



Joshua Coleman

## Blenheim Bridge, a Restoration

*"It's unlikely that any framer will ever again construct an object this ambitious in timber."—Jan Lewandowski, TF 102*

**I**N December 2011, *Timber Framing* published an article by Jan Lewandowski about the Blenheim, NY, covered bridge, presented as "a Remembrance" since it had, just months earlier, been washed from its abutments by the flooding Schoharie Creek. In his article, Mr. Lewandowski reflected, "It's unlikely that any framer will ever again construct an object this ambitious in timber." This unlikely opportunity presented itself in the form of an invitation to bid. As we sought to learn more about the scope and scale of the project, the prospect did indeed seem excessively ambitious. Having had just enough experience in repairing and rebuilding covered bridges here in Pennsylvania to have been struck with the desire to do more, the idea of putting together a proposal for the reconstruction of the mighty Blenheim bridge was intoxicating. Thankfully, we had the good fortune of aligning ourselves with Stan Graton, a descendant of Bridgewright Milton Graton. Stan's guidance, based on vast experience, brought balance and skill to our raw ambition. Being awarded the contract for the design and manufacturing of this giant was quite exciting, and once the reality set in there was nothing left to do but roll up our sleeves and dive in. As so many of us have experienced, there are some projects that just seem to wash over us like a tsunami and while we're in the mixed-up wash of the wave, it's hard to see which way is up. The wave inevitably passed and once our feet hit the ground, we stood up, dazed but grinning at the exciting opportunity before us. Working on the Blenheim bridge reconstruction was most certainly one of these experiences. We feel a debt of gratitude to those who came before us, who have passed on the knowledge, experience, and value of these amazing structures, and for the rare opportunity to once again construct an object in timber as ambitious as the new Blenheim bridge.

**A Brief History** The Blenheim covered bridge was built in 1855 by Nichols Powers at an overall length of 228 ft., with a free span of 210 ft., in North Blenheim, NY. This timber structure, spanning across the Schoharie Creek, stood as an inspiring example of innovative covered bridge construction for over one hundred fifty years until it was destroyed by the flood caused by tropical storm Irene in August 2011. The bridge had become entwined with the identity of the town of North Blenheim, and its absence was felt sorely by locals and covered bridge enthusiasts alike. Through the long-enduring efforts of these bridge supporters, funding was procured for the reconstruction of the bridge, which was completed in 2018, providing ample occasion for a team of timber framers and contractors to take part in a project which would prove to be the opportunity of a lifetime.

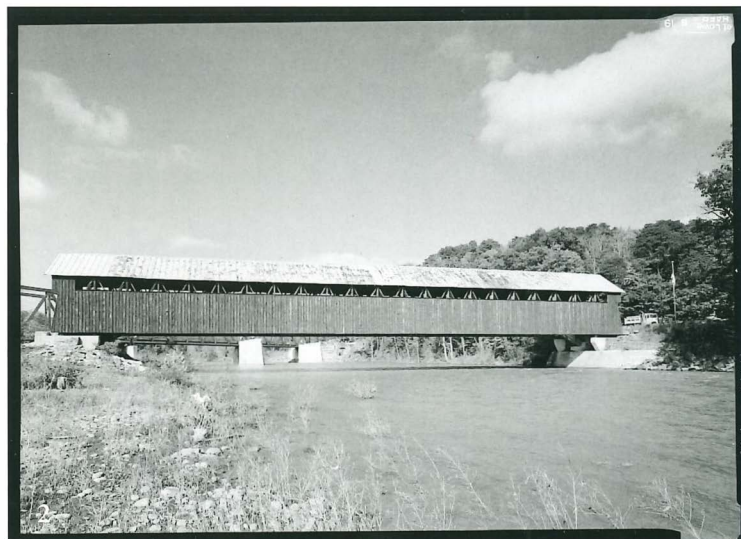
**Nichols Powers: Bridge Builder** Nichols Powers was a classic example of early American resourcefulness and Yankee ingenuity. Throughout his varied career he capitalized on the innovations of the age, sustained by the demands of a constantly developing country. One noteworthy example of his engineering skill was when he moved the bell tower on the Rutland, VT, County Courthouse from the center of the building, where it often disrupted the court proceedings, to the front of the building where it stands today "despite the insistence of . . . superintendents that it could not be done" (*Rutland Herald*, June 20, 1952). As Powers continued

**1** As viewed from the west shore, the new abutments of the bridge stand approximately 11 ft. higher than the original.

