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RESTORATION OF THE ICONIC SHAW BRIDGE

Dr. Ian NITSCHKE

Chair, Historic Preservation
Advisory Committee
Town of Claverack, NY, USA

Ian.Nitschke@mac.com

Dr. Francis GRIGGS Jr., PE & PLS

Distinguished Member ASCE
Historic Bridge Consultant
30 Bradt Road, Rexford, NY, USA

fgriggsjr@verizon.net

Summary

The restoration of the iconic Shaw Bridge will be initiated in 2017 using a matching grant from New York State. Although built in 1870 for horses and carriages and later used by motorized vehicles, the restored bridge will be a footbridge. The long neglected Shaw Bridge is the best example of a Whipple Bowstring Truss bridge (patented in 1841) the first bridge design in the world that used scientific principles, by Squire Whipple, who published these principles (1846-47) in a book: *A Work on Bridge Building*. Designed for the Enlarged Erie Canal (1836-1862), hundreds were built for the canal and many others were built over waterways. The Shaw Bridge is one of only eight of the vintage Whipple Bowstring Truss bridges left, the lone one in its original location and the only double span. The bridge is clearly eligible for Historic Civil Engineering Landmark status and this paper will argue that it is a World Heritage Bridge candidate. Whipple's importance cannot be overstated. Besides being one of the first to clearly document theoretical and mathematical principles for bridge design, he was critically important for the development of the Enlarged Erie Canal and early railway industry, helping make New York State and New York City become world leaders in the 19th century. The accurate restoration of the Shaw Bridge will be a fitting tribute to the genius of Squire Whipple whose extraordinary intellect and achievements were masked by his humility.

Keywords: historical; aesthetics; structural concepts

1. Introduction

In a quiet picturesque area of Columbia County, in the Hudson Valley of New York State, there is a charming double-span iron bowstring truss bridge over a scenic trout stream – the Claverack Creek. Currently it is neglected and closed, but this bridge, the Shaw Bridge, was designed by the famous 19th century engineer, Squire Whipple, and was once an important bridge on the historic Albany-New York Post Road. This paper tells the story of this world-renowned bridge and the modest gentleman who designed it.

2.1 The Story of Squire Whipple – the Genius Behind the Design of the Shaw Bridge

Squire Whipple was born in Massachusetts in 1804, the ninth son of a farmer and mill owner. The young Whipple was exposed to the latest construction techniques and materials and methods used to power mills of all kinds. He was a voracious reader who had a passion for learning. He advocated non-violence, became a vegetarian, and would not use horses or oxen as beasts of burden (later elaborated in a 1847 pamphlet *The Way to Happiness*). After receiving the best common school education available, in 1830 he graduated from Union College in Schenectady, New York and spent the decade of the 1830s working on various railroads and the Erie Canal enlargement. He also designed, built, and sold mathematical instruments. In 1841, he designed and built a 300-ton weigh lock scale for canal boats which was adopted elsewhere.

Whipple became interested in the design and construction of bridges for the proposed Enlarged Erie Canal. These investigations led to his design of the elegant bowstring truss that used cast iron for compression members, wrought iron for tension members, and a wooden deck that could be replaced without affecting the strength of the bridge. He applied for and was issued a patent, April 24, 1841; see Figure 1(a). Between 1842 and 1870, hundreds of Whipple Bowstring Truss Bridges were built over the Erie and its branch canals, either by Whipple or to his patent, as his design was eventually adopted by the Canal Commissioners as the standard bridge to cross the canals of New York State. Others (like the Shaw Bridge) were built over United States waterways and one was even built in Japan. Frequently, contractors would build to his patent without paying patent fees, so Whipple never received large sums of money from builders using his patent.

