking difference in color gives the bridge interior an unusual clarity, immediately showing even the casual observer just how much of the original fabric was reused (Fig. 18).

Over time this contrast will fade along with the memory of the original design decisions and temporary repairs and stories of tanks crossing the bridge. I wonder if Mr. William Howe could have envisaged how and where his truss design would be used. I say "his" design, but of course the idea of using diagonally braced wood upper and lower chords with iron rods tying them vertically was around before his 1840 patents. John By, a major with the British Royal Engineers, used it in 1811 (without the angled blocks), but since the majority of the literature attributes the design to Howe, and the worked-up ideas came through him, we can still consider this bridge an American in Europe.

—Philip S. C. Caston

*Philip Caston (caston@hs-nb.de), a frequent contributor, has been studying wooden bridges around the world for 15 years. In 2003 he was Field Supervisor of the Burlington, Vt., team recording covered bridges in New England for the Historic American Engineering Record.*

15

16

17

18

1

Photos and drawing Silas Treadway

# Restoration Tactics in Tunbridge, Vermont

TUNBRIDGE, Vermont, just over the hill from my home in South Strafford, is notable for its array of intact historic barns from all periods within its settlement history, the earliest dating from about 1790. I began restoration work there in January 2013 on a large, ca.-1842 barn (Figs. 1 and 2) whose owners had received matching grant funding from the Vermont Division for Historic Preservation, though it was then unclear what this money would cover. Before my involvement, the only proposal had been for complete takedown and reconstruction as a much smaller structure, not something the grant program would usually support. In addition to the grant, an insurance award was secured to help compensate for snow-load damage, though the main structural problem with the barn was very much historical. There was also an ultimately unsuccessful Kickstarter crowd-funding campaign. All this is to say, the Morrison family, the owners of Another Button Farm, were very motivated to keep their landmark barn intact.

The barn sits just north of the village, up against a steep hillside, but the property includes prime agricultural land on the banks of the First Branch of the White River. This river bottom locale was the original site of Tunbridge town center. Reportedly a meetinghouse was constructed there, then dismantled and re-erected in what is now Tunbridge village. Troops during the Civil War also assembled on this site.

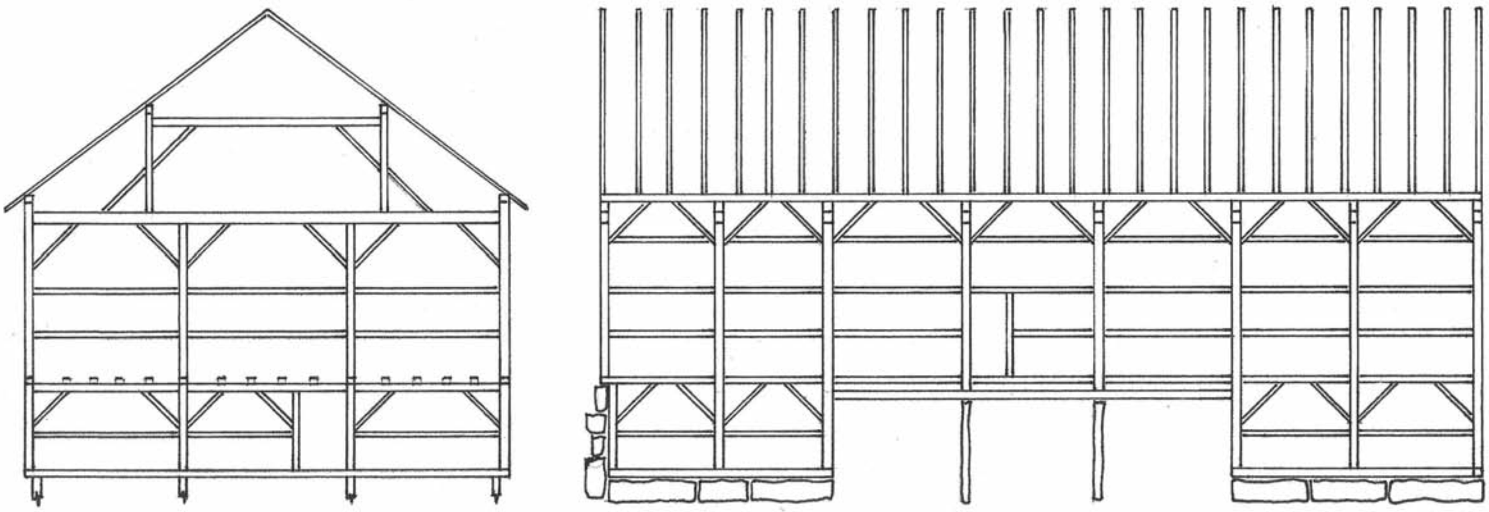
Local historian Euclid Farnham, in his *Tunbridge Past, A Pictorial History* (2000), writes first about the house:

> [The] brick home of Edgar and Eva Rowell . . . dates from around 1835. Granite for the foundations and window trim was quarried on Brocklebank [across the river and atop Brocklebank hill] and the sandstone for fireplaces was split from rock in the nearby brook . . . . The barn on the farm was built in 1842. Hemlock trees from across the river were cut and hewed into 110 beams—each 40 feet long. The two men working on this project were paid $20 a month from which $8 was taken for board. The property came into the possession of the Rowells about 1886 and remained in the family for some 70 years.

The barn frame measures 42 ft. 2½ in. by 77 ft. 3½ in. and stands at 24 ft. to the eaves. So the (unattributed) beam count from Farnham's book might be correct. About 50 full-length 40-ft. beams were used in the main frame. Assuming the remainder of the sticks were cut into shorter lengths for posts, girts, joists, etc., 60 more pieces would account for all of the large 8-in. to 9-in. squared hewn timber. Smaller stuff sawn at 4x4 was used for nailing girts and common rafters; braces were sawn at 3½ x 4½.

Stone for the barn foundations is consistent with the "sandstone" mentioned by Farnham for fireplaces, though for its color more commonly called "bluestone" in Vermont. Some of this may have come from the creek bed, but also from the adjacent hillside. I split one large boulder found on the hill above the barn, yielding several new foundation and plinth stones (Fig. 3). Newer masonry elements are easy to identify by the line of round drill holes used today for splitting, versus the trapezoid-shaped mark of a cape chisel that the original builders used (Fig. 4). The cape chisel was used in rock just as a mortise chisel is used to chop mortises directly in wood. Wedges or wedges and feathers driven progressively deeper into the small apertures then split the stone in a line.

The original foundation stonework is impressive and must have been even more so when first constructed. In the mid-1900s, the entire ground level of the barn was gutted to make way for an enlarged dairy operation. All interior posts and braces were cut off, and concrete, metal posts, stanchions and a gutter cleaner were added. After all this was removed and I dug for placement of new plinth stones, I was surprised to find standing granite posts buried much deeper than I ventured to dig. Extant mortises on the

2



3


4


5

underside of the gable sill also suggest walkout access to what was the understory of the barn, since filled in. The main road (Vermont Route 110), built in close proximity to the barn, adversely affects grade and drainage for this low level.

A long retaining wall on the opposite end of the barn allows drive-in access to the main level and includes a very good original threshold detail. (I've copied this scheme on four new drive-in thresholds since.) A large threshold stone (3x12 ft. in this case) supported by two underlying stones (Fig. 5) is positioned to cantilever over the lower retaining wall and juts 8 in. inside the sill line of the floor frame. With this detail the transition from stone to wood is well protected from weather. Also, any debris inclined

**1 Cider-making in fall of 2014 to celebrate completion of work.**

**2 Hemlock frame about 42 by 77 ft. has eight bents with dropped tie beams through-mortised and pegged to wall posts 8 in. below plate. Tied purlin-post-to-plate assembly supports one-piece rafters at midspan in simple notches.**

**3 Splitting sandstone using wedges and feathers in drilled holes.**

**4 Split sandstone showing tracks of cape chisel, earlier tool for making holes for wedges and feathers.**

**5 Threshold stone juts 8 in. inside wall line of frame to meet recessed header, protecting timber from weather.**

6 Stabilization of wall posts that had split on inadvertent fracture lines produced by peg holes for tie beam tenons and inner cheek plane of post tenons to wall plate. Splits were forced apart by rafter action resulting from inappropriate joint design at purlin plate support points.

7 One-piece rafters crossed purlin plate in simple trench, each restrained by single peg that decayed and failed, allowing rafters to slip downward. Triangular repair blocks establish additional bearing. Locust pegs reduce vulnerability to decay.

8 Early iron strap repair to failing wall post. Existing cables rerigged to pull more directly on plates.

9, 10 Fifty special turnbuckle and strap rigs to pull slipped rafters back to position for refastening at purlin plate. Turnbuckles load-rated at 2200 lbs were weakest links.

11 Tie rods 10 ft. long anchored at base of purlin posts now restrain wall posts and plate.

to build up in this crack can fall through or at least dry out readily from beneath. There isn't a hint of rot at this entry.

THE major structural issue that precipitated restoration of this barn was at the tying joints. The dropped tie beams were through-mortised to the wall posts 8 in. below the plate and pegged 4 in. from the shoulders, in line with the inner face of the post tenon up into the plate. Meanwhile, one-piece rafters were pegged to the purlins where they crossed in simple trenches.

The gable corner tie joints were sound since nailing girts and boarding helped hold things together. Almost every other eaves wall post split in line with the tie-beam's tenon pegs and with the inside edge of the post top tenon (Fig. 6). This fatal alignment of peg holes and tenon inner face so near the top of the post was actually repeated at the purlin post ties, such that several purlin posts were thus split as well. But in most cases the pegs driven through the rafters into the purlin plates, their only connection, had rotted and sheared and the one-piece rafters were able to slide down over the purlin plates and transfer all their outward force to the birdsmouth joints at the wall plates. Fig. 7 shows the rafters in their trenches, after repair and addition of bearing blocks.

