Society for Industrial Archeology · New England Chapters

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President's Report, SNEC

INDUSTRIAL ARCHEOLOGY'S CHALLENGE FOR THE 1990s:

The pattern of many scholarly traditions, including industrial archeology, is one of specialization and eventual fragmentation. During the previous decade, for example, bridge inventories and research flourished. As an area of interest pursued by a growing number of industrial archeologists, bridge research has grown to such proportions that there is now a national conference devoted to bridges, as well as a "Bridge Conference" held as part of the national SIA conference. Unfortunately, the field of industrial archeology, as well as many areas of research generally within the umbrella of historic preservation, is prone to the "niche" mentality. With so many people pursuing more narrow interests, the strength of the larger organization and the public issues it pursues suffers, The challenge for the 1990s is to bring the individuals and organizations in related fields together so that they can grapple with their common preservation goals.

One of IA's greatest strengths has been its ability to attract persons with special interests who are not academically trained in a particular field. Railroad enthusiasts, for example, comprise a broad group of individuals whose members belong to a variety of local and national organizations. As much of IA is focused in urban areas, coordinating activities with railroad groups should be expanded. Other transportation-related interest groups include canal societies and aviation clubs interested in vintage aircraft, both of whom share common interests with traditional IA.

Maritime history has many groups whose interests range from traditional sailing vessels and small craft to vintage power boats. A major portion of our IA heritage is along the waterfront, yet New England IA is only beginning to become involved in this diverse area of resources.

Rural agriculture and industry are two related areas which present opportunities for collaboration with other professionals and local experts. The Association of Living Historical Farms and Agriculture Museums (ALHFAM), another Smithsonian-based organization, is a growing group of institutions and individuals whose interests include agricultural machinery, labor history, and oral history. The overlap with many IA interests is pronounced.

Finally, there is the architectural community, and particularly the Society for Architectural Historians, whose general regional membership needs to be aware of IA activities. Some SNEC members also belong to SAH, but a broader constituency can certainly be developed in the SAH.

The Newsletter is jointly sponsored by the Southern and Northern New England Chapters of the Society for Industrial Archeology. This issue was typeset and printed by the Printed Word, Inc. of Concord, New Hampshire.

Efforts toward involving a broader constituency in IA could include the following:

1. SNEC and NNEC should sponsor a two or three-day workshop aimed at professionals and special interest groups (e.g., railroads) that would address industrial archeology's particular issues. The workshop would be arranged to allow participants to work directly with instructors on the recording and analysis of a particular industrial property.

2. Expanding the annual regional IA conference by inviting other organizations to participate (e.g., SAH, railroad), and,

3. Develop a "bulletin board" that could be distributed by IA-related organizations that list the activities of the separate groups.

The 1990s will undoubtedly keep up the pressure for the modernizing of our public infrastructure and the replacement of our more economically marginal properties. Unfortunately, both these facts of our society can have significant impacts on historic industrial resources of interest to a diversity of professional groups and individuals. Only by collaborating in efforts to recognize the significance of individual resources and becoming involved in planning for their management can their future be assured. As Ben Franklin succinctly stated in addressing the first Continental Congress, "Together we stand, parted we hang!"

Jeffrey Howry

Spring SNEC Meeting

The Spring SNEC meeting will be Saturday, June 9, 1990 in Haverhill, Massachusetts. where there will be a tour of the Falconi piano factory, among other sites of interest. A flyer with details will be mailed to chapter members.

President's Report, NNEC

This is my first report to the Northern New England Chapter since being elected Chapter President last fall. I know that with the support of all members, the chapter will continue to grow in activities and in membership. Everyone in the chapter knows of the work that Dennis Howe has done as President, and I hope to be able to continue in that tradition.

All members should hace received their annual dues reminder from Vic Rolando. If you have not yet paid your dues, please send Vic a check as soon as possible. His address is:

Vic Rolando
41 Lebanon Avenue
Pittsfield, Massachusetts 01201

Those of you who attended the Third Annual Conference on New England Industrial Archeology know what a great success it was. If you didn't get to the conference you will never know what you missed. This annual conference is becoming an important part of industrial archeology activities in New England. Be watching for announcements for next year's conference which will be hosted by the Southern New England Chapter.

Two other upcoming activities are the second year of the dig at Fort Independence in Vermont and the Society for Industrial Archeology's annual conference. David Starbuck will lead the dig at Fort Independence. His address is:

David R. Starbuck
Department of Anthropology
Williams Hall
University of Vermont
Burlington, Vermont
05405-0168

The SIA Annual Conference will be in Philadelphia, Pennsylvania, this year from May 31 to June 3.

Vic tells me that plans for the Spring Meeting are shaping up. We will meet on Saturday, May 19, in Fairlee, Vermont, to tour the copper mining and smelting remains in Vershire, Vermont. This will be an outside tour with a lot of walking, so dress appropriately. I look forward to seeing you all there.

So far there are two items of new business for our Spring Meeting. Vic tells me that the cost of printing and mailing this newsletter is going up. To meet those costs we need to consider an increase in chapter dues. We also need to choose a site and a tour leader for our Fall Meeting.

I look forward to seeing all of you in Fairlee.

