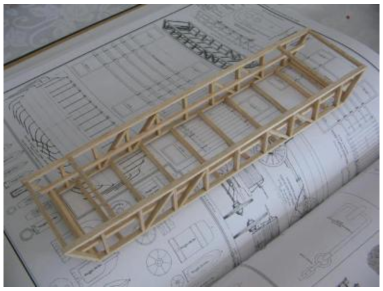
RECREATING THE CANVAS PONTOON BRIDGE

Build a one-quarter scale reproduction of a Civil War pontoon bridge in Northeastern Connecticut? Most people thought we were crazy, but when the Education Programs Office at an historic New England house museum ventured into the world of Civil War school programs in 2004, that's exactly what we knew we had to do. The 19th century summer home of wealthy New York merchant, abolitionist, and newspaper publisher Henry Chandler Bowen, Roseland Cottage, located in Woodstock, CT, is now owned and operated by Historic New England (fig. 1).

We decided all the lessons in the new Civil War program would address some major theme or factor in the war and include a hands-on practical component for students. One of the first lessons developed was the artillery lesson, addressing northern industrial superiority in general and using federal artillery as a clear manifestation of this superiority. The hands-on component developed for the lesson was a Quaker Gun mock-up of a 12-lb. Napoleon smoothbore field piece (fig. 2). The Quaker Gun afforded students the opportunity to learn the school of the piece, performing all functions, including projectile selection and determination of elevation and fuse settings from the original tables of fire. The artillery lesson also provided an interdisciplinary opportunity, combining history with some basic physics and applied mathematics.

At the same time we began development of a Corps of Engineers lesson, addressing the transportation and mobility challenges facing armies of unprecedented size campaigning in regions with underdeveloped and inadequate road grids. The ideal hands-on component would clearly be student assembly of a collapsible canvas pontoon bridge. Why the canvas version of a pontoon bridge? Our decision making process was driven by the same logistical considerations of transportability, compactness, and lightweight that drove Sherman's army in the west and Sheridan's cavalry to select the canvas, or Russian pontoon, over the heavier permanently assembled wooden bateau, or French pontoon. This began a three-year effort to research and reverse engineer a ¼ scale canvas pontoon bridge with a portable water tank, all capable of being transported to area schools in the back of a station wagon. Robert Niepert's excellent article on Civil War pontoon bridges in the *Florida Reenactors Online News Magazine* served as the starting point for our research, and he generously gave us permission to use it as one of the student handouts for our lesson. The measured-drawings, originally prepared by the 50th New York Volunteer Engineers and included as illustrations in the article, were the basis for our early calculations. Discovery of a reproduction of the full sheet drawings in the atlas to the Official Records helped clarify some of the dimensions for the original bridge components.



We chose the small 21’ canvas pontoon as the basis for our scale version. The first step was to build a miniature prototype model from modeling wood (fig. 3). One option considered early-on was to keep the bridge in this small scale, allowing for more pontoons and considerably simpler logistics/transportability. We quickly rejected this option, as the bridge would be too fragile and intricate for students ranging from 5th-to-10th grades to manipulate. Various scale options were evaluated, with considerations of durability, ease of assembly, materiel expense, and requirements for water tank dimensions/capacity and transportability all taken into account. We eventually determined the ¼ scale option would be the most practical. The resultant pontoons would have a “length overall” of 63”, a 16” beam, and 7” depth from the gunwale (fig. 4). The individual balks (originally 22’ beams used in assembly of the bridge bays) would be 66” long and the chess (11’ planks for the road bed) would be 33” long.

The scale lumber cross-sections for the pontoon and bridge components were then calculated. Although rails, uprights and diagonals for the original full-sized pontoon sidewalls included both 3”x 4” and 2”x 4” cross-sectioned timbers, we compromised on a standardized 3”x 4” cross-section from which to calculate ¼ scale timbers (¾”x 1”) for the sidewall components and pontoon thwarts. The full-scale pontoons included two reinforced 6”x 3” upper thwarts equipped with cleats for securing the fore and aft anchor lines, requiring additional ¼ scale timbers with a ¾”x 1½” cross-section. The balks and side rails (beams used like curbs to define the roadbed and secure the chess to the underlying balks) were originally 4½”x 4½” beams, resulting in a requirement for 1⅛”x 1⅛” scale beams. All these scale dimensions were literal or true dimensions, requiring custom milled stock. A ¼ scale bridge of two pontoons with three bays, spanning a 12’ wide river (water tank) would therefore require almost 100’ of ¾”x 1” stock, about 5’ of ¾”x 1½” stock for reinforced upper pontoon thwarts, and over 115’of 1⅛”x 1⅛” stock for balks and side rails. The wood for the project was generously donated and custom milled by *Eastford Building Supply* in Eastford, Connecticut.

The solution we arrived at for the scale chess planks involved a concession to economy at the expense of strict scale authenticity. Instead of 3” wide, 33” long individual planks, we compromised on 30” long 3-plank segments of bead board. These were then notched at each end to approximate the chess plank profiles (fig. 5).