When I first arrived at the barn, the splits at the top of several eaves posts were open by as much as 8 in., stabilized more or less by wire rope around the plates. Earlier in the barn's history, forged iron straps 2-in. wide, with short, hand-forged spikes, had been used to solidify some of these connections (Fig. 8).

Comparable barns in the area I've looked at do not repeat this construction. A livery barn built in the village right around the same time as the ca.-1842 Morrison barn includes similarities such as material species, sizing and conversion type, housing depths, etc., but the livery's roof framing uses the time-tested English tying joint with principal rafters and common purlins. While it may be hard to reconcile the Morrison barn's deviation from the proven method used in the contemporaneous livery barn, experimentation was the norm by the 19th century in vernacular building, and the dropped-tie in the Morrison barn saved layout and cutting time while providing convenient loft heights.

To fix the split posts, I had to get the outward pressure and weight of the rafters off the plate. I was able to use the less-affected purlin plates as anchors to pull rafters back uphill. Iron straps fastened by structural screws to the rafters and fitted with ⅝-in. turnbuckles and 1-in. tubular webbing slings made reasonably affordable rigs for 50 individual rafters (Figs. 9 and 10). On the badly affected north side of the building, I had to re-rig turnbuckles once, for almost 12 in. of uphill travel. As I took pressure off the plates, I drew them inboard, utilizing existing (though re-rigged) cables and turnbuckles. I clamped badly split posts with heavy locust blocks and ¾-in. bolts or threaded rod. With everything back in place, I through-bolted each post 10 ft. back to the bottom of the purlin posts (Fig. 11). Oversized plate washers on the outside of wall posts catch the wall plate as well. This hardware will permanently restrain posts and plates.

9

10


11

The purlin plates, meanwhile, are now held with iron tie rods positioned directly above the purlin ties, passing through existing peg holes with black plastic water pipe used as sleeves to fill space and avoid condensation problems. Finally, I repegged the rafters just above the purlin plates, using small triangular beech blocks and new locust pegs to check downhill movement (Fig. 7). This setup allowed for installation of everything from within the barn, without having to take the roof off.


12


13

12 Twenty-one support towers and six steel beams supported main floor in preparation for scores of new posts and braces.

13 Restoration of entire ground level wood support system gutted during 1950s in favor of concrete and steel.

14 Scarfed post-bottom repair follows original chalk layout line struck 2 in. from far face of post.

15 Remnant door frame provided pattern for construction of missing and additional doors.

16 Repairs completed, patched-in siding gives scant clue to extensive renovation and reinforcement within.


14


15


16

BACK underneath the barn, I used 14 cribbing piles, two per bay, plus seven structural scaffold piles (to save some cribbing) down the center aisle. Six 40-ft. steel beams placed under the main floor carrying beams held the barn one side at a time so I could make repairs or replace understory framing (Figs. 12 and 13). The barn was laid out by square rule, and its original red chalk lines set at 2 in. or so from hewn reference faces are still present on well-protected portions of the frame. I set a post scarf repair to one of these lines (Fig. 14, right side of post). Peg holes were drilled on these lines, and ½-in. standard housings thus put them 1½ in. from mortise faces. Peg holes in tenons throughout the barn were clearly marked out and drilled for drawboring, using a ¼-in. offset.

Large foundation capstones got replaced or shuffled around to make new drive-through entryways. About half of the original stones were missing or buried deep. An old schoolhouse south of town, demolished a decade earlier, provided some nice matching stone, augmenting the few pieces I split. Originally this barn had a full wood floor at the current sill level. I was in favor of partially rebuilding this floor system, but the sandy, well-draining soil works well for livestock. Piglets were born in the barn in late winter when I still had the north side up on cribbing.

I rebuilt one pedestrian door that provided a model for accurate reconstruction of another missing door (Fig. 15). Original 20-light window sash were reproduced by Michael Cotroneo in Morrisville, and new glass fitted in a fine transom over the upper entry. Later-era double-hung windows were rebuilt and four sets of large rolling doors were added to fully enclose the understory.

In July 2014 I finally buttoned up remaining door details, drainage and site grading. That fall the owners held a cider-pressing and open-barn event to celebrate their newly restored barn (Figs. 1 and 16). I am grateful for their patience and trust in me to complete such a commission. —Silas Treadway

*Silas Treadway (silas.upstream@gmail.com) operates Upstream Builders in South Strafford, Vt., specializing in timber restoration and reproduction as well as traditional and natural building methods.*

# Keyed Through-Tenon Performance

KEYED through-tenon joints use an extended tenon secured by one or more wedges passing across it on the far side of a through-mortise. Such joints, also known as outside-wedged through-tenons, are sometimes found in kingpost trusses to join the kingpost to the bottom chord (Fig. 1). They are commonly found in New World Dutch barns joining the anchor beam to the posts in the characteristic H-bent (Fig. 2). Little engineering design literature exists for these joints.

Outside-wedged through-tenon joints are typically loaded in tension. Compared to pegged-only joints, their advantage is to eliminate tension failures perpendicular to the grain at the mortise face, because the keys are placed on the back of the mortise, causing compression forces at the face of the mortise.

Test specimens were fabricated from Douglas fir and white oak and tested to failure to identify potential failure modes (Figs. 3–7). Specimens with different tenon lengths (4 in. and 11 in.) were tested, as well as specimens with one key and two keys.

Test results indicated that proper detailing and proportioning of keyed through-tenon joints is crucial to their structural performance. Some test joints failed prematurely in a brittle fashion while others demonstrated ductile behavior, the latter a desirable attribute of structural joints.

Joints with relatively short tenons (4-in. projection) tended to fail when the relish behind the key mortises sheared off. Joints with long tenons (11-in. projection) did not exhibit this failure mode. Relish shear failures are a brittle failure mode to be avoided, thus it is crucial that tenons be long enough to preclude it.

A second brittle failure mode observed was splitting of the tenon, caused by tensile stress perpendicular to the grain of the tenon. This failure mode was only observed in joints that contained a single key. Joints with two keys did not exhibit splitting failures.

Keyed through-tenon joints that did not experience brittle relish shear or splitting failures behaved in a ductile fashion. The keys first crushed at their bearing surfaces and then progressed to a bending failure. Even after the keys fractured in bending, the joint continued to resist load, exhibiting ductile behavior. All of the joints tested used a single wedge as a key. Pairs of opposing wedges instead of a single wedge may be anticipated to result in improved bending resistance.

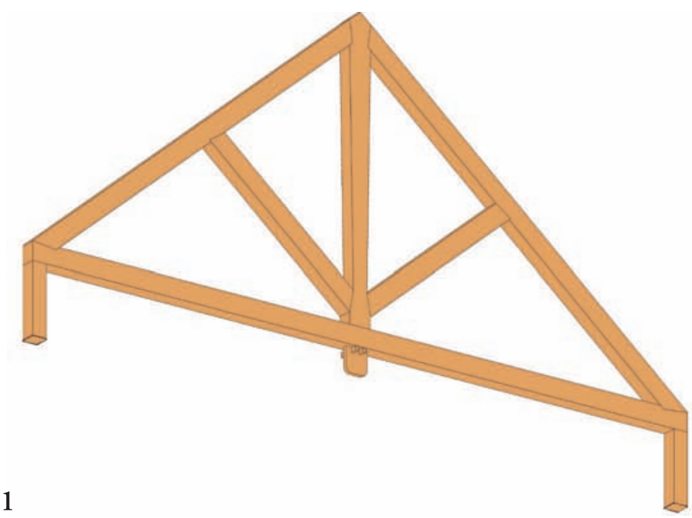
In analyzing the structural capacity of a keyed through-tenon joint loaded in tension, three failure modes should be evaluated:

1. Net tension strength of the tenon.
2. Relish shear resistance of the tenon at the key mortises.
3. Crushing strength of keys.

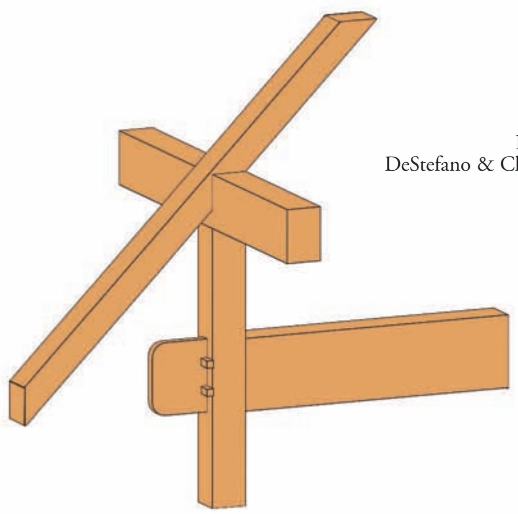
THE following guidelines for proportioning and maintaining keyed through-tenon joints are intended to minimize the likelihood of a brittle joint failure. Minimum dimensions are indicated and may need to be increased where required by structural calculations (Fig. 8).

1. The distance from the key mortise to the end of the tenon should not be less than 10 in.
2. A minimum of two keys should be used, each ideally consisting of opposing wedges.
3. Tenon thickness should be not less than 2 in.
4. Key mortises should be sized to allow for seasoning (shrinkage) of the tenon and consequent tightening around the keys.
5. Keys should be made from seasoned hardwood with a specific gravity not less than that of the timber.
6. As the mortised timber seasons and shrinks, keys must be tightened to keep the face of the joint closed.