Walter Ryan
Post Office Box 1321
Claremont, New Hampshire 03743

Exhibits

Concord, New Hampshire: A Furniture-Making Capital

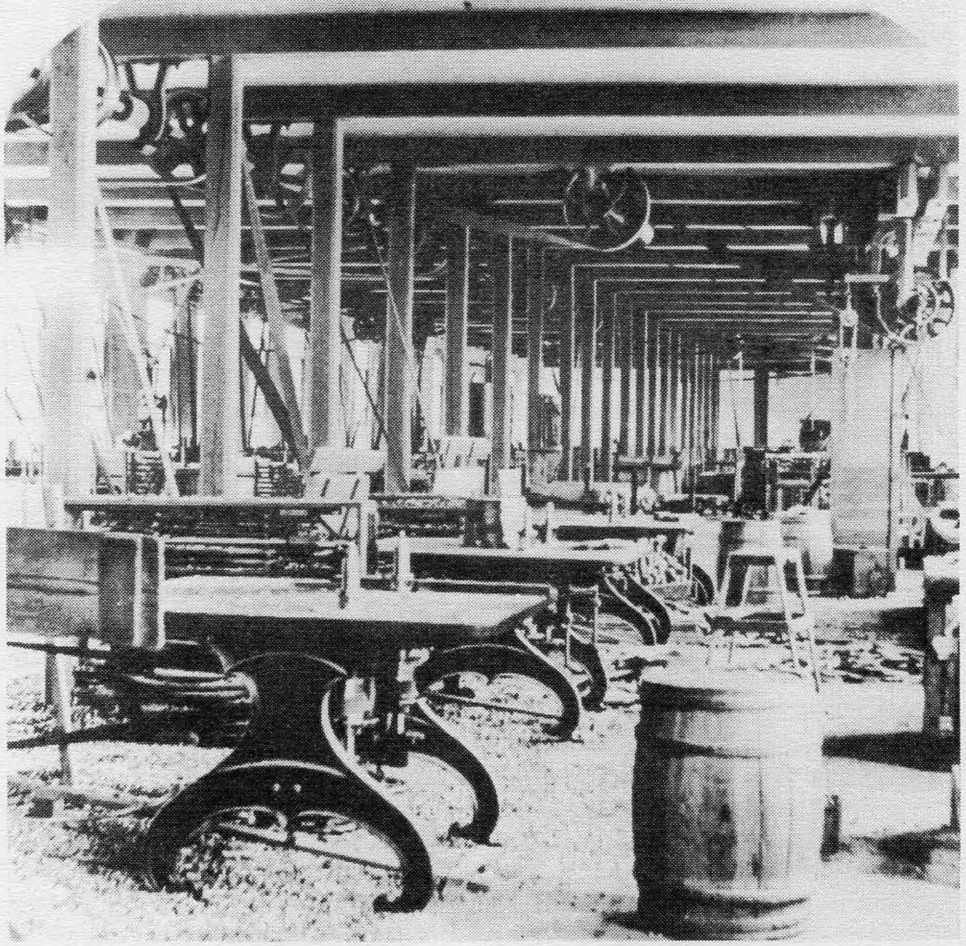
On May 6, the New Hampshire Historical Society is opening an exhibit which, together with an accompanying illustrated catalogue, traces the history of the furniture-making industry in Concord, New Hampshire, from its beginnings in the handcrafts of the eighteenth-century joiner and chairmaker to the mechanized factory production of the nineteenth century. The rise and fall of the cabinet industry is depicted in relation to changing demography, technology and transportation methods, as well as in connection with more general social, governmental and economic trends. Specific associations between local cabinetmaking and the town's related clock, musical instrument and woodenware industries are also featured.

A segment focusing on the cabinet shops at the New Hampshire State Prison introduces nineteenth-century trends toward increasing specialization and expanding markets. Also demonstrated is the geographical shift of the local industry around mid-century away from downtown Concord toward the outlying mill village of Fisherville (now Penacook).

The exhibit includes approximately forty pieces of furniture, together with graphic material picturing Concord furniture makers, their shops and their newspaper advertisements, along with their original business records. In addition to displaying finished products and relevant documentary material, the exhibition illustrates furniture-making processes and includes selected tools of the nineteenth-century woodworker.

"Concord, New Hampshire: A Furniture-Making Capital" will remain on view through December 1990 and will be open to the public daily, Monday through Friday, 9:00 a.m. to 4:30 p.m.; weekends from 12 noon to 4:30 p.m. The catalogue, containing more than 60 illustrations, is available for purchase through the Society's Museum Store.

Donna-Belle Garvin
Concord, NH



Stereograph documenting the appearance of one of two cabinet shops at the New Hampshire State Prison where, around 1870, approximately 66,000 bedsteads were manufactured annually for distant markets. The machinery employed at this date included fifteen circular saws, fourteen turning lathes, four planers, six boring lathes and one tenoning machine. (New Hampshire Historical Society Collections)

Research Request

Lustron Houses: Steel Homes of the 1940s

An early attempt at prefabricated housing, Lustron Homes were produced of steel panels with pastel-colored porcelainized finish. Mass-produced steel building parts were loaded onto trucks for delivery to the building site. Only about 3,000 were shipped nationwide, and two have been discovered in Connecticut, one in Fairfield and one in Berlin. I am looking for information about other Lustron houses which may exist in Connecticut.

Please contact Mary M. Donohue, Architectural Historian, Connecticut Historical Commission, 59 South Prospect Street, Hartford, CT 06106, (303) 566-3005.

A Lustron prefab steel house.

Book Announcement

ORNAMENTAL IRONWORK
Two Centuries of Craftsmanship in Albany and Troy, New York
By Diana S. Waite
Foreword by Margot Gayle

Ornamental ironwork is an important but often overlooked feature of nineteenth and early twentieth century architecture. Iron railings, balconies, fences, window grilles, roof crestings, stairways, and storefronts protect, support, and add character to buildings great and small. Because decorative ironwork usually appears on prominent facades or in accessible interiors, it stands much like a collection of public sculpture, freely available for the examination and enjoyment of all passers-by.