Plans for the scale sidewalls of the pontoons were then drawn on a roll of brown paper. These were used to layout the individual rails, uprights and diagonals on the wood stock. After being cut, the sidewall components were then placed on the template (fig. 6).

The original pontoon sidewalls used mortise and tenon joinery. We compromised on doweled joints for the 30 permanent joints on each sidewall (fig. 7). Non-permanent doweled joints were also used to attach the removable thwarts to the sidewalls.

The most elusive fact regarding fabrication of the original canvas pontoon bridges remains the exact nature of the canvas covers for the pontoons. The dimensions and patterns for the covers are clearly depicted in the aforementioned measured-drawings prepared by the 50th New York Volunteer Engineers. There are no specifications for the weight of canvas or for any treatment requirements to waterproof the canvas. A careful review of period texts, such as Capt. J.C. Duane’s *Manual for Engineer Troops*; of after action reports contained in the *Official Records*; of subsequent accounts by participants, such as Colonel Wesley Brainerd’s *Bridge Building in Wartime* and John D. Billings excellent pontoon bridge account in *Hard Tack and Coffee*; and of modern works such as Phillip M. Thienel’s *Mr. Lincoln’s Bridge Builders* and Jack Coggins *Arms & Equipment of the Civil War*, failed to answer the critical question of canvas treatment requirements. Period accounts and after action reports do mention the need to wet or soak the canvas to increase its watertight integrity. They also mention there was continual slow seepage, requiring periodic bailing. Period photographs clearly show light natural-colored canvas, making it highly unlikely they were made of oilskin or tarred/painted canvas. Correspondence with the historian for the Army Corps of Engineers was very helpful but could shed no additional light on the question of canvas treatment requirements. A potential resource not yet fully explored is the U.S. Military Academy at West Point. Its online photo archive (http://digital-library.usma.edu) contains excellent images of cadets assembling Civil War era pontoon bridges in training exercises before WWI. These afford some valuable insight into canvas pontoon assembly and launching techniques, as well as bridge construction.

Lacking historical specifications, we elected to produce the canvas covers from tent canvas. At ¼ scale, the original 25’9” long covers are 6’5¼” long and 2’7½” wide. Forty clew lines, used to secure the cover to the pontoon frame, are attached to eyelets in the ¾” hem around the perimeter of the cover (fig. 8).

With the nature of the original waterproofing treatment still in question, we purchased a commercial canvas waterproofing treatment used successfully in the past for canvas water buckets. After much reflection, however, the decision was made to leave the canvas untreated. References in period accounts to wetting the canvas or allowing it to soak raised concerns that treating it with a modern waterproofing compound might inhibit the natural ability of the fibers to swell when wet and could actually result in more leaks. We opted to place a sheet of clear plastic between the wooden frame and the canvas upon assembly in order to ensure watertight integrity while allowing observation of the rate of seepage between the canvas and the plastic barrier once the bridge was assembled in the water tank. The first operational deployment of the bridge revealed the rate of seepage between the untreated canvas and the plastic barrier was actually relatively low once the canvas fibers had been given the opportunity to swell. Bridge assembly without the plastic sheeting barrier awaits further testing.

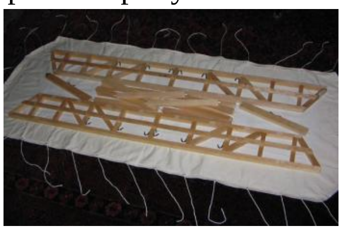
The next hurdle was the design of a portable 12’x 6’x 6” water tank in which to assemble the bridge. Key to the design was the requirement to transport the entire program, bridge and tank, in the back of a station wagon. The school of hard knocks with the artillery lesson’s Quaker Gun made ease of program transportability a major consideration. The solution was a rectangular wooden fence or frame of 1”x 6” pressure treated planks lined

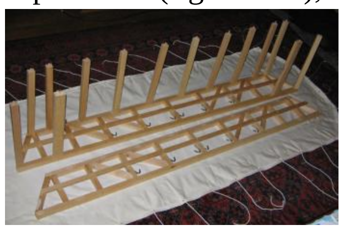
with a plastic tarp. Each long side of the frame is composed of three 4’ planks connected end-to-end by steel reinforcement plates, secured by ¼” bolts with wing nuts (fig. 9). The 6’ ends of the tank, representing the riverbanks, are composed of two 3’ planks, similarly connected and then attached to the long sides at the corners by steel angle irons and ¼” bolts with wing nuts. With the tarp in place and filled to about 4”, the tank holds roughly 290 gallons of water.