*Editor's note. This article was adapted from the Guild's Timber Frame Engineering Council's "Technical Bulletin 2016.8," a brief summary of extensive research done outside the Guild to quantify the strength of keyed through-tenon joints in timber. The bulletin was published in July and prepared by Daniel Hindman, Associate Professor in the Department of Sustainable Biomaterials at Virginia Tech, and Jim DeStefano, president of DeStefano & Chamberlain, Inc., and TFEC publications committee head for 2016. The original research on keyed through-tenon joints was conducted by Lance David Shields under the supervision of Professor Hindman and presented in June 2011 as an MS thesis in Civil Engineering under the title "Investigation of Through-Tenon Keys on the Tensile Strength of Mortise and Tenon Joints."*



1



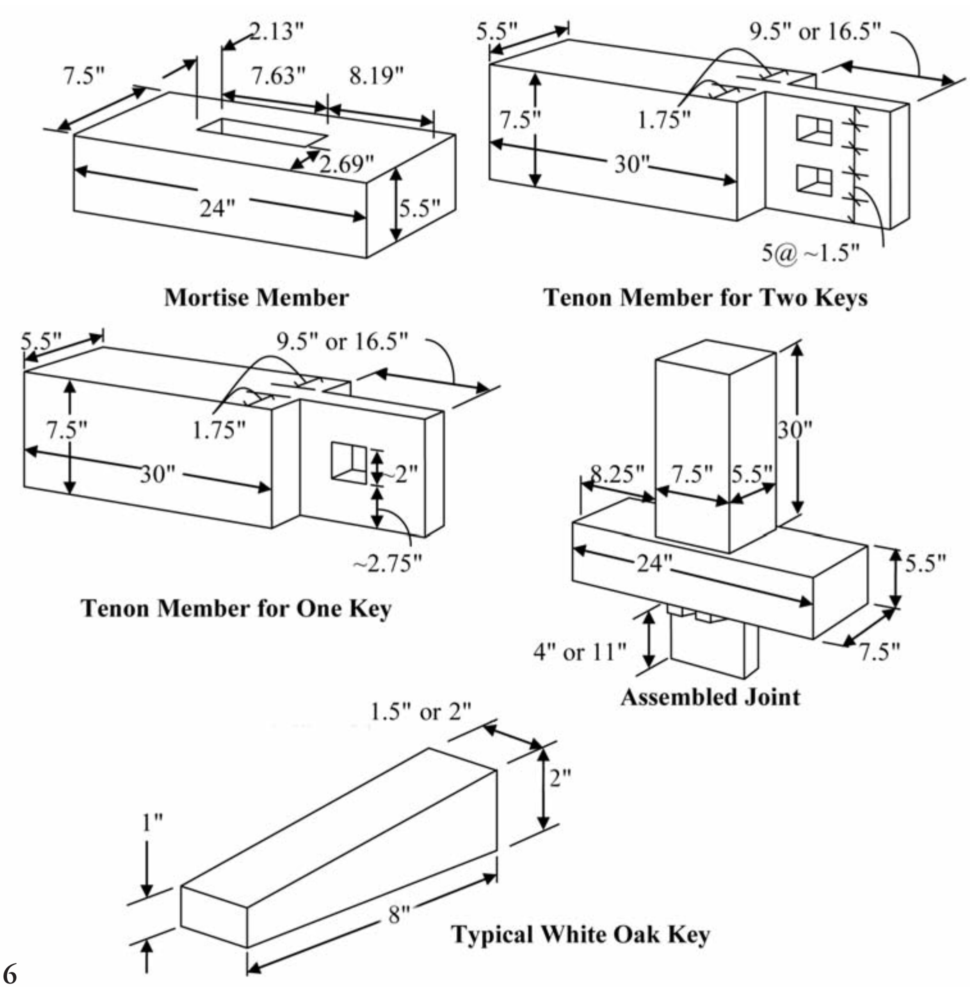
Renderings
DeStefano & Chamberlain

2

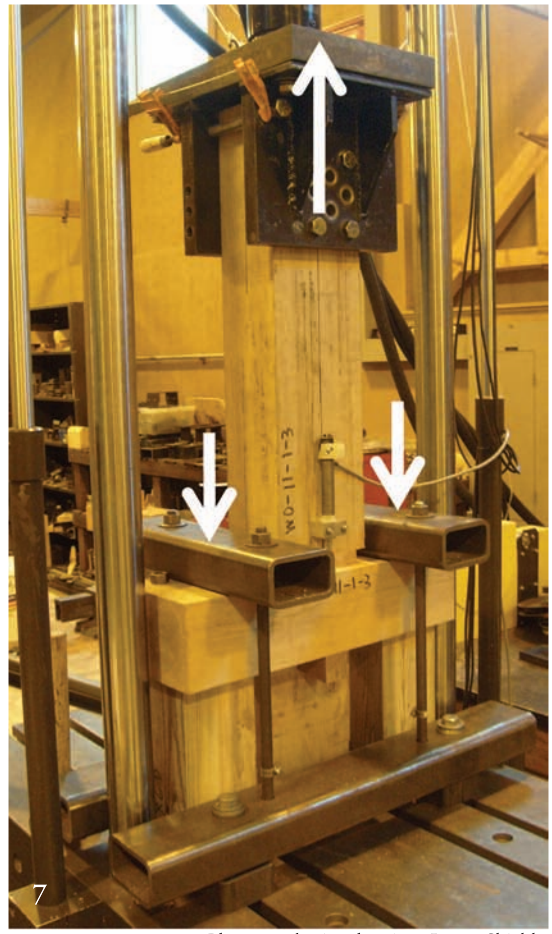

3


4


5



6


7

Photos and joint drawings Lance Shields

1 Representative kingpost truss with through mortise in tie beam and extended post tenon with two keys.

2 Representative New World Dutch barn anchor beam connection to purlin post with extended tenon and two keys.

3 Relish failure in shear along the grain in Douglas fir tenon with two keys and short relish.

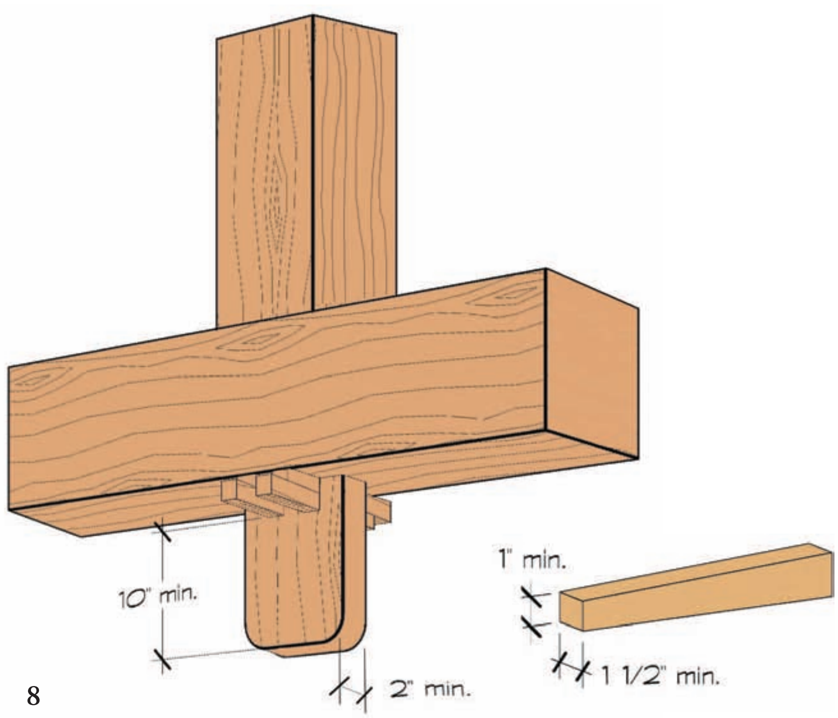
4 Bending and crushing of white oak keys in long-relish white oak.

5 Tenon split in short-relish Douglas fir tenon with single key.

6 Configuration and dimensions of test joints. Not to scale.

7 MTS Servo-Hydraulic test apparatus with load cell range of 50,000 lbs. Lower white arrows indicate clamps holding mortised piece on blocks. Transducers with range of 2 in. and sensitivity of 0.001 in. are attached at opposite sides of joint to measure tenoned member slip relative to mortised member.

8 Keyed through-tenon recommended mortise end distance and dimensions. Hypothetical folding wedges not tested.



8

# Get Paid for Unpaid Consulting

AS *Star Trek's* Spock said, "It's only logical." When a prospect calls with an inquiry or seeks your expertise, it's only logical to put a price on it. The client must put some value on your input or he wouldn't be calling you. Alter course from the neutral zone to engage in paid consulting. Make it number one, or you will be absorbed.

There is some overlap between *qualifying* (see "Qualifying Client Inquiries" in TF 120) and *paid consulting*. Conversations with a client when qualifying an inquiry or sales lead are the perfect opportunity to mention paid consulting. By revisiting the subject frequently, and well in advance of seeking a consulting agreement for preconstruction services, the client will not be taken by surprise.

To review for a moment, qualifying is a gatekeeping activity of eliciting the information from the prospect to assess if there is a sales opportunity for you. Qualifying is the process of determining if the client has enough "pain" to move him over a threshold into your sales funnel. When the client has been qualified, a lot of preconstruction consulting work is still needed before getting a signed contract. Many service providers and suppliers (engineers, architects, designers and others) get paid for this work, but historically timber framers have worked as unpaid consultants. For the experienced timber framer, now is a good time to start to get paid. Practice and experience soon will make you fluent in the process. One wise timber framer said, "There's a certain amount of finesse, judgment and timing to be exercised in these matters." We will talk about the nuances of becoming a paid consultant.