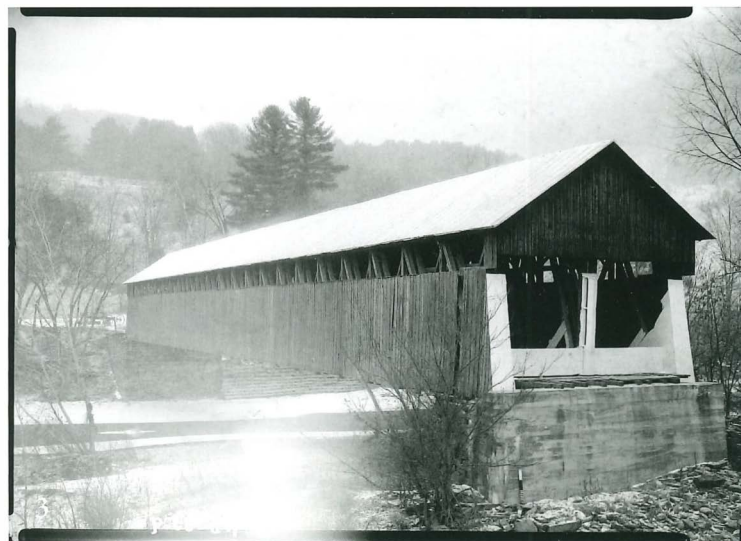
to operate and run his farm and dairy in Clarendon, VT, he also began to develop his reputation for bridge building. While he was in Schoharie, NY, to repair a covered bridge, he was contacted and later commissioned by the Blenheim Bridge Company to design and construct a bridge across the Schoharie, in Blenheim, at a cost of \$6,000. Interestingly, the Blenheim Bridge Company was incorporated in 1828 but there is little record of what bridges may have existed prior to the one built by Powers. According to the Historic American Engineering Record (HAER NY-331), a strong impetus for the construction of this bridge was the commercial interest of a local businessman, Major Hezekiah Dickerman, who sought access to the hemlock bark on the opposite side of the Schoharie Creek for his newly established tannery. This bridge was not the longest of its time, but it would turn out to be the longest surviving bridge of its kind and is certainly considered to be Nichols Powers's masterpiece.

In 1886, Powers did go on to build the PWB (Philadelphia, Wilmington, Baltimore) Railroad bridge across the Susquehanna River in Havre de Grace, MD, which consisted of 12 spans of 250 ft. and a draw span of 175 ft. It would be amazing to see a wooden bridge that was over 3000 ft. long but unfortunately the original was replaced by a steel structure (see Fig. 4) soon after, demonstrating the fast pace of the changes occurring during the industrial revolution.

**Innovations in Construction** In the course of construction, the Blenheim bridge was assembled twice. The first time, the timbers were cut and assembled on the west side of the Village of Blenheim. This process allowed the foundation and abutments to be constructed concurrently with the carpentry work on the bridge. Additionally, it gave an opportunity for the design and engineering of the bridge to be tested and proven before attempting to span the Schoharie. When the initial assembly was completed, the falsework was then constructed, most likely while the bridge structure was being disassembled, which was then relocated to the site for reassembly on the awaiting falsework. There is an anecdote of Nick