This book opens up a fascinating new world of highly skilled craftsmanship. It explains how to distinguish between wrought and cast iron and points out the many motifs that master ironworkers created — scrolls, foliage, Greek frets, Gothic tracery, and latticework, to name a few. It reveals how early blacksmiths fashioned delicate railings to grace Federal-style residences and how large foundries turned out thousands of prefabricated iron building parts and even whole fronts of buildings that were at once economical and decorative. Many readers will be intrigued by the stunning ironwork inspired by the Arts and Crafts movement.

Using hundreds of examples of ironwork still standing in Albany and Troy, New York, this book illustrates how the technology and design of architectural ironwork developed in America. Because ironwork in Albany and Troy was stylistically and technologically up to date with the best in America, this book provides a sound framework for comparing and documenting ironwork in other cities. A chapter for property owners explains how to protect and repair ironwork and how to find and work with a contractor. For those who want to explore the ironwork of upstate New York firsthand, there are walking tours of Albany and Troy.

144 pages, 140 illustrations, 8 1/2'' x 11'', ISBN 0-9625368-0-6, $19.95 pb, May, 1990.

Sales representatives are Walck-Rikhoff Bookpeddlers, 1416 Lake Ave., Rochester, NY 14615, telephone 716-458-6246. Printed by Mount Ida Press, 4 Central Avenue, Albany, NY 12210, telephone 518-426-5935.

Current Research in New England

Maine

On March 10th, 1990, five consultants converged on the town of Readfield, Maine, because it is about to celebrate its two hundredth anniversary. One of the members of the Readfield Bicentennial Committee, John Knox, is concerned that "recommendations [be made] to the town as to how the town's former mill can be brought to life for the town's bicentennial in 1991." The Bicentennial Committee received a small grant, prepared by John Knox, from the Maine Humanities Council to cover the cost of the day's planning. The consultant team was made up of Dick Borges (SIA), Director of Old York Historical Society, who served as facilitator of the group; Aileen Agnew, Director of the Maine Center for Archeological Studies; Erik C. Jorgensen, Director of the Pejepscot Historical Society; Kerry O'Brien, Curator at the York Institute Museum; and Betsy Warner, Director of Education at the Yarmouth Historical Society.

The five consultants arrived at about 9:30 to meet with various representatives of the town. John Knox provided a brief overview of the day's agenda and then introduced Marius Peladeau, former Director of the Maine League of Historical Societies and museums and now a resident of Readfield. Mr. Peladeau gave a thorough review of the Readfield mill history followed by a tour of the various industrial sites. Unfortunately, no buildings are still standing, and the ground had significant snow cover, making it difficult to discern building foundations. Many of the foundations of the several business establishments still exist as well as the extensive waterway used to power the machinery.

Although there were settlers in the Readfield area much earlier, Readfield did not break away from Winthrop until 1791. Readfield is located approximately twenty miles west of Augusta on Route 17. From its earliest days, an emphasis was placed on the development of commercial enterprises with as many as twenty different manufacturers, the greatest number concentrated in the Factory Square area. The power source for the mills was fed by Torsey Lake, located in the northwestern corner of Readfield. Where the tributary from the lake crosses Old Kents Hill Road, at least four mills were located on the south side of the road. This area was known as the First or Upper Dam; it is here that the oldest mills were located c. 1770. This site included the James Craig Sawmill, Joshua Bean's gristmill, a tannery and brickyard, and a fulling and carding mill.

About a mile down the stream in a generally southeasterly direction, the second and third dams were located, known as the Factory Dams. There was a dam on each side of Factory Street (Giles Street), the street cutting this commercial site down the middle. On this site were located about six commercial establishments including a scythe factory, a woolen mill and box factory, a barrel mill, two boarding houses for mill hands, the Morrell Store and clothing manufactory, and Johnson's Store. The woolen mill was the largest of all the structures and had a bell tower. Here "Readfield Cloth" was produced for the Union Army during the Civil War. In its later years it was used for a box factory.

A little further down the stream was the third commercial area known as Mill Dam. In this area, which was bisected by Mill Street, were located the James Craig grist mill and later the W. C. Record Feed Store, the Craig Sawmill, Williams Blacksmith and Carriage Shop, a cheese factory, a sash factory, the F. I. Brown Store and a malt house and brewery. Further down the stream were the Currier, the Bean, and the Hunt brickyards.

Taken together, this collection of commercial activities is remarkable, but it is surprising that not one of the original structures exists today. There is still much to uncover and learn about this aspect of Readfield's history. And that is precisely why the Bicentennial Committee is examining the possibilities. Readfield is losing its identity as a self-supporting community and rapidly becoming a bedroom community for Augusta. It is important that recording and preservation programs get underway as soon as possible before more physical evidence is lost.

The consultant group had numerous recommendations to make to the Readfield Bicentennial Committee to preserve, examine, study and interpret these industrial sites. The committee selected several and put them in priority order. The number one project is the documentation and recording of the approximately twenty sites in the three areas. This would require a major effort, probably beyond the resources and capabilities of the town. A recording project by the NNEC of the SIA would be a wonderful way to get this work done in the shortest possible time. I will be proposing this project to the group at the May meeting in Vermont.

Other projects that the Bicentennial Committee will undertake are a walking tour of the water system and mill sites along a cleared greenbelt on the mill stream supplemented by a brochure and historic markers; they will conduct a photograph and artifacts day, encouraging people to bring in images and items that are related to the mill sites that will be photographed at that time in order to collect an archive of related material; a slide lecture will be developed from this material and presented to the town; a diorama of the Factory Square area will be constructed by high-school students and exhibited at Town Hall or the Readfield Historical Society; an application will be prepared to put Factory Square on the National Register; and work will begin to develop a local Historic District to preserve the industrial remains. These projects comprise a very ambitious program for an important water-powered system.