**What is unpaid consulting?** When a prospect asks you for a free proposal, do you provide it? If your answer is yes, you may be an unpaid consultant. If a prospect asks you to solve their problem and you immediately provide solutions, or seeks to pick your brains over coffee for a ballpark quote, you may be an unpaid consultant.

"Frank" was an experienced timber framer who had done two years of unpaid preconstruction consulting for a major New York firm acting as general contractors for a high-end private house. The preconstruction work involved many emails, phone calls and project team meetings at head office in the city. The scope of the project kept changing, and the client could never quite find time to sign the contract for Frank and pay a deposit. Recently, Frank was advised that the job was on indefinite hold. In short, he got fired and all that work was gratis. He believed that there was a gentleman's agreement in place. But he was wrong. There was no gentleman to be seen nor any agreement.

Frank had spilled his candy in the lobby before getting to the show. He had worked through all the relevant parameters of the project, expecting to be the timber framer. Frank became a victim of unpaid consulting when he crossed the line from diagnosing problems and began providing solutions gratis. The client had no further need of him.

Historically, quotes and basic preconstruction consulting work by timber framers have been free, with the understanding that you go home with the one who took you to the dance. That is to say, ethically, if the client got the job, you got the job as payment for your input. Recently that arrangement has become the victim of selective amnesia. Now when the client gets the job, he ignores the unpaid partner and proceeds to dance a solo en-pointe rendition of the price-checking cha-cha. The unpaid timber framer, with fallen arches and tired joints, shuffles offstage as the sulking understudy for a flamenco version of the death scene from *Romeo and Juliet*.

Whom to blame? Put yourself in the client's shoes for a moment. If you went into a store and they offered you the choice between getting a new computer for free or paying for it, you'd pick free and you would not think twice that the store had made no money for that sale. I know free is my favorite price, for anything. So it's the client's prerogative to ask for your time for free. Let me say that again—it's their prerogative to ask. The most important thing to do is not become frustrated with the client for asking. If you don't like people asking for time for free, and if you don't have a well-defined structure in place for you to be paid, the blame falls squarely on you. You are responsible to establish an alternative to free consulting and to clearly establish early on that your time and expertise have value. If you don't want to talk about getting paid, then get used to working for free.

**What's the comfortable way to move beyond free?** Mack Magee, current Guild president, writing in *Wood Design & Building* 73, noted recently that "Moving beyond an established norm, particularly when the innovation is more demanding, is almost always uncomfortable."

When folks ask you, "How's it going?" reply with your version of, "It's going great. We are busy with a lot more paid preconstruction quotes, raising scripts, site visits and design work. We just finished a consulting contract for work similar to what you are seeking. Paid consulting allows us to avoid free work on highly competitive projects with unrealistic budgets. Engaging a timber framer early on helps to overcome problems with costs and design. Then the project will be fully supported by a realistic budget. A consulting timber framer saves you money, jobsite time and costly errors that only become evident after the job starts."

By mentioning paid consulting often during qualifying, the client will understand that he will need to hire you for preconstruction work. After you have qualified the client's inquiry for service, it will be a smooth transition when you say, "I'm tied up at this moment but I can start on your job, working up a quote (proposal, meeting) tomorrow. But we should take a minute to discuss the retainer and fees normally charged for this work." If you have skimmed over the subject during prior conversations, however, you can expect to hear, "No thanks, I'll go somewhere else." I sadly discovered this in the early stages of writing this article, when I received a couple of inquiries and eagerly launched into some of the initial script ideas (mentioned later). I was met with varying degrees of animosity. What I learned was that the key to success is to talk about paid consulting well in advance. Establish early on that you get paid for preconstruction work, proposals, quotes, wood selection and timber frame expertise.

One main purpose of seeking payment for your time is to motivate those downstream (GCs, architects, engineers) to do their qualifying legwork with owners before calling you. When they know that they will need to pay for your time, they will qualify the budget, schedule, and job parameters before asking you to do work. This will also tell the timber framer if he is in serious contention for the project, or if the client is just price checking and seeking unpaid consulting. Preconstruction consulting will generate a qualified, professional, inquiry that you can quickly convert to a signed contract. The bonus for you when there is a good conversion rate from inquiry to contract, is that you become a preferred customer for your upstream suppliers and professional partners. When the suppliers reduce their cost of sale, you get lower prices, making you more competitive. So in the end both you and the client will benefit from preconstruction consulting.

Transitioning to paid consulting may require a modest amount of free work for your preferred clients. The good news is that they are familiar with you, view you as a partner in their operations, and know the value of what you offer. So they don't want to leave you. Ask them for advice about how to initiate change. Their input will be helpful, and involving them will make the process more collaborative. Advise them that for your next couple of quotes, proposals or meetings, you will make up a complimentary invoice, and follow up with a phone conversation about paid consulting. Discuss that you are changing your system and that in the future charges will apply.

With any change or new plan, inform clients before you do it, while you're doing it and after you've done it. No surprises, no harm. You will find out very quickly which clients plan to continue to value you. Those clients who remain will benefit from focused effort that goes well beyond free work.

**Scripts for avoiding free consulting** Here's a script for how to respond to a request for a site meeting, quote, design advice or preconstruction proposal. Practice on long-term prospects and price-checkers who don't give you work. To lose chronic price-checkers is okay, so just relax and have fun. If the idea of actually paying you money makes them start to sputter, then gracefully end the conversation. With practice your delivery will become more fluent. You have earlier mentioned consulting during qualifying, so the following conversation will be expected.

What you do not explain, or justify, is why you are entitled to be a paid consultant, because there's no need. Just like any seasoned professional your time is valuable. That's a given. Even if you're not used to thinking of it that way yet, get used to responding confidently and clearly, as though you are. Soon, paid consulting will become part of your culture.

Key words: *You called, You asked me, Consulting, Work, Job, Quote, Contract, Retainer*.

1. Thanks for calling me. I'm excited that you asked me to do some work (on the engineering, timber supply, design, planning, frame quotation) for your project.

2. We just finished a preconstruction consulting contract (for a quote, design meeting, proposal, site visit) on a project similar to your job.

3. We can start your job with our basic consulting agreement and retainer.

4. Would you like me to tell you how that works? (Now be silent.)

After Question 4, you are waiting for permission to continue, and putting the prospect in the driver's seat, in control of the outcome. He needs to think about how to proceed, but silently wait for his response. Your advance conversations about consulting will make it easy for the client to move forward. By now he should be curious about how to proceed. When the client says yes, that's great! You can move forward with a new job. You have the green light to get a contract and a retainer, and to start work. Keep your consulting contract and rate sheet handy and move forward.

When the service has historically been free you will often hear "No thanks." Typical comments:

1. We haven't paid (for quotes, meetings, samples) in the past.

2. We don't charge *our* customers (for quotes, proposals, services, etc.).

3. We can get this quoted free from four others, we don't need you. (Good-bye, no loss.)

4. Paying for a quote is not in the budget. We don't do things that way.

5. You can just give me a rough ballpark price, okay?

What to say when you hear "No thanks"? Be polite, don't argue, be defensive or justify. Say:

1. I completely understand.

2. You have my card and contact info, so please call when you are ready for us to work on this project.

3. May I send you photos, information about consulting work on projects similar to yours? (You're seeing if there is hope for the future or not. Go for the No.)

4. I hope that our general information is useful in deciding when you need to hire us.

5. I can't in good conscience give you a ballpark quote, without taking time to learn about your job. A poorly done quote (or other work) could send you in the completely wrong direction, and cost you delays and expense.

**Ballpark quotes and free advice** More than one timber framer has lost work and was rained out or ejected from the game because a ballpark quote was a foul ball. The biggest danger in giving a ballpark quote is that low estimates tend to stick in clients' minds. Often, the client uses your ballpark number to seek financing and preliminary approval for the project. If that number is off, your client has to do some fast talking to explain to his boss, architect or owner why he is changing a budget, even before the project begins, and, of course, you will be blamed. Providing a quote before you've grasped the nuances of a project can put you in a bad position when the full details and final costs are revealed.

Free advice is worth what you pay for it. You need to be clear with clients from the outset that yours is a professional paid relationship. In the big scheme of things, a modest retainer is a tangible token of a serious owner or client who is ready to proceed, and lack of it will filter out indecisive prospects. Working with motivated and engaged clients improves your conversion rate and lowers your cost of sales. The lower cost of sales improves credibility with your service partners, which results in lower prices and better service that will in turn gain you more projects.

Stand firm on getting paid for preconstruction work, and be prepared to walk away. This will show that you have integrity and full respect for your abilities. Legitimate prospects will share that respect. What you do not want to do is hedge, waver or discount. If a project is not awarded to you, the client at least will know that you have been paid fairly for your work, and he will feel comfortable in seeking your input as a paid consultant or as the invited timber framer on future projects. —Bruce Lindsay

*Bruce Lindsay (brucelindsay@shaw.ca) operates Evergreen Specialties Ltd., consultant and timber broker, in North Vancouver, B.C.*

# Homage to the Queenpost Truss

AT THE first Timber Framers Guild gathering in 1985, at Hancock Shaker Village near Pittsfield, Massachusetts, I was wandering around and stepped into a woodworking shop, where the resident carpenter docent was showing some items he was working on and explaining burnishing a scraper to finish wood. I was, as I remember, impressed with the openness of the room (no posts), which had a seemingly large second story above it. The carpenter pointed out the tenons passing down through the ceiling beam and explained that over us was a queenpost truss that supported the ceiling and floor level above.