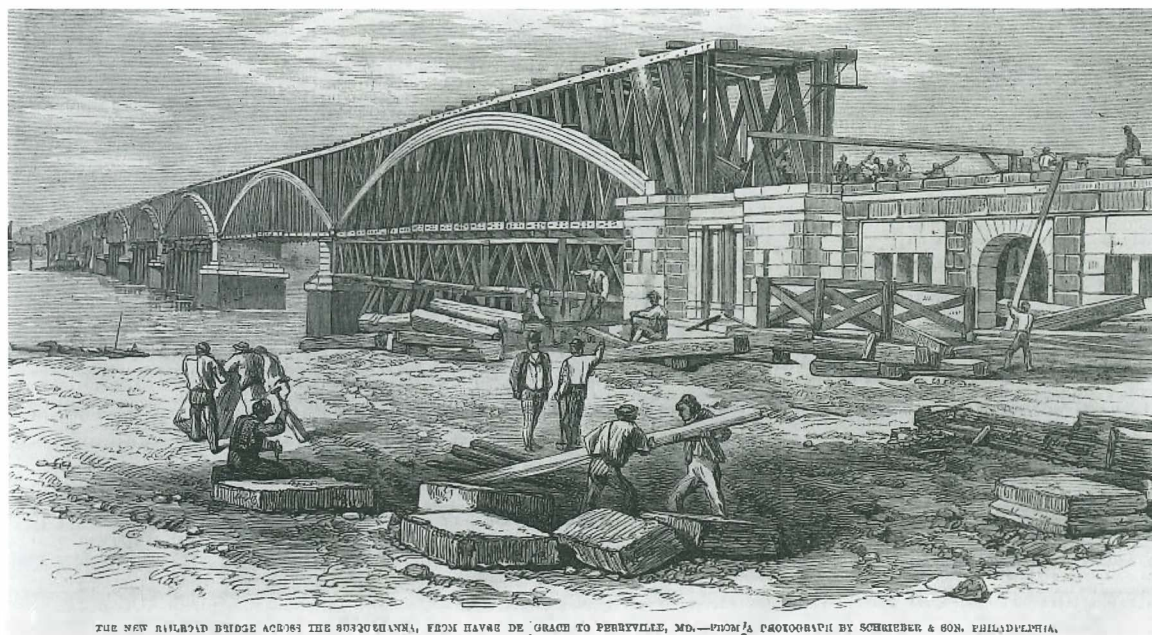
HAER NY-331



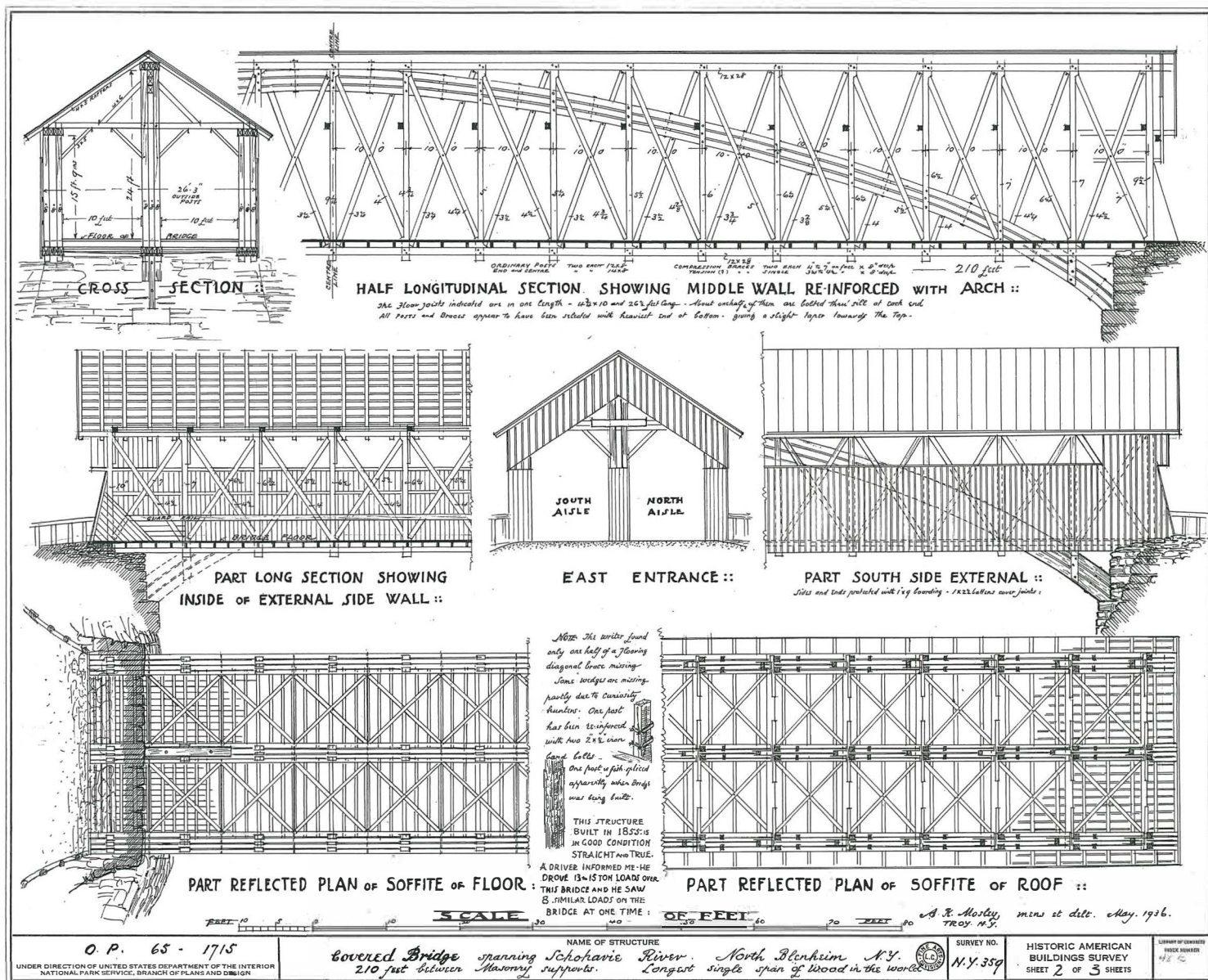
HAER NY-331

2 Photographs of downstream elevation (1938 survey).

3 View from west shore (1938 survey).



4 Drawing of Philadelphia, Wilmington, and Baltimore Railroad bridge being built by workers directed by Nichols Powers in 1866. Note the falsework supporting the closest span still under construction as compared to the spans already completed beyond (engraving from *Frank Leslie's Illustrated Newspaper*, Dec. 22, 1866, p. 217).



HABS NY-359

Powers, as retold by his grandson in 1952, that he sat on the ridge of the bridge as the last piece of the support trestle was removed, claiming that "If this bridge goes out, I never want to see the sun rise again." This claim was perhaps as much dramatic spectacle as it was self-confident bridge builder since the structure had already been built once, leaving little doubt that it would support itself once in its final location. Regardless of any implied showmanship, the Blenheim bridge was most certainly one of the giants of covered bridges, and the design has stood the test of time.

**Preservation** In the 1930s, plans for a new steel and concrete bridge threatened the fate of the Blenheim bridge but through the efforts of several advocates, the bridge was retained as a public historical relic. The concrete and steel bridge was built and the Blenheim bridge taken out of service, but it remained as a link to the history of the covered bridge era, open to the public for pedestrian use and inspiring visitors for generations to come.

It is noteworthy that there had been a span of bridge connecting the road to the abutment of the covered bridge, which washed out several times through the years. It was the loss of this span in 1930 that drove the need for the steel and concrete replacement

5 Part of a set of drawings from the 1936 Historic American Building Survey showing the various aspects of the bridge configuration and details. This set of drawings was a useful resource to help reproduce much of the joinery since the scant remnants of the frame were mostly destroyed.

and so the connecting span was never replaced. Consequently, the western end of the Blenheim bridge has been without a point of access since that time. It was this unique characteristic which enabled the supporters of the restoration effort to obtain funding from the Federal Emergency Management Agency (FEMA). After several unsuccessful attempts to gain funding for the replacement of a "bridge," the supporters cleverly submitted the request as a "pier," which was ultimately approved. In the strictest definition, the Blenheim bridge is a "platform supported on pillars or girders leading out from the shore into a body of water" which is the very definition of a "pier."