According to a booklet produced by the American Revolutionary Bicentennial Commission of Readfield, Maine, *Reflections of Readfield (The Story of Our Town)*, "so intense was the industry and commerce, in this little area now called Factory Square, that it was known as 'little Brittany.'" The diversity of this once dense commercial area is certainly worth preserving and interpreting. It is key to the successful kindling of interest in the heritage of Readfield. As more and more people continue to move into the Readfield area, it is critical that the past be resurrected and made available to the residents. The increased interest created by the town's upcoming bicentennial celebration should be nurtured. This is the kind of project the SIA should be assisting with. I hope the NNEC will heed the call.

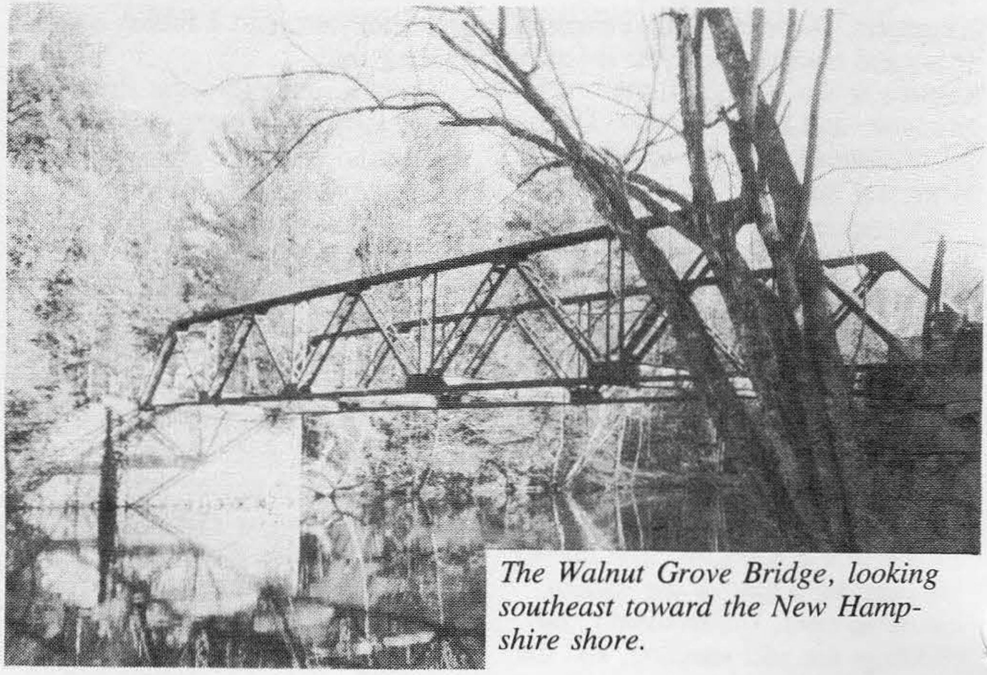
Richard Borges
Director,
Old York Historical Society

New Hampshire

A NOTE ON AN ABANDONED BRIDGE BETWEEN MAINE AND NEW HAMPSHIRE

As a resident of Somersworth, New Hampshire (on the state border across from Berwick, Maine), who enjoys jogging, I have rather thoroughly explored the surrounding countryside. I should mention that in this area, the border between the two states, continuing up from the Piscataqua River between Portsmouth and Kittery on the coast, is formed by the Salmon Falls River. One day, I ran down a "new road" and discovered, to my delight, an abandoned steel bridge.

The bridge site is northwest of Berwick, Maine, about midway between that town and East Rochester, New Hampshire. The Walnut Grove Bridge is located at the end of Walnut Grove Road, now a side road off the Salmon Falls Road in New Hampshire, which roughly parallels the border. The corner is marked by the tiny 1860s Walnut Grove Church, one indication that this area was once a more important thoroughfare than it now is. However, the Walnut Grove Road now effectively ends at that corner, whereas it once continued south to Route 16, crossing the area where the Rochester Airport is now located. On the Maine side, the road to the bridge is a side road from Hubbard road in Berwick, still running through the "piney woods." Neither approach road is paved, and there are no old houses on either one because (at least on the New Hampshire side) the route ran through undivided farms. Today, when there is no reason for a crossing here, one wonders why one would need a more direct route



The Walnut Grove Bridge, looking southeast toward the New Hampshire shore.

from Rochester, New Hampshire, to Lebanon, Maine—a question remaining to be answered.

Mrs. Fowler, resident of the farm surrounding the church, recalls that the bridge went out of service following damage connected with the hurricane "around 1954." Berwick town records show that construction of the present bridge was approved at a town meeting held May 22, 1920:

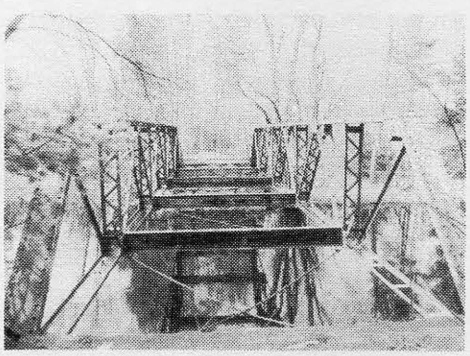
> Article 2, Voted to authorize The Municipal Officers to contract, in conjunction with the city of Rochester, N.H., for a steel bridge to be erected over the Salmon Falls River at Walnut Grove, and to borrow a sufficient sum of money for the same.

However, the warrant article for the meeting began with the words "To see if the town will vote to rebuild the Walnut Grove Bridge..." In fact, there was an earlier bridge, mentioned as the "new bridge" in a warrant article dated June 15, 1877, the town meeting to be held on June 23, 1877:

> Second- to see if the town will vote to accept a new road laid out by the Selectmen, the road beginning at the main road leading from Great Falls [now Somersworth] to South Lebanon, commencing three rods North of the school-house in District No. 4 in said Berwick and running in a Westerly course across land of Lewis Tebbetts one hundred and fourteen rods to the new bridge across the Salmon Falls River and make appropriation for the same.