As a young guy, hyped up to learn what I could about building timbered and log buildings, I was struck by the cleverness and utility of this configuration. Only one long member (the bottom chord) was required; the rafters, posts and spreader member could be relatively short and manageable. To support a roof, principal purlins could be mortised over the queenpost tops and diagonal bracing could run from purlin to queenpost. In this doubly convenient arrangement, common rafters could span shorter distances than when combined with the kingpost trusses which I was more familiar with, and consequently could be smaller. With strong enough tension joints between queenpost and bottom chord, it would be possible also to support a floor at the bottom chord level.

I later discovered that the queenpost truss would conveniently accommodate what became one of my favored features, the ridge skylight. I didn't realize it at the time, but I would come back to this roof configuration time and again in my building projects, in both log and squared timber. —Deane Hillbrand

*Deane Hillbrand (dhillbrand6@frontier.com) operates Hillbrand Woodworking in Sturgeon Lake, Minnesota.*

1

Jack Sobon

2

Photos Deane Hillbrand unless otherwise credited

3

**1 Queenpost truss at Hancock, Mass., Shaker Village machine shop and laundry building (half-view). From left, straining beam, one queenpost and one upper chord (or main brace). Post descends through floor to join exposed tie beam in room below with through mortise and visible kerf-wedged dovetail joint.**

**2 Queenposts and straining beam support 24-ft. ridge beam of garage in Inver Grove, Minn. Upper chords begin at wall posts as braces, then diminish in thickness to pass through bottom chord and bear at queenposts. Architectural design by Katherine Hillbrand.**

**3 Black ash log queenpost truss over author's workshop in Sturgeon Lake, Minn., with mortise and tenon joinery throughout. Scribed purlin splices are bolted, however.**

4 Queenpost truss, 24-ft. span, for poolhouse in Marine on St. Croix, Minn. Squared recycled Douglas fir timber tie beams, with ash log queenposts, upper chords and straining beams, flattened on two sides. Architectural design by Katherine Hillbrand.

5 Unclassifiable assembly with probably unique segmented tie beam in ceiling of house in Cloquet, Minn. Central segments of tie beam were split from ash log to join would-be queenposts.

6 Splayed log posts with grown and tenoned braces near Blackduck, Minn., support scribed purlins in assembly lacking upper chords of queenpost truss but demonstrating advantage of queenposts over kingpost for ridge skylighting.

7 Queenpost truss in Douglas fir spanning 24 ft. for lake cottage in Alexandria, Minn., supports one end of loft while tying into dormer framing. Tapered rafters, queenposts, upper chords.


1 **Cupola under construction for house in central Vermont.**

Photos Adam Miller unless otherwise credited

# Pursuing the Guitarde

I HAD been hesitant to take on compound framing projects. While hips, valleys and gable dormers intrigued me, rarely did they find their way into my work. The complexity of the joinery design and a lack of confidence in its execution made for difficulty in estimating, but I did not want to get complacent about shortcomings and let that limit my work.

With the interest to learn compound joinery more or less firmly planted, how to proceed? My mind does its best thinking graphically, so I turned first to my toolbox to find my framing square staring back at me. Time to unlock some of the higher possibilities of that most ubiquitous of layout tools. With half a bookshelf of old steel-square treatises in hand, the mental knot around regular pitch, regular plan hips and valleys loosened. Now I could employ the framing square as a graphical calculator for these situations. I started to imagine gable dormers everywhere and fancy cupola roofs along every ridgeline.

With new confidence in the use of the framing square, I read through Will Beemer's excellent series of compound joinery articles (see TF 70, 71 and 73), particularly those presenting fundamental developed-drawing concepts. In the midst of this exploration, at work I was tasked with fabricating a large cupola roof with curved hip rafters and a bow top dormer on each side (Fig. 1). But framing-square techniques were not going to be of much help on a roof frame where the only things not curved were the eaves lines—and this work was on the clock. All through the many glueups for laminated components, using computer models and templates, a question nagged at me: How do I figure out the backing for those curved hips? While I knew the backing angle must vary along its length, following the changing roof pitch, that's all I knew. In the end, I derived the hip backing empirically, using a spirit level carefully oriented across the roof plane to directly describe the lower edge of the hip backing.

At the 2014 Guild conference in Manchester, N. H., I sat in on Patrick Moore's presentation called "L'art du trait" (the art of the line—in effect descriptive geometry) and his educational experience in France to become accepted as a *Compagnon*. In a densely packed hour, he touched on the length, breadth, and depth of the thousand-year-old tradition of the Compagnon's *tour de France*. Patrick provided French carpentry manuals to leaf through, full of *épures*, the developed drawings at the heart of the Compagnon's layout practice. Appearing as convoluted matrices of lines dashing off in all directions and yet following a distinctly rational system of drafting, these graphical solutions to complex framing situations left no doubt about the tradition being a science as well as an art (Figs. 2 and 3).

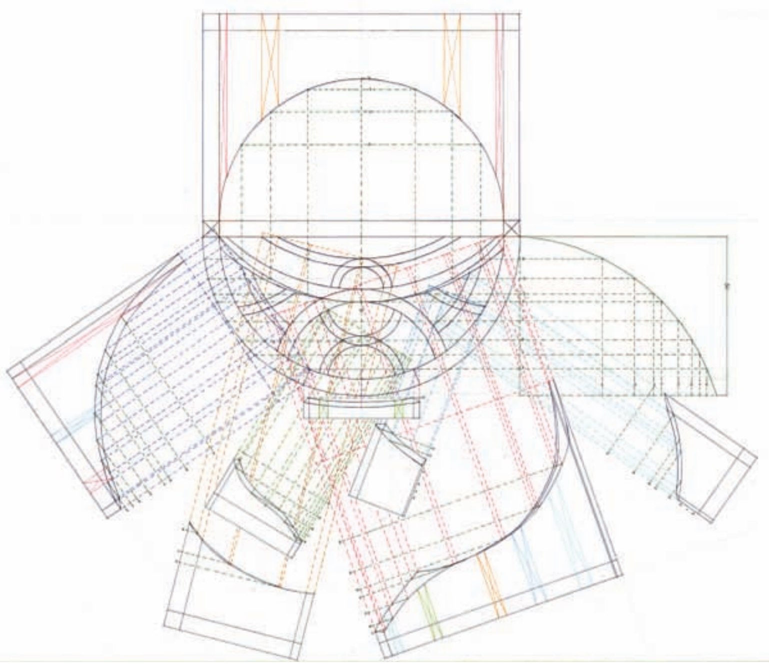
The two weeks I then spent studying *l'art du trait* with Patrick at The Heartwood School in 2015 yielded the most intense learning experience of my life. Through lectures, drawing and model building, often for 14 hours a day, my five classmates and I sought to develop our capacity to think in three dimensions and communicate it on paper (Fig. 4). Our struggles were amply matched by our successes.

Using what was left of my years of French classes, I began to pick through French carpentry manuals, particularly those of the Billon Frères (*L'art du trait de charpenterie*, ca. 1900) and Louis Mazerolle (*Traité théorique et pratique de charpente*, ca. 1884), both lately reprinted. The Billon Frères I found more accessible, but the Mazerolle includes an invaluable glossary of the innumerable technical terms that make up the substance of both texts.

I wanted to build a series of models to learn from, starting with something I could comprehend largely from the drawings. I settled on a progression of three overhanging dormer roof forms in Billon (Fig. 5). The first, a *capucine*, is defined by its rectangular plan and the addition of *empanons*, or jack rafters (Fig. 6). The second is a capucine with a similar basic structure to the first, but with the addition of numerous *tenailles* ("pincers") or ties (Fig. 7). The third model in Fig. 5 is a *guitarde*, defined by its half-round plan.

All were based on variations of hip framing already familiar to me. The capucines show the solution to the problem of backing a curved hip, encountered earlier, and build on that by being irregularly pitched. The guitarde then does away with straight members entirely, the hips replaced by a pair of large guitarde ties. The prospect of drafting and cutting multiply curved compound members firmed up the curriculum.

L'art du trait is a system that accurately represents three-dimensional structures in two-dimensional working drawings detailed for efficient layout of the component parts. The drawing describes every surface of the model's parts. Two dimensions are in



2

Erwan le Vourch    Coyau / Wikimedia Commons

**2 At left, *épure* (developed drawing) by author of *guitarde* model based on Plate 91 in Billon Frères, ca.-1900 standard French carpentry manual. Half-round plan view in black at center surrounded by elevations of individual parts. Blocks marked with X show where parts abut, in respective colors. Centerline elevation in dark green with hash mark on righthand side. Righthand and lefthand parts are mirrored.**

Will Beemer

the plan view that lies at the heart of the overall drawing; the third dimension is described by the elevations of the individual parts or assemblies, as shown in Fig. 2. This is as true for twisting, curved surfaces as it is for flat, straight ones, though in practice curved lines are described by lofting their form through a series of points defined by the drawing. I like to think of this process as a graphical form of calculus for carpenters. A successful structure using this system is a physical proof of both the conceptual framework and the accuracy of the lines put to paper in the drawing.