In 1936, a series of hand drawings were made by A. K. Mosley for the Historic American Building Survey (HABS) showing the overall configuration, member sizes, and connection details that are found on the bridge (see Fig. 5). The artistic aspect of these

documents is simply beautiful, and the care taken to show the various elevations and perspectives is inspiring. It is fun to imagine being tasked with the job of spending so much time getting to know the intimate details of the bridge and making careful sketches from various vantage points. My favorite note on the drawing states “A driver informed me — He drove 13–15 ton loads over this bridge and he saw 8 similar loads over the bridge at one time.” Talk about load testing!

**Which is the longest** There is always a tendency in human nature to want to have the biggest or best, and the claim of longest bridge is certainly one of those categories. There is, to a certain extent, a competitive aspect to this claim that encourages very specific qualifiers to limit the number of competitors and push a favored

candidate to the top. The Blenheim bridge, when it was built, was not the longest by any stretch since there were many that preceded it with much greater lengths. The fact that this particular bridge has lasted so long may have more to do with the relatively rural setting and a wide river valley with plenty of room for both the historic covered bridge and the modern bridge built in the 1930s. Besides the Blenheim bridge, there is another contender for the world’s longest single-span covered bridge, the Bridgeport covered bridge in Yuba, California, built in 1862. This single-lane Howe truss with an auxiliary Burr Arch (see Fig. 6) has sugar pine (*Pinus lambertiana*) shingle siding installed tight to the exterior surfaces so that the curves of the arches are visible on the exterior. This structure has, for the last few years, been supported by a temporary steel suspension cable system, but it will not be so for long. I recently learned that, at



Mark Yashinsky

**6** The profile of the auxiliary supporting arch on the outside face of the Bridgeport bridge in Yuba, CA, can be seen clearly under the sugar pine shingle siding.



HAER NY-331

**7** The concrete extensions added by Milton Graton in 1972, in contrast to the original stonework, shortened the span but extended the life of the bridge. Note the steel bridge in background which replaced the old Blenheim bridge.