The earlier bridge was probably constructed of wood. One story suggests that the bridge was built by a group of residents and presented to the two towns; that must concern the first bridge. The present bridge, built by the towns, has unfortunately lost a plaque remembered by several people. Until recently, the stringers existed, and boards were laid across the bridge so that it could be used by snowmobilers in the winter. This activity stopped when the price of scrap metal made it profitable for scavengers to remove the stringers and some of the other metal to sell. At present, the bridge stands, largely intact, at a bend in the river, surrounded by woods and visited only occasionally. A number of questions concerning the bridge and its function remain to be answered—questions regarding its builder but also the larger issue of its function in the economy of southern Maine and the New Hampshire Seacoast in the early twentieth century. Help was provided by Richard W. Stillings, Berwick, Maine, Town Planner, and members of the Fowler family of Salmon Falls Road in Rochester, New Hampshire.

Woodard D. Openo
Somersworth, NH



The Walnut Grove Bridge, looking toward the Maine shore. Note the depredations of metal salvagers visible in the foreground.

Massachusetts

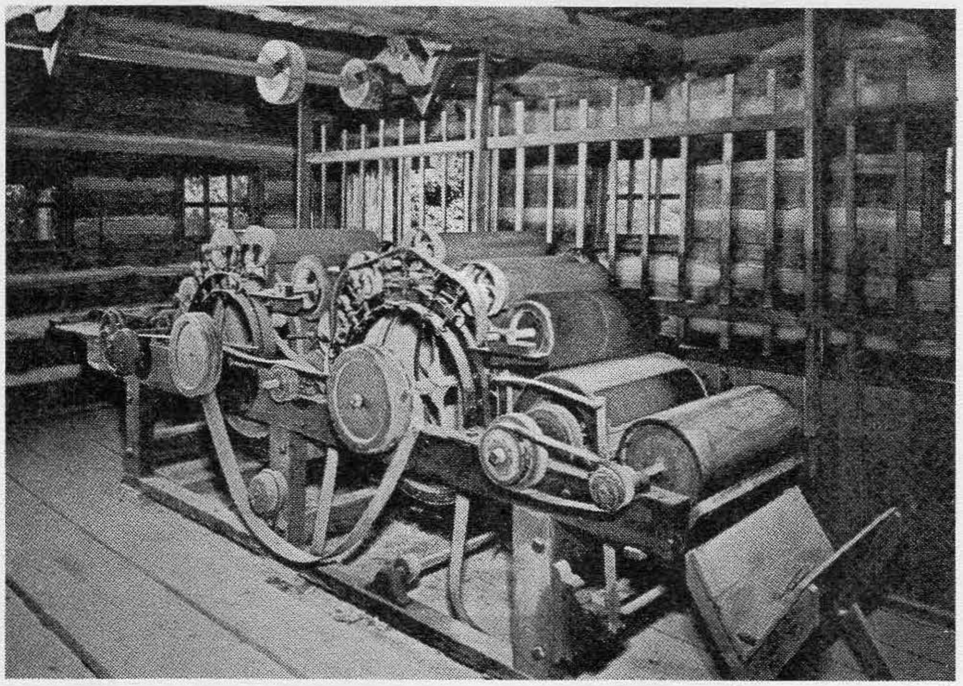
Illinois Carding Machine

In the spring of 1989 Laurence Gross, Curator of the Museum of American Textile History, North Andover, Massachusetts, went out to New Salem State Park, Lincoln's New Salem, Illinois, to look at an old carding machine. This machine was in a state of disrepair and apparently had not been in operation for many years. Mr. Gross decided that the machine could be put back into running operation if it was sent to the Museum's warehouse in North Andover, Massachusetts.

According to a postcard showing the machine (printed in 1966 by Dexter Press, West Nyack, NY), the following is an account of the machine: "Samuel Hill, owner of one of the stores [in New Salem], erected a carding mill and wool house in the spring of 1835. He advertised that he would commence carding May 1. 'The machines are nearly new and in first rate order, and I do not hesitate to say, the best work will be done. Just bring in your wool in good order and there will be no mistake.' The mill was operated by Hardin Hale, who later purchased it from Hill."

In our area of New England there was plenty of water power available, but in that area of Illinois where the card was located, other sources of power had to be utilized. The postcard further states: "The power was furnished by two oxen treading [a] circular wheel."

The carding machine arrived in North Andover, Massachusetts, in October, 1989, and an appraisal was taken of its condition: the card had been housed in a log cabin, and there was considerable rust on all the metal parts; apparently it had



The New Salem (Ill.) State Park carding machine as it appeared prior to restoration by Thomas Rockwell of North Andover (from post card printed by Dexter Press).

been made about 1830 to 1840 by a carding company in Worcester, Massachusetts; it had been severely damaged sometime; it was in poor condition; all parts would have to be repaired and welded; the rust would have to be removed; the final wooden roll would have to be fluted; and there were only a few small parts missing.

The striking feature of the card was that it was in two main sections, and these two sections did not match each other. One theory was that at some time the card had been smashed, and the parts were replaced from another carding machine. The other idea was that perhaps the card had originally been a one cylinder machine, and it had been enlarged to make it a two cylinder machine. The latter theory seems to be the more likely. The two main rolls were not the same construction as they would have been if the card had been originally manufactured as a unit. Some of the pulleys were made of wood and some of iron.

We tried to repair the machine so that no changes were made in its design and to leave it in its original style. The only item radically changed was the final wooden roll which we had to have fluted.

All of the necessary card clothing was readily available from the Redman Card Clothing Company, Andover, Massachusetts, and any necessary repairs were done by a local welder who then machined the parts. The wooden roll was fluted by Lawrence Pumps, Lawrence, Massachusetts, who had a machine large enough to handle the 11-3/4" diameter roll.