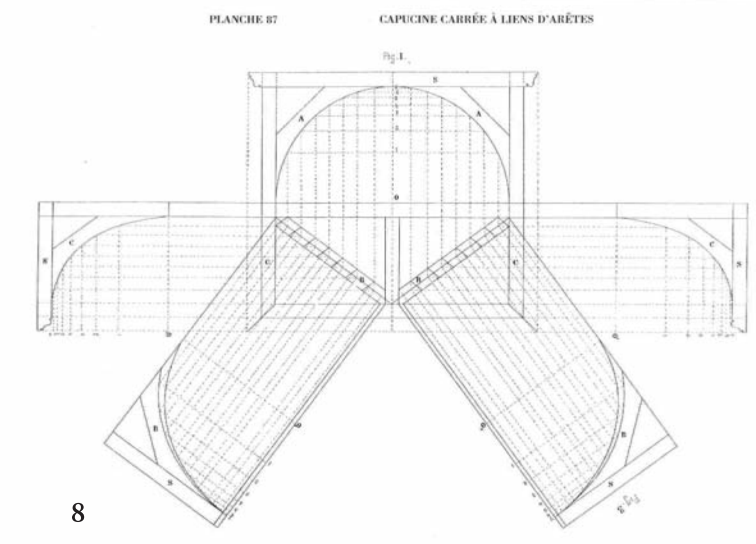
**3 At top, French guitarde dormers. At left, guitarde in Mehun-sur-Yèvre (Cher). At right, guitarde in Chartres (Eure-et-Loir).**

**4 Author (at right) in discussion with Patrick Moore, a recently qualified *Compagnon*, at Heartwood School in Becket, Mass.**

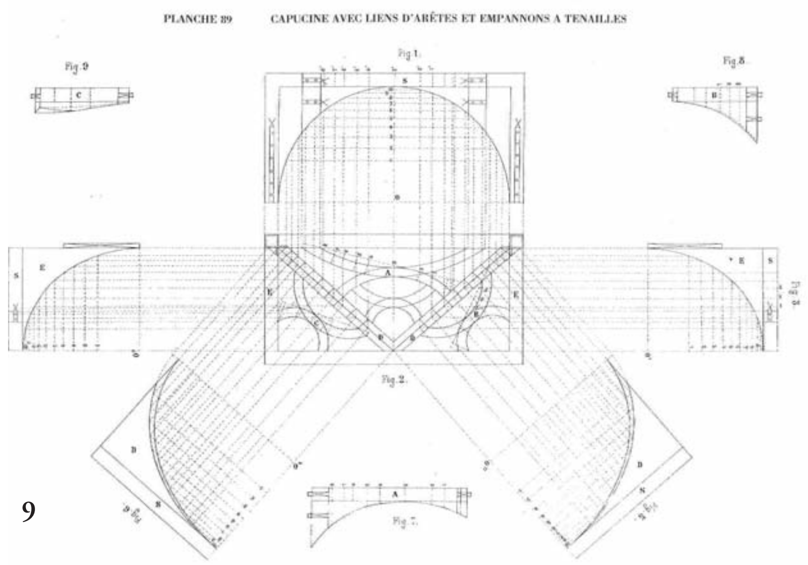
**5 Three dormer frame models, two *capucines* and one guitarde.**

**6 Model of capucine with *empanons*.**

**7 Model of capucine with *tenailles* or guitarde ties.**




8

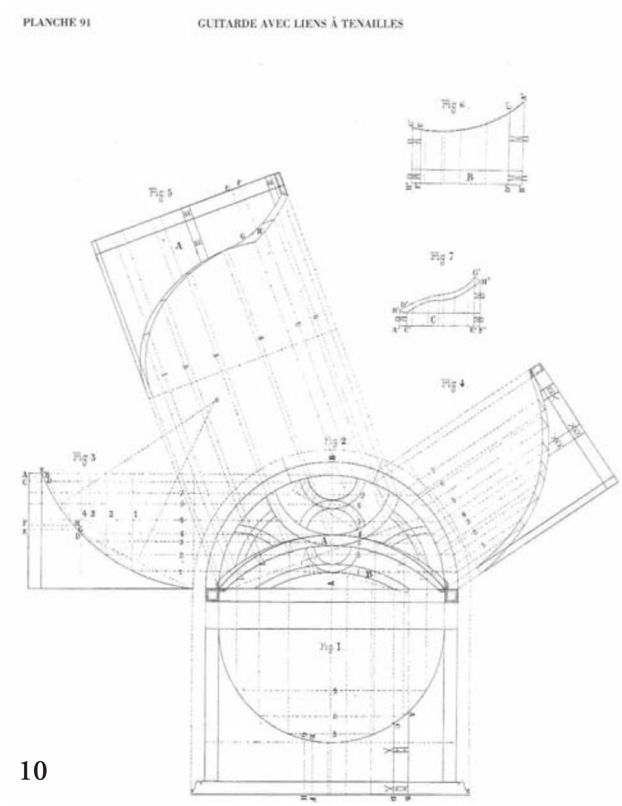



9

**The Capucine with Empanons** (Fig. 6) Determining the asymmetrical backing for the unequal-pitched hip was my greatest challenge in drawing and building this model. Billon Plate 87 showed only a single backing on the elevation of the hip and the text mentioned "the little line," whose application I did not understand, in laying out the backing. As a result, I took an approach that led to a more cluttered drawing showing in elevation the backing on each side of the hip.

After gaining more experience by completing this and the next model, I started to understand how this little line works to show in plan the angle across the width of a straight hip between points of equal height along the curved backings, elegantly evolved over the more cumbersome method I used. This little line is an example of the detailing that makes an épure an efficient working drawing, emphasizing the three-dimensional relationships on the paper. The Billon plates were at times puzzles as much as guides, and working through these puzzles provided some of the best lessons.

After completing the capucine as shown in Plate 87, I decided to include jack rafters as shown in Plate 88 (not shown), by first adding them to the plan view, then to the existing related elevations. In an otherwise complete drawing, these two steps quickly give the length, width, height, angle of cut against the hip, and shape of the elevation's curve along its length.




10

Plates from Billon Frères, *L'Art du Trait de Charpenterie,* 2001, Éditions H. Vial

11

**8 At top left, Billon Plate 87, basis for author's model in Fig. 6, illustrates how elevations of its various components fold down around central plan view. Épure shows side view and hip elevations on both right and left sides, mirrored. Note "little lines" running across plan view of hips.**

**9 At top, Billon Plate 89, basis for model in Fig. 7, adds guitarde ties to structure otherwise very similar to Plate 87. Note elevation views of minor components drawn in locations unrelated to their positions in plan view.**

**10 Above, Billon Plate 91, basis for model in Fig. 11, shows conceptual evolution over Plates 87 and 89 to deal with half-round plan: centerline elevation is to left of plan view and determines proper placement of elevation lines for many guitarde components. (Elevations for several components are not included in this épure.) Compare arrangement of elevations here to Fig. 2, author's drawing for same model.**

**11 Guitarde model completed with half-round plan and principal guitarde ties.**

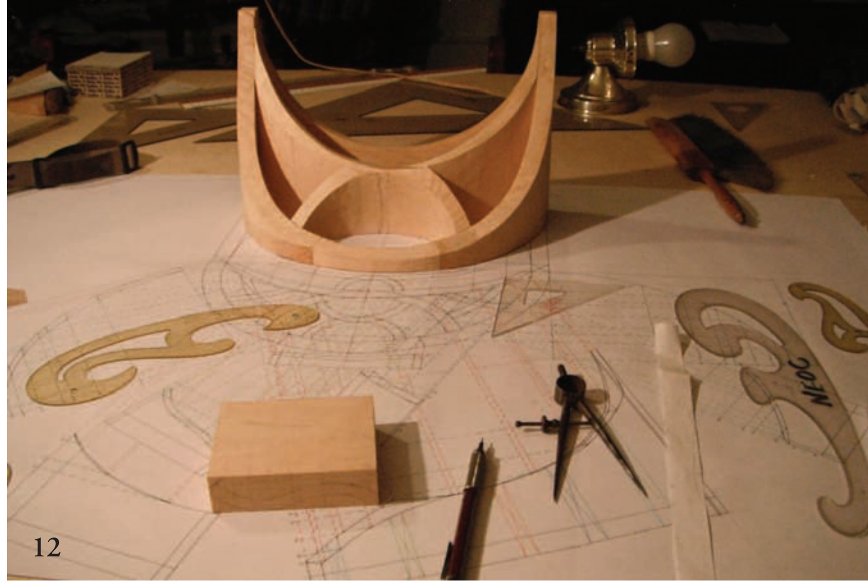
**The Capucine with Guitarde Ties (Figs. 7 and 9)** Following Billon Plate 89, the second model was a lot more intimidating than the first. Though their proportions vary a bit, however, the basic structures of these two models are nearly identical. The second model adds a lot of practice drafting and cutting guitarde ties.

Naturally, the épure grows more complex with elevations of an increasing number of parts. While it is possible to use story poles to draw independent elevations of the minor parts, I prefer to keep their positions geometrically related to the plan view, as shown in Fig. 2. This allows for faster and accurate transfer of lines, serves as a reminder of an elevation's relationship to the larger structure and allows for efficient reference and investigation of questions.

Unlike in the first model, where each elevation was composed of a rafter and a separate plate, in the second and third models the parts are solid in elevation. The principal parts consist of a plate laminated to a rafter with grain running parallel to its length to minimize weak cross-grain sections along the curves. Though in a full-size guitarde the depth of the stock required would become ponderous, and so is often reduced away from the plate height, the solid elevations allow all the end cuts to be laid out square to the plates.