With the bridge and tank completed, the next task was to calculate the approximate load capacity of each scale pontoon. Assuming a maximum safe limiting draft of 5” and combining the right triangle portions of the bow and stern, the underwater hull portion of the pontoon at maximum displacement can be expressed as an elongated cube 58” long by 16”wide by 5” deep. Using the equation L x W x D = Area in cubic inches, each pontoon displaces 4,640 cubic inches of water when fully laden. One cubic inch of water weighs .036127 lbs. Each pontoon at maximum safe limiting draft, therefore, displaces 167.6 lbs. of water. This is the approximate load capacity of the scale pontoon (approximate because it does not take into account the weight of the bridge itself). When assembled with other pontoons into a bridge, load capacity is increased by the connecting balks, distributing the weight amongst adjacent pontoons and river bank abutments.

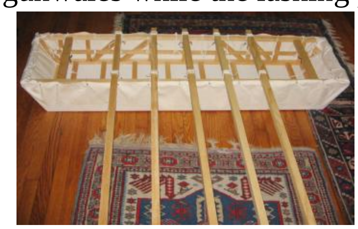
The bridge project affords an interdisciplinary opportunity to discuss some aspects of stability and buoyancy, applied mathematics, and basic physics. Experience during the Civil War demonstrated pontoon bridges were capable of supporting heavily laden artillery batteries, supply wagon trains, and mounted cavalry formations with no threat to bridge integrity. The greatest danger came not from heavy loads moving across the bridge, but from columns of infantry marching in step across the bridge, setting up a dangerous oscillation or resonance along the length of the bridge and tearing it to pieces (similar to the familiar film sequence of the Tacoma, Washington bridge shown in virtually every high school physics class). Students can simulate the rhythmic effect of troops marching in step and watch the destructive effects upon the scale bridge in the water tank.

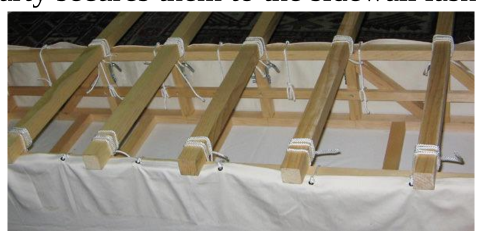
Bridge assembly and disassembly can be completed within the normal 40-minute class period. Students are divided into working parties following the procedures already outlined in Robert Niepert's article and as recounted in *Hard Tack and Coffee*. The pontoon party assembles the pontoons (figs. 10a/b), attaches the canvas covers (fig. 11),



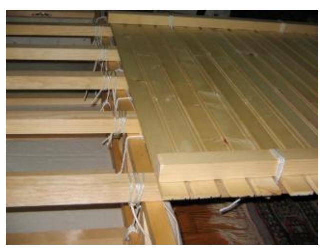


and positions them adjacent to the abutment or existing pontoon bays in the tank. The balk party delivers and positions the balks on the pontoon gunwales while the lashing party secures them to the sidewall lash hooks (figs. 12a/b). The chess party lays the roadbed, followed by the balk party with the side rails, which are then





lashed to the underlying outer balks, defining the roadbed and securing the chess planks



(figs. 13a/b). Quality of construction is heavily dependent upon the knot tying abilities of the students, as the bridge is assembled without using a single nail, screw, or pin. Lashings are the essential component. Experience thus far suggests there is a strong correlation between the presence of a Girl Scout or Boy Scout in the class and the quality of assembly. This echoes period references to the importance of knot tying practice and drill for engineer troops when not engaged. When fully assembled with secure lashings, the scale bridge bays are extremely stable and capable of supporting heavy loads.

As the images clearly show, the hands-on elements of our lessons are representative, evoking the essence of the subject but making compromises regarding strict authenticity. Students man the guns in *Farb's Battery, 3rd Imaginary Connecticut Volunteer Field Artillery*, or span rivers as part of *Farb's Pontoon Train, 50th Imaginary New York Volunteer Engineers*. Modern concessions and "farbisms" notwithstanding, the hands-on components give students the opportunity to participate actively and experience in the field what they have learned about in the classroom.

Roseland Cottage is one of 36 historic house museums owned by Historic New England, the oldest, largest and most comprehensive regional preservation organization in the country. Historic New England offers a unique opportunity to experience the lives and stories of New Englanders through their homes and possessions.

Suggested Reading:

Billings, John D. *Hard Tack and Coffee*. Boston: George M. Smith & Company, 1887.

Brainerd, Wesley. *Bridge Building in Wartime: Colonel Wesley Brainerd's Memoir of the 50th New York Volunteer Engineers*/edited by Ed Malles. Knoxville: The University of Tennessee Press, 1997.

Coggins, Jack. *Arms & Equipment of the Civil War*. New York: Doubleday & Company, 1962.

Duane, J.C. *Manual for Engineer Troops*. New York: D. Van Nostrand, 1862.

Thienel, Phillip M. *Mr. Lincoln's Bridge Builders: The Right Hand of American Genius*. Shippensburg, PA: White Mane Books, 2000.

U.S. Army (War Department). *The War of the Rebellion: A Compilation of the Official Records*. 130 volumes including 1 volume index and 3 volumes of atlases. Washington: GPO, 1880-1901.