The finisher doffer had been originally covered with sheet card clothing, but this type of clothing is no longer available except at a prohibitive cost. Therefore, we decided to cover the roll with ordinary continuous fillet clothing, mark off the places where there should be no wire, take the clothing back off the roll, and remove the wires previously marked. This was a long, tedious task, but the idea was very successful. This solution, though not perfect, did work successfully when the machine was run.

When the card was repaired and put back into working condition, we procured 50 pounds of well picked wool and then ran the machine for several hours to correct all the errors. A temporary motor drive was used with the materials we had on hand. Our problem was to slow the machine down to about what they will run the machine at when it is back in Illinois. The carding machine at the Museum of American Textile History is running at 40 r.p.m. on the finisher cylinder. And the two cards at Old Sturbridge Village, Sturbridge, Massachusetts, are running at 24 r.p.m. and 30 r.p.m. With the equipment we had available, we were able to slow the machine down to 46 r.p.m. by using a temporary counter shaft. The State Park is again training two oxen to produce the power to operate the card. Undoubtedly they will also rig up an auxiliary motor to use when the oxen are not available. Their machine will be powered from an overhead shaft, with a belt coming down to the machine.

Most of the work on the card was done by Thomas P. Rockwell who had been a Card Erector for the former Davis & Furber Machine Company, North Andover, Massachusetts, which had been in the business of making textile machinery from 1832 to 1982. When a company buys a carding machine, it is necessary to have a person from the manufacturer go to the mill and install it and show them how to run it. Mr. Rockwell had been to about 60 mills to erect cards and to make repairs on existing cards, so he was well-qualified to make the necessary repairs on the Illinois carding machine.

To complete the work necessary took about 160 hours, plus the help of an assistant for about 75 hours.

The carding machine has now been returned to Illinois and put back together. They are waiting for the necessary power to operate it.

Thomas P. Rockwell
North Andover, MA

Connecticut

HOP BROOK RAILROAD EMBANKMENT

The Public Archaeology Laboratory, Inc. of Pawtucket, Rhode Island, recently completed an archeological excavation and historic research summary of the abandoned Hop Brook Railroad embankment near Hop Brook Dam in Naugatuck, Connecticut. The Army Corps of Engineers, New England Division, requested that the archeological investigations be conducted prior to planned remedial repair measures involving the stabilization of the extant cinder and slag embankment and 200-foot-wide stone arch culvert. The project was undertaken in order to archeologically verify the presence of a wooden trestle system and historically document its construction and design within the embankment fill.

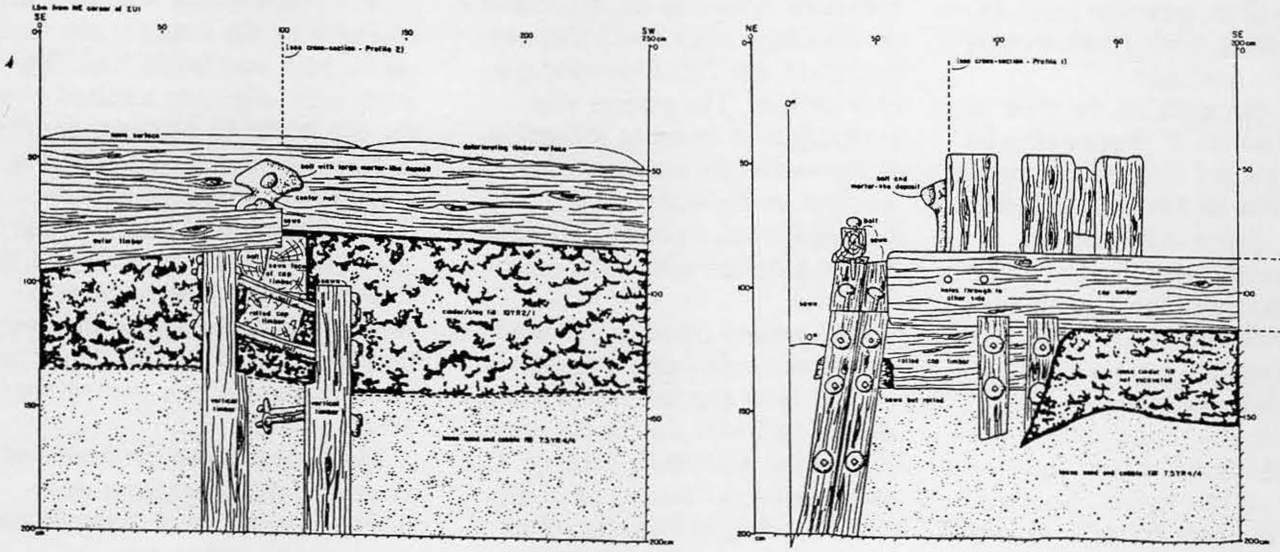
Background research revealed that two stone arches and a timber trestle had been erected at this location over Hop Brook during the second half of the nineteenth century. Construction of the two stone arches may have begun as early as the 1860s under the Boston, Hartford, and Erie Railroad Company. These structures were necessarily in place by 1879 when construction of the monumental (90 feet high, 300 feet long) wooden trestle was begun by the newly formed New York and New England Railroad Company. The timber (probably white oak) and bolt frame trestle was manually erected by Irish immigrants in 1879 and 1880, partially filled between 1888 and 1893, and partially rebuilt and completely filled in 1897. Locally-derived granite blocks were used to build the arches, using the keystone technique.

The two stone arches and wooden trestle functioned as part of the western division rail line of the New York and New England Company from 1881 to 1898. In 1898 the line was acquired by the regional New York, New Haven, Hartford Railroad Company, which operated freight and passenger service along the western division until the 1930s. This line constituted the second regionally important rail link to the growing industrial centers in Naugatuck and nearby Waterbury.