Gerald Felter

**8** The flooded Schoharie Creek threatens the Blenheim bridge as the water level continues to rise during Tropical Storm Irene in August 2011.



Courtesy Windfall Films

**9** Two trusses, the interior and one of the exterior trusses, are assembled on a frame of steel tubing. The camber of the trusses is evident even from this distance.



Courtesy Windfall Films

**10** Two crawler cranes support the interior truss as bracing is installed. There is just enough room in the laydown area for the remaining exterior truss to be assembled and stood up in the same manner.

the time of this writing, the Bridgeport covered bridge is currently being restored, with plans for completion in 2020.

The issue of measuring the clearspan length of a bridge is knowing which points of the structure to measure. A commonly accepted basis for measurement is from face to face of the abutments. In the instance of the Blenheim bridge, the face-to-face measurement has historically been recorded at 210 ft. The Bridgeport covered bridge, on the other hand, has an average face-to-face measurement of 209 ft. By these measurements, Blenheim has been shown to have the longest clearspan, which has been the conclusion of most covered bridge enthusiasts for many years. The twist in the story comes with the repair of the Blenheim bridge by the famous bridge builder, Milton Graton, in 1972. The bearing ends of the bridge were suffering from rot and Graton added concrete support arms, effectively reducing the span of the wooden structure but extending the life of the bridge well into another century. Since the funding of the bridge's replacement had the strict mandate of replacing what was damaged in the storm, the concrete support arms (see Fig. 7) were reproduced in the new abutment design. As a result, the effective span of the wooden structure is 200 ft. although the face-to-face measurement on the abutments remains at 210 ft. In any event, the size and span of both beautiful bridges will continue to inspire and awe generations. (It's not a race . . . unless you're the winner!)

**Goodnight Irene** In late August 2011, Tropical Storm Irene bounced along the East Coast until finally heading inland near New

York City and moving slowly north through New York, Vermont, and New Hampshire, flooding nearly every river valley in its path. As with many others, the Schoharie Creek was flooded beyond its capacity. Until Irene, the Blenheim bridge had withstood many floods but as the flood waters rose, the bridge began to lift from its foundation, enough that the force of the rushing waters carried it away until it encountered the Route 30 steel and concrete bridge just downstream. The water level reached just below the new bridge, and the mass of the timber structure floating down the creek was projecting out of the water just enough that the entire structure was sliced right in two with the roof framing settling on the unyielding concrete bridge and the rest of Nichols Powers's masterpiece passing underneath like so much firewood.



Courtesy Windfall Films

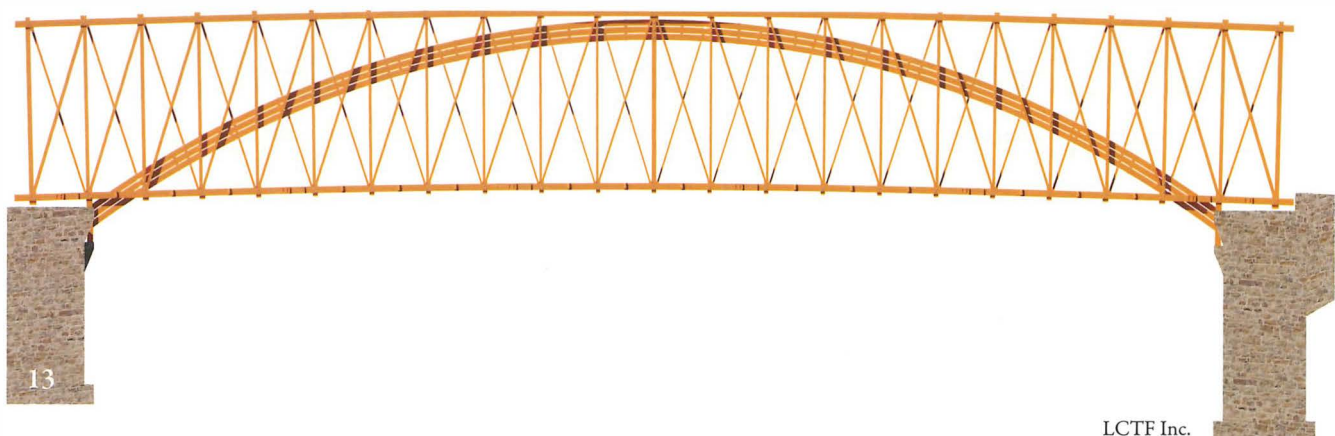
**11** One rafter saved from the original structure was installed in the new roof as a remembrance of the structure that Nichols Powers built over 150 years earlier.