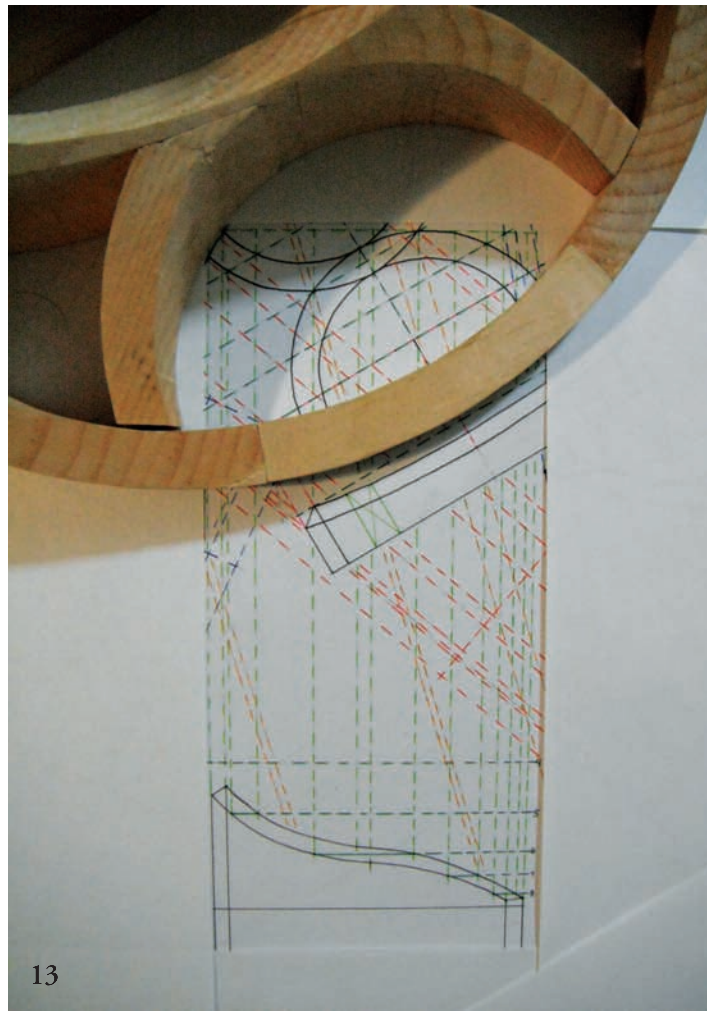
**The Guitarde (Figs. 10 and 11)** I took time to study Plate 91 in Billon to understand how the arcs of the curved components related to each other. This understanding gave me a stronger approach to drafting the épure for this model. As I built it, I discovered an error in my drawing. Though never a pleasant experience to find an error, the logical process and geometric relationships embodied in the épure required nothing more than comparing one pair of dimensions and a few additional tick marks to correct the errorand to identify ramifications in other parts of the drawing.

The increased difficulty and finer points of building the guitarde compared to the two capucines were not, as I had at first assumed, principally related to its half-round plan, but rather to the fact that the axes of the other two cylindrical forms, set perpendicularly to each other, lie at differing elevations and are of different diameter. This led to a lot of head-scratching in both the drafting and the cutting of the principal guitarde ties, the lower portion of which form a hip curved in both plan and elevation, the curve reversing where the ties cross, arcing up to the plate along a single cylindrical form. Laying out and cutting these ties was a true test of patience.



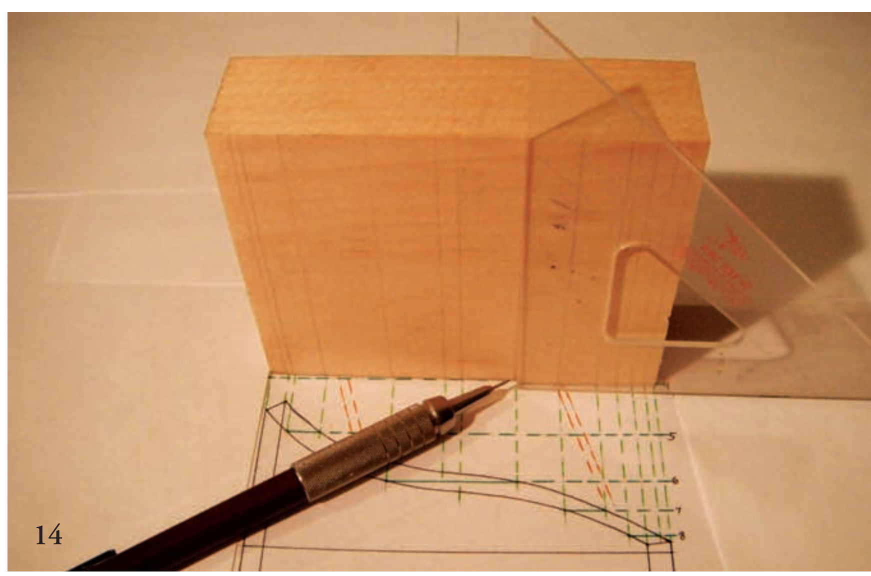
12

**Fig. 12** Along with a good drafting pencil, a small drafting triangle, sturdy dividers, a paper story pole, and a good selection of French curves, the full-scale drawing becomes an efficient and reliable layout tool. The stock for each part should be square and true.



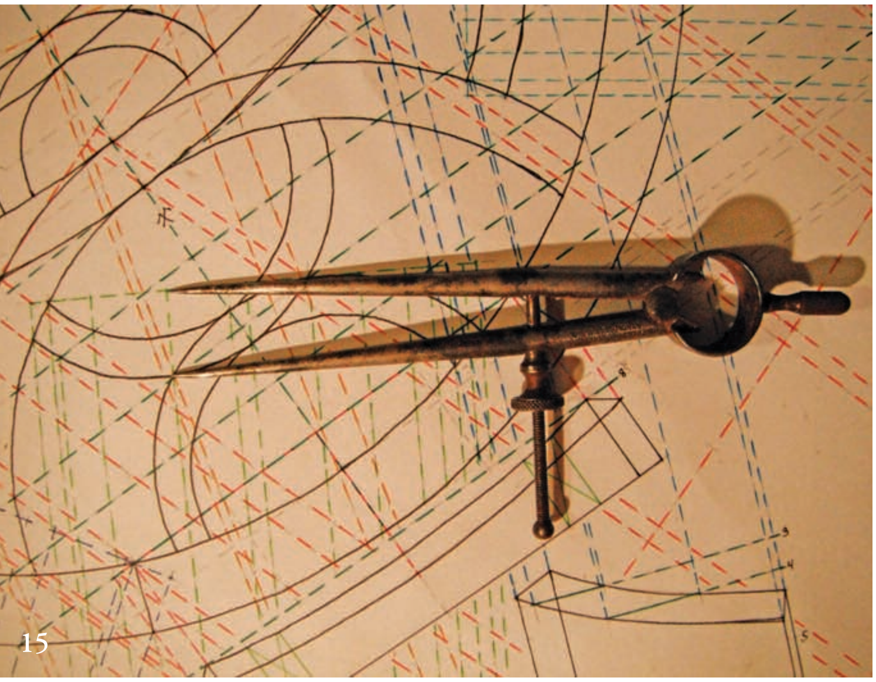
13

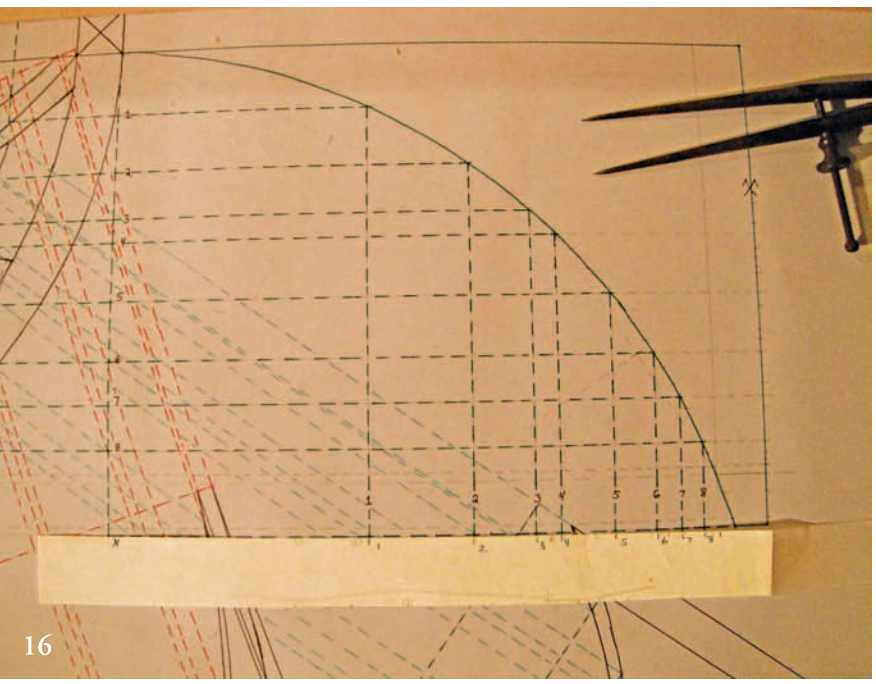
**Fig. 13** The masked épure shows the plan (horizontal S-shape at top) and folded-down elevation (bottom) of a small secondary guitarde tie and its location in the model. Light green (vertical) dashed lines relate points between plan and elevation. Dark green dashed elevation lines (diagonal in plan view and horizontal in elevation view) intersect with light green lines to define points along both curved edges of backing.



14

**Fig. 14** Reference lines are transferred directly from drawing to workpiece using a small drafting triangle and a 0.3mm mechanical pencil. Lines are chased around the workpiece onto all relevant faces similarly, using the drafting table as a reference surface.