Following the 1930s abandonment of the western division line, the rail bed was purchased by a locally prominent businessman who sold the easement to the state for use as a public park and bridle trail. The stone arch originally situated over the old Route 63 roadway parallel to Hop Brook was dismantled in the early 1960s to accommodate the construction of a new Route 63. As a result of this rupturing of the former rail bed, the stone arch culvert and embankment presently over Hop Brook are no longer accessible for use as a part of the bridle path.

Field excavations conducted at the crest of the embankment were designed to obtain a sectional plan view of any timber remains associated with the old trestle. A sectional profile from the crest to about two meters in depth was also obtained in order to document the structure's internal composition. The field excavations of the trestle, combined with information concerning late nineteenth-early twentieth century railroad engineering techniques, revealed the presence and structural design of a relatively intact open-floor wood-frame trestle system within the embankment fill. This embankment was and still is partially supported by the extant stone arch culvert and remnant timber crib abutments at the base of the slope. These types of constructions were commonly used by railroad companies during the latter nineteenth to early twentieth centuries both as a cheap first cost temporary structure (wooden trestle) and as more permanent structures (two stone arches, crib abutments).

A review of turn-of-the-century railroad engineering manuals, as well as historic engineering inventories from southern New England, has indicated that the presence of both the intact stone arch culvert and relatively intact trestle embank-



Longitudinal profile (on left) and transverse profile (on right) of the trestle timber-and-bolt system of the Hop Brook Railroad Embankment as noted from two excavation units.

ment constitute a unique combination of historic railroad construction technology that has survived into the late twentieth century. These structures have been evaluated as being potentially eligible for listing in the State and National registers of Historic Places. The information and recommendations presented in the survey report (*Historic and Archaeological Reconnaissance Investigations, Hop Brook Railroad Embankment at Hop Brook Dam, Middlebury and Naugatuck, Connecticut*, PAL, Inc., Report No. 337) will serve as a guide during the proposed remedial repair measures to the railroad embankment and stone arch culvert.

One of the report's recommendations was that a professional archeologist/industrial historian be present during the partial dismantling of the trestle and embankment. This will enable a more comprehensive and perhaps more revealing photodocumentation of the wood trestle structure. This work is tentatively scheduled for sometime before the end of 1990.

Suzanne Glover
The PAL, Inc.

SIMEON NORTH PISTOL FACTORY

Kevin A. McBride and Mary G. Soulsby of the University of Connecticut recently completed a study of the Simeon North Pistol Factory Site in Berlin, Connecticut. Documentation for nominating the site to the National Register of Historic Places has been submitted to the Connecticut Historical Commission.

The Simeon North Site is a late 18th-early 19th century industrial site associated with the changes that took place in manufacturing processes during the initial stages of the Industrial Revolution. The factory was in operation from approximately 1795 until 1843 and is the site at which small arms were produced under the first federal pistol contract in 1799. After 1813, North shifted the focus of his operation to a new site in Middletown, Connecticut, and thereafter his factory in Berlin was engaged in the production of parts for the pistols made in Middletown. All production at the Berlin factory stopped in 1843, and the factory was destroyed in a flood in 1857.

The site was originally located by several members of the American Society of Arms Collectors in 1986. Recognizing the potential archeological sensitivity and significance of the site, they contacted Allen R. Saltus, Jr., an archeologist and researcher in residence at the Center for Regional Studies at Southeast Louisiana University, to conduct an archeological survey of the property. Limited archeological investigation conducted at the sites demonstrated intact archeological materials that reflect the factory's structural remains, activity areas, arms manufacturing processes and the types of tools and machinery used in the processes. Recovered archeological materials reflect every gun part in all stages of manufacture from raw iron to finished product. More than 900 artifacts were recovered from the site. Over half of the items were ferrous metal objects. A relatively small percentage of the material was modern (36 can fragments and two wire nails), but the remaining artifacts were determined to be associated with the North factory and were organized into four categories: arms production, tools, hardware and nails.

The structural collapse of the factory in the 1857 flood actually served to preserve much of the archeological integrity of the site. The lower (cellar) structure appears to have imploded, with the upper floors collapsing downward, sealing the lower levels in a stratified context. It may be possible, then, in certain areas of the site, to distinguish between various levels of the original factory.

In addition to issues related to the processes of industrialization, the site has the integrity and potential to address such issues as early fabrication of firearms, types of arms and other materials made at the site, how the site supported North's Middletown factory, what tools were utilized at the site, and what the nature and distribution of activities were within the factory site.

The birth, growth and decline of this factory provide an excellent illustration of the development of the early U.S. arms manufacturing industry. But North's factory was also instrumental in developing and implementing manufacturing techniques which were adopted and made standard by many other industries.

Simeon North was an extraordinary person, an inventor and a businessman who played a critical role in the development of the U.S. arms industry and whose innovations and advances made important contributions to U.S. industrialization. North implemented the concept of occupational specialization as early as 1808. North is also credited with being one of the first, if not the first, to implement the concept of parts interchangeability, and he made numerous changes and advances in machinery to achieve and improve interchangeability.

North made specific innovations which were later adopted by some of the largest gun manufacturers, and he made several advances in tooling and manufacturing, including the construction of the first known milling machine in America, which he invented in 1816 to improve barrel-turning.