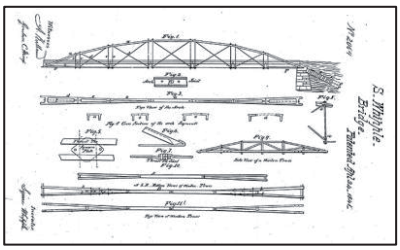

Figure 1 (a) Whipple's Bowstring Patent Drawings 1841 (b) Shaw Bridge c. 1900 (c) Shaw Bridge 2016

In 1846-47 Whipple wrote his 1847 seminal book *A Work On Bridge Building*. For the first time anywhere in the world, this book presented the correct methods of analyzing and designing a truss using the properties of appropriate materials. His technique, now known as the method of joints, is still the way that truss analysis is taught. He used both trigonometry and geometrical construction – the force polygon method – to find his member forces. Europeans credit graphic statics to the 1865 book *Die Graphische Statik (Graphical Statics)* by Karl Culmann but Whipple documented graphical statics in 1846-47, many years before Culmann's book.

Whipple went on to design and build the first successful long span trapezoidal railroad bridge. This double intersection design was the most common railroad truss bridge until the 1890s. Whipple also designed swing bridges and lift bridges and continued to update and expand his first book with an Appendix in 1869 and a more formal book (1872 reprinted until 1899): *Treatise on Bridge Building.* He contributed several articles to American Society of Civil Engineers (ASCE) Journals and was the first person, after the post-Civil War rebirth of ASCE, to be named an Honorary Member in 1868. He died in 1888, venerated by his colleagues.

2.2 The Story of the Supremely Important, Charming, and Neglected Shaw Bridge

In 1870 J. D. Hutchinson built Whipple's patented double-span bowstring truss bridge where the Albany-New York Post Road crossed the Claverack Creek. Traditionally named after the owner of the nearest farm, in this case William Shaw, the bridge became known as the "Shaw Bridge".

The bridge was photographed and featured on a postcard, see Figure 1(b), documenting the original state of the bridge. Later the Shaw Bridge was bypassed (1931), repaired with a new deck structure (1966), celebrated with the listing of the bridge on the National Register (1980), and finally closed (1989). Several attempts were made to open the Shaw Bridge beginning in 1990 but were unsuccessful until 2016 when a matching grant of $170,000 from New York State Office of Parks, Recreation and Historic Preservation was awarded. With substantial money now available, it is expected that matching money, material and in-kind services will finally result in the much-needed restoration of the Shaw Bridge, see Figure 1(c).

3. Discussion and Conclusion that the Shaw Bridge is a Potential World Heritage Bridge

Despite being neglected for so long, the bridge is in remarkably good condition, which speaks well for its original design and materials. The U.S. National Parks, *Secretary of the Interior's Standards for the Treatment of Historic Properties* will be followed using the ***Restoration*** approach, which focuses on the retention of materials from the most significant time in the bridge's history (circa 1870 to 1900 before the introduction of motorized vehicles), while permitting the removal of materials from other periods.

Of the hundreds of original Whipple Bowstring Truss bridges built, only eight are known to survive. Of these eight, the Shaw Bridge is by far the best example of this world-famous bridge: it is the only remaining *double-span* Whipple Bowstring Truss and the only one in its original location with all the original metal structure, stone abutments, and stone pier virtually intact. Only the badly rotted wooden stringers and deck (which were last replaced in 1966) are not original, see Figure 1(c). The circa 1900 postcard photo in Figure 1(b) and the *New York State Canals – 1871 – Specification of the Manner of Constructing Whipple's Patent Iron Arch Truss* will be used to meticulously restore the Shaw Bridge.

Clearly eligible for Historic Civil Engineering Landmark status, the restored Shaw Bridge has the potential to become a World Heritage Bridge. To be included on the World Heritage List, sites must be of outstanding universal value and meet at least one of the ten selection criteria (see http://whc.unesco.org/en/criteria/ for the complete criteria list). It can be convincingly argued that the Shaw Bridge satisfies four selection criteria: (i), (ii), (iv), and (vi), especially (i) "To represent a masterpiece of human creative genius".