**12** Completed timber structure ready for roof framing and siding.

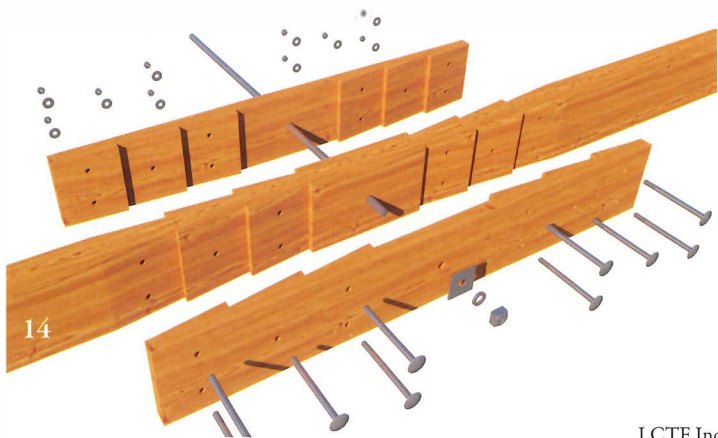
**13** CAD drawing of the interior Howe truss, 28 ft. tall, featuring the tripled arch enclosed by double posts and quadripartite bottom chords. The confluence of these members at the point where the arch passes through the bottom chord results in seven layers with intersecting joinery.



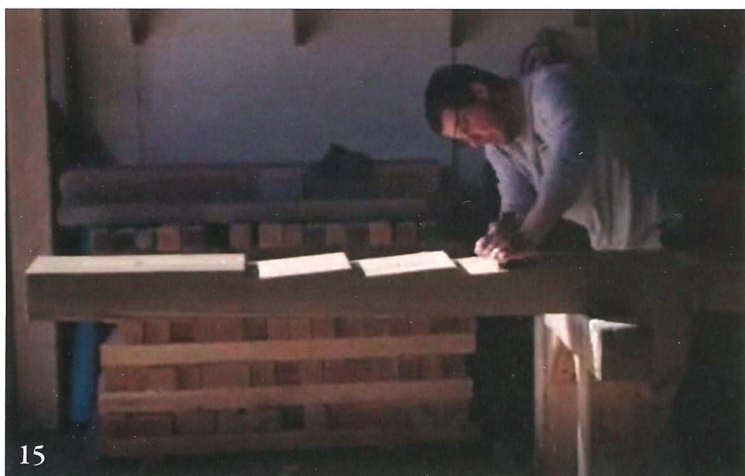
Stan Graton II



LCTF Inc.



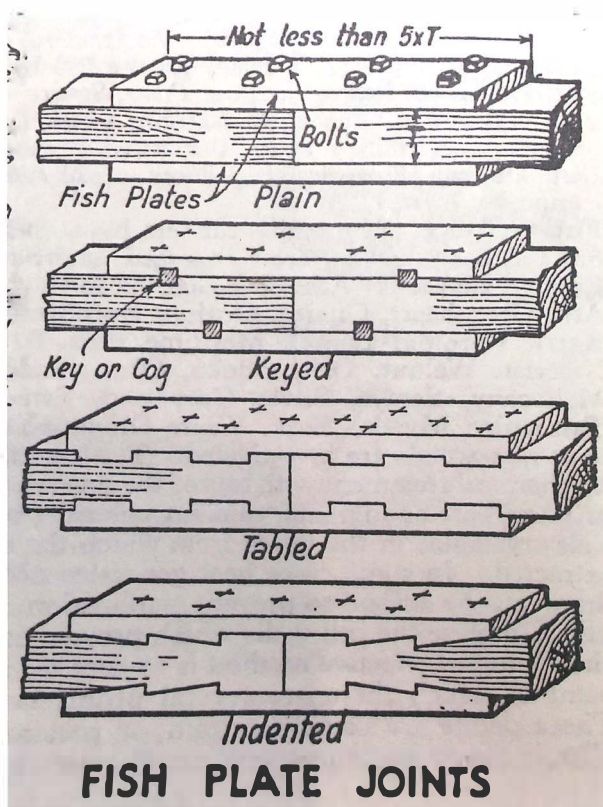
LCTF Inc.



Joshua Coleman

14 Exploded view of the bolt-o'-lightning fish splice joint.

15 LCTF shop foreman, Mike Eenigenberg, demonstrating the carving of a fish splice joint.



16

## FISH PLATE JOINTS



Joshua Coleman

16 Diagram of various types of fish plate joints. Thomas Corkhill, *The Complete Dictionary of Wood* (New York: Dorset, 1980).