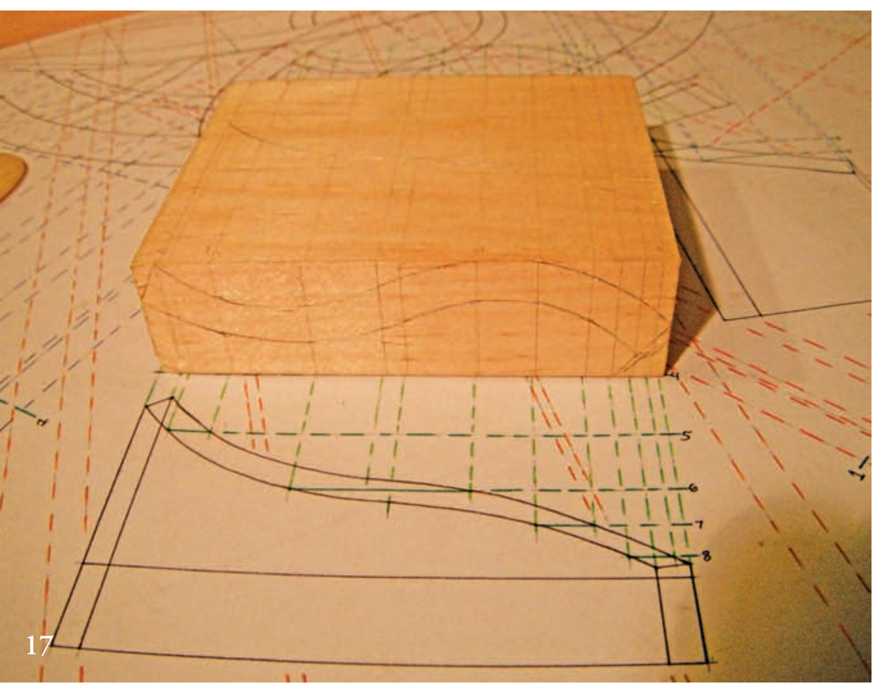


**Fig. 15** Shape in plan is transferred to the workpiece by marking waypoints along its length. The line is completed with French curves. The reference lines represent both points of height common to all elevations and points relevant to the individual part, such as its four corners and intersections with other parts. The upper leg of the dividers rests on the hinge line representing one edge of the workpiece stock; the lower leg is at the intersection of the guitarde tie and its mirrored twin.

**Fig. 16** The story pole (paper strip along bottom edge) used to transfer waypoints along the shape in elevation is derived from the centerline elevation of the guitarde, shown in dark green on the right side of the épure (Fig. 2).

**Fig. 17** Layout of plan and elevations on workpiece complete.

**Figs. 18–20** The model parts are quite small (the guitarde model is just under a foot wide) and so require a cutting technique different from full-scale construction:

A. Saw kerfs to guide the cutting of the shape in plan.

B. Rough in elevation first with coping saw to reduce shaping time.

C. Hold workpiece with scrap blocks nailed to a fixture board.

D. Form shape in plan with chisels. Outside curves can be faired with a block plane working across the grain.

E. Check accuracy with the small drafting triangle as in the original layout marking process.

F. Following completion of the plan shape, mark the shape in elevation on each side of the curved workpiece, describing its varied, rolling surface. Shaping in elevation can be done primarily with knives. (I used Swedish sloyd knives.)

**Figs. 21 and 22** With some careful fitting, the completed guitarde tie is installed in the model.

IN pursuing the guitarde, a combination of fundamental instruction, motivation and a well-suited series of practice exercises can realize one's goals. The models posed in order reveal a progression in learning to think and reason in three dimensions, a most satisfying learning experience.

Working just beyond what is comfortable and familiar is how we improve our craft. By purposely putting ourselves in this situation, through practice toward a goal, we gain the confidence necessary to pursue ever higher levels of competence. The production environment takes a necessarily dim view of risk, embodying what it can of David Pye's concept, in *The Nature and Art of Workmanship*, of the workmanship of certainty. To grow our craft through the workmanship of risk (another of Pye's telling categories), we need to spend educational time off the production floor, where we are free to stop and ponder, stretching our mental and manual acuity. Success here means that it has to be okay to spend ten hours crafting what turns out be a beautiful piece of firewood. Without the room to "fail," we miss some of the greatest opportunities to learn. And without that learning and confidence in our capacities as craftspeople, what happens on the production floor will never be able to reflect what we are truly capable of as passionate and skilled craftspeople.

This practice is a meditation on the craft, with opportunities to seek clarity through patience and acceptance rather than succumbing to frustration. The Compagnon's origin myth begins

18

19

with the construction of the First Temple in Jerusalem, reminding us that all our highest aspirations and efforts are steps toward realizing something of the infinite. —Adam Miller

*Adam Miller (rangeradammiller@gmail.com) is lead timber framer at The Wooden House Company in Wells River, Vermont.*

**Resources**

Ayers, Sim. sbebuilders.blogspot.com.

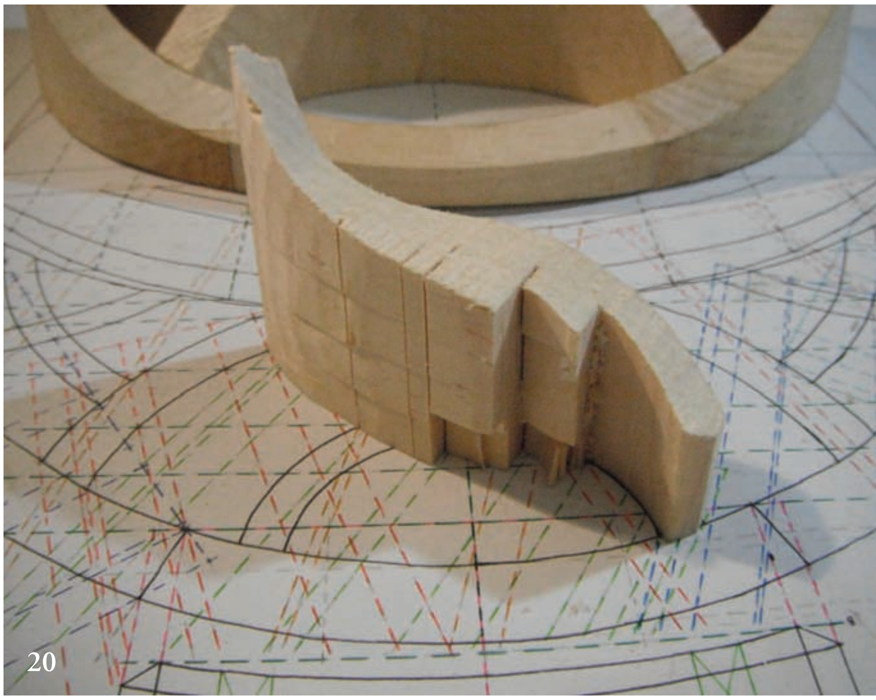
Billon Frères. *L'Art du trait de charpenterie*, ca. 1900. Dourdan, France: Éditions H. Vial, 2001 (text reset, drawings reproduced). ISBN 978-2-85101-041-7.

Hall, Chris. thecarpentryway.blogspot.com.

Mazerolle, Louis. *Traité théorique et pratique de charpente*, ca. 1884. Dourdan, France: Éditions H. Vial, 2002 (reprint). ISBN 978-2-85101-014-8.

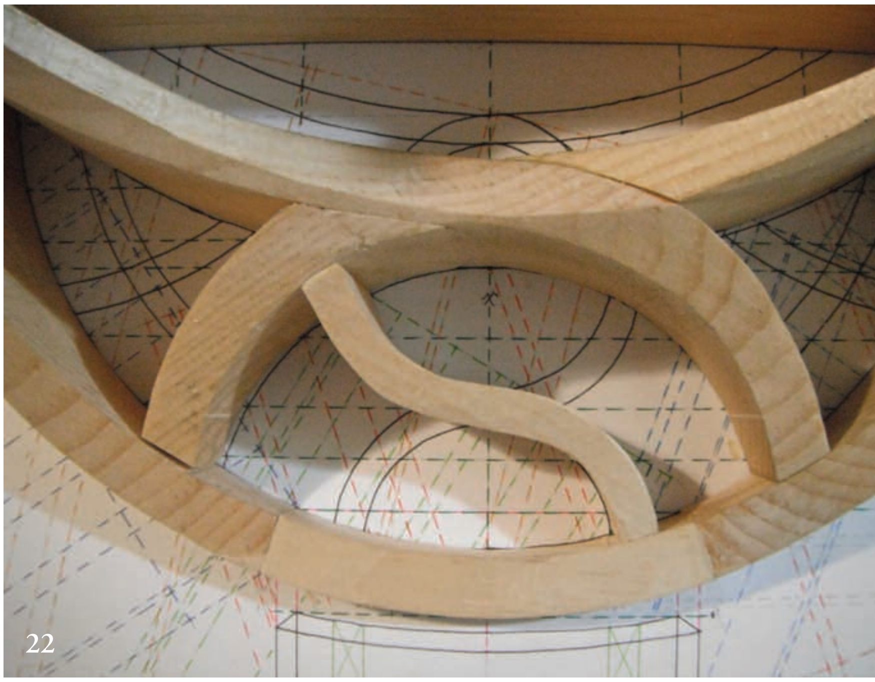
Moore, Patrick. historicalcarpentry.com. A wealth of information on l'art du trait, including a photo gallery of guitardes.

Pye, David. *The Nature and Art of Workmanship*. Bethel, Conn.: Cambium Press, 2002 (reprint). ISBN: 0-9643999-0-3.



20

21



22

PUBLISHED BY
THE TIMBER FRAMERS GUILD
1106 HARRIS AVENUE
BELLINGHAM, WA 98225