17 Assembled fish plate joint as viewed from below.

Through subsequent years, persistent local advocates spent many hours attempting to recover materials from the bridge, in the hopes that it might be able to be rebuilt. The amount of material recovered, much of it from miles downstream, was scant. A new strategy was formed and several applications for funding to replace the bridge were submitted to, and rejected by, FEMA. Primarily, the rejections were due to the bridge not having functioned as an active roadway or passage across the creek prior to the storm. In the end, an application to replace the structure was approved by classifying it as a pier. It was, after all, a pedestrian walkway leading out from a shore and extending into a body of water.

With the funding established, plans were drawn up by the appointed engineering firm, and contracts awarded. Stan Graton II, grandson of the same Milton Graton who had completed the repairs to the bridge back in 1972, was chosen as the bridge contractor. Stan, along with his cousin, known as J.R., brought a wealth of experience from his venerable career building, moving, and repairing covered bridges. A plan was developed to build the bridge structure on the nearby bank of the creek and then move it into place using house-moving equipment. This approach allowed the reconstruction of the timber bridge structure to start well before the abutments were demolished and then rebuilt, which reduced

the timeline of the project, not to mention the cost. Fabrication of the timber components started early in the summer of 2017, and assembly of the 30-ft.-tall interior truss and north (downstream) truss began a few months later. The trusses were assembled lying flat on a grid of steel beams and then stood up using two large crawler cranes, moved into position, and braced together.

By late fall of 2017, the main structure of the bridge was assembled. As winter approached, the roof rafters and then the siding were added. The metal roofing was left off for fear of any distortion to the materials during the moving process. The goal was to assemble as much of the material that would be difficult to install from the outside since, once the bridge was moved into position, access would be significantly limited. One sentimental aspect of the reconstruction was the inclusion of a requirement that one token rafter from the original bridge be reused in the new rebuild. This rafter was selected from the pile of timbers rescued from the creek and stored in a local barn with the hope that it might someday be reconstructed (see Fig. 11).

**Distinctive Design Details** The design of the bridge was a combination of two proven truss types, both well established. The bridge has two lanes, thus double-barreled, with the exterior trusses utilizing a modified Long truss, named after Lt. Col. Stephen H. Long, and the middle interior truss utilizing a tripled arch which is clasped by the doubled posts. The variations to the design necessary to handle the significantly larger than typical span involved doubling nearly every member that a shorter truss might require. Consequently, the trusses used double posts and quadripartite top and bottom chords, where single posts and double chords might have been adequate in a shorter span design. The bridge was designed with approximately 24 in. of camber. As a rule, the vertical members remained perpendicular to the bottom chord. The geometric result of this gradual arc over such a long distance was that the posts at the ends were leaning nearly 11 degrees out of plumb. This outward lean is hardly noticeable at the ends of the bridge after the portal ends were framed sloping back toward the midspan of the bridge, creating the visual effect of buttresses pressing in toward the center. Another notable design feature is that the actual size for the diagonal and counterdiagonal members were adjusted relative to their location from the midspan, in direct correlation to the load that they are to carry. Powers must have well understood the varying forces in the truss design, not to mention the economic forces on the bottom line of the project, to be so thrifty as to shave a half an inch off of each subsequent diagonal, saving board footage in the process.

The interior truss featured a tripled arch of 9x11-in. members that passed right between the double posts, at the centerline of the bridge axis, to serve as the backbone for the entire structure. The arch extends from approximately 6 ft. below the floor deck all the way up to the underside of the top chord, functioning as a ridge beam (see Fig. 13); the resulting height of the truss is 28 ft. At the point where the arches pass through the bottom chord of the truss (which is also at a vertical panel point) there are seven layers of timber members passing by each other, all of which are bolted together. The resulting pattern of lap joints necessary for this to occur is exquisitely complicated.



All photos this page Joshua Coleman

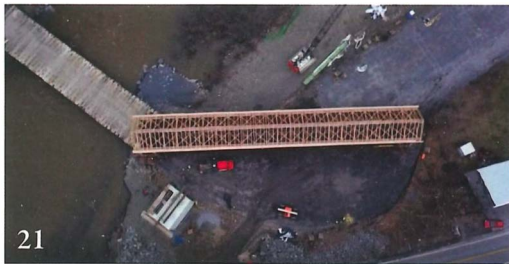
18 The Blenheim bridge is ready for the move from the staging area, across the temporary bridge, and up onto the abutments.



19 The needle beams can be seen extending through the timber structure. Each end of the bridge was supported by four hydraulically controlled axles that take the weight and allow each end to be steered independently.



20 View of the underside of the bridge just before it began to roll.



21



23



25



22



24



26

Photos 21–26 courtesy Windfall Films

21 The trajectory of the bridge as it was directed into position is evident in the aerial view.

22 Even at the last minute, it was necessary to excavate more of the bank behind the bridge so that it was able to swing into alignment with the temporary bridge.

23 The Blenheim bridge has been rolled into position and is starting its ascent to the top of the new abutment.

24 Detail of the cribbing that will support the bridge as it is lifted.

25 Viewed from the end, the stacks of cribbing that will support the bridge as it is lifted are just getting started.

26 Once it had reached the correct height, the bridge was slowly pushed laterally across yet another needle beam, using more hydraulic jacks until it was centered on the abutments.

One particular connection which was essential for the success of the bridge structure was the bolt-o'-lightning splice joint which occurred at every point where the bottom chords needed to be spliced together (see Figs. 14–17). This joint requires two 6-ft.-long fish plates, each with six tapered bearing shoulders, three on each side of the joint, that engage with similar bearing shoulders in the end of each bottom chord. These fish plates are then bolted together, creating quite a large amount of surface area to transfer the tension through the joint. Since there are four-member bottom chords in each of the three trusses, the joints are staggered in each of the four layers, one joint to a panel, occurring in 66 locations and requiring 132 fish plates. Based on some rough calculations, the capacity of this joint is approximately 35,000 pounds.

**On the road** In the spring of 2018, the bridge was assembled and ready to relocate, the abutments were ready to support the bridge, and the remaining task at hand was to move a 425,000-lb. timber structure across the creek and then lift it nearly 20 ft. to set it on the abutments (Figs. 18–26). The father and son team of professional house movers, Jerry and Gabe Matyiko, were instrumental in making this impressive feat possible. One basic trait of this type of structure, namely that it was designed to be supported at each end and therefore does not require any support along the length, made this approach possible with a relatively simple system. Using a fleet of eight hydraulically controlled axles, four on each end of the bridge, the entire bridge structure was essentially driven across a temporary steel and timber roadbed. Very few structures of this size and weight are designed with so few support points, which made this project a perfect fit for the hydraulic axle system. Once the



27

Joshua Coleman

27 Standing high above the Schoharie Creek, the complicated system of lateral bracing and bottom chords are visible from the creek bed.

preparations were made, the bridge was successfully moved across the temporary bridge in just a matter of hours. With tolerances measuring in just inches, the wheels of the bridge structure were directed carefully across the temporary roadbed. Once across, the bridge was positioned in its final resting place to within a fraction of an inch.

The next step in the process was to lift the bridge to the correct elevation in order to slide it sideways over the abutments. This was accomplished with a straightforward process using hydraulic jacks and cribbing to slowly raise the bridge upward. Cribbing was added with each lift of the jacks and the jacks were then moved up one step, repeating the process again and again until the bottom of the bridge was above the top of the abutment. Needle beams, which are steel I-beams threaded through the timber structure to create additional support points, were then fed in from each side. This allowed the entire bridge structure to be slid sideways over the abutments. Load-rated rollers allowed the hydraulic jacks to push the bridge along the needle beams in a similar manner to the lifting process. Jacks pushed the bridge, released, reset in the next position, and then pushed again. Once the bridge was in position over the abutments, the final remaining step in the process was to lower the bridge, using the cribbing and jacking process in reverse, until the arches, lower chords, and bearing posts all rested on their custom-fit bearing blocks.

**Restoration Completed** The remainder of late spring and early summer 2018 was spent installing roofing, deck boards, flooring, and miscellaneous railings. The landscaping and grading was also finished up throughout the summer, and a grand opening ceremony was held in the summer of 2019. During the commemoration, a special tribute to Milton Graton was donated by his grandson Stan, which includes a handmade case displaying Milton's slick and several other tools used by the bridgewright that will be featured at the schoolhouse museum near the bridge.

The new Blenheim bridge now stands in the same place as the original, an exact replica using the same configuration, design, and connections. This important link to the era of historic covered bridges has been reconnected, and with careful stewardship will remain as an icon of the accomplishments of great bridgewrights and serve as inspiration to a new generation of craftsmen who seek to carry on these important traditions.

—JOSHUA COLEMAN

*Joshua Coleman has been timber framing since 1999. He is a loving husband and father of five great kids. He is a project engineer and lead designer for Lancaster County Timber Frames, Inc.*



Joe McCarthy

28 After nearly seven years of hard work by many thoughtful and conscientious bridge enthusiasts, the new Blenheim bridge has been rebuilt.