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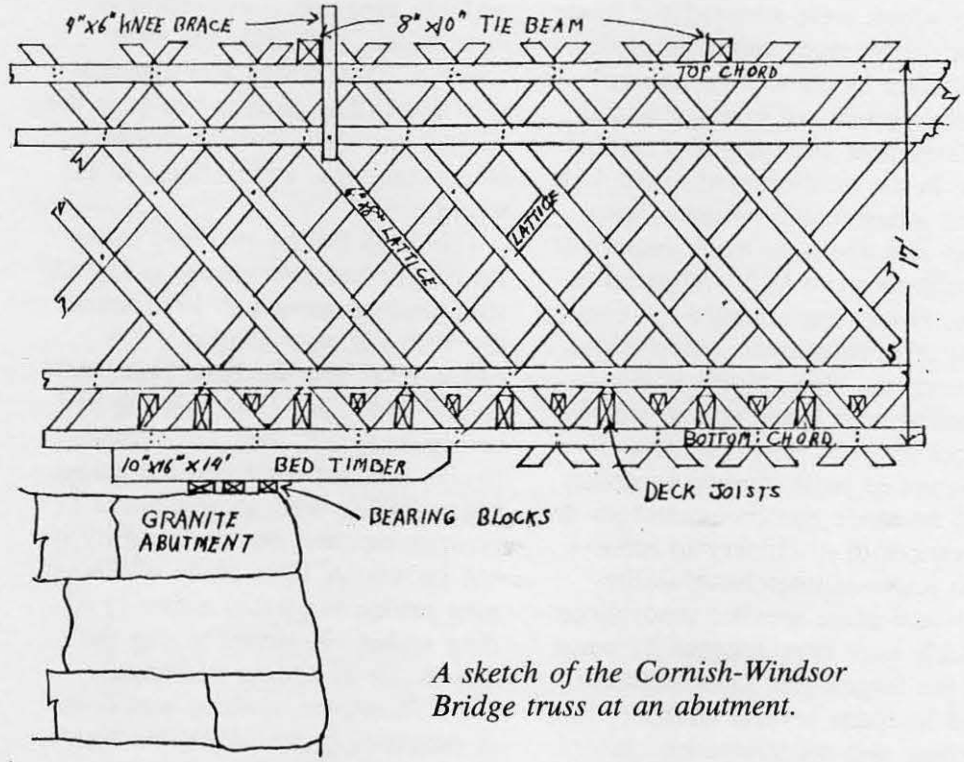
Article

The Restoration of the Cornish-Windsor Bridge

In 1866 a 464-foot-long wooden bridge was built across the Connecticut River connecting Cornish, N.H. and Windsor, Vt. This was the fourth bridge at this location and was a Town timber lattice in two spans, each 232 feet, and covered. The previous bridge, built in 1850, was covered and of similar construction, but was lost to a flood. The bridge prior to that had been built in 1842 and appears, from early drawings and a piece of surviving chord, to have been of multiple kingpost construction in three spans, with only the truss covered. This bridge was also lost to a flood. The current bridge is the longest two-span wooden bridge in North America, and perhaps in the world.

The 1866 bridge survived many floods but had a tendency to sag. A study commissioned in 1912 found the Vermont span sagged 9 7/8" below level and the New Hampshire span 7 1/4". By 1986 this sag had increased to 17" and 12", respectively. It is assumed that the bridge began its life with some amount of positive camber, but the quantity is not known. A 1908 study of the aging bridge suggested either 1) adding arches, 2) strengthening the chords, or 3) adding additional piers. However, nothing was done at the time. In the 1930s the New Hampshire span of the bridge was jacked from capped piles driven into the river bed, and many of the ice- and flood-damaged lattice members on the north side were replaced. Throughout the 20th century steel plates and additional bolts were added to the chords to retard the opening of joints in tension or their buckling in compression. Additional timber and steel channels were added to strengthen the upper chords over the central pier, the location of maximum tension in the bridge. The bridge continued to sag until anxiety over its safety led New Hampshire to close it in 1986.

The question of how to restore the bridge was debated by the two states, their Historic Preservation Officers, and interested private groups for two years. The addition of wooden arches, a method occasionally used in the 19th century to upgrade a bridge, was proposed but eventually rejected for several reasons. First, the arches would



A sketch of the Cornish-Windsor Bridge truss at an abutment.

alter the historic structure system of the bridge and its appearance as well. Second, arches would deliver an immense horizontal thrust to abutments designed only to carry the vertical load of the lattice truss (the abutments and central pier are of cut granite, very handsome and in good repair). Third, any springing of the arches below the bottom chords of the bridge would expose the arches themselves to ice and water damage. Ultimately it was decided to strengthen the chords, repair the lattice and increase the role of the bed timbers by adding large bolster beams at the piers and abutments (see Figure 1). Chesterfield Associates was chosen as the General Contractor, and David Fischetti, P.E. as Engineer. I was chosen as the subcontractor in charge of wood framing.

We decided to repair the bridge in place because it was hard to find anywhere to put it, and because much of it was in good condition and better left undisturbed. It was originally built in a pasture on the Vermont side and assembling over the river on falsework. The remains of the wooden sills of the falsework can be seen under certain light conditions across the entire width of the river. They appear to form a frame of roughly 12" x 12" timber, dovetailed and pinned together. The falsework and centering of various wood or stone bridges may have comprised the mightiest timber frame structures of all time but were by nature transitory, and thus little is known of them, making the Windsor remains worthy of study. Since we were dismantling 60% of the chords of the bridge we needed support, but ice was sure to sweep away anything left in the river through the winter. Consequently, the General Contractor erected three 80-foot steel towers, slid 40-foot steel needle beams between the two upper chords, and attached the needles to the towers at 24 points by means of threaded steel rods. Thus, Cornish-Windsor was temporarily turned into a two-span suspension bridge. A large nut could be driven up the rods by means of a hydraulic wrench, pulling with it a frame attached to the needle beams. By this means, and by dint of great labor over two weeks time, we were able to drag the bridge up into 24 inches of positive camber. We would repair the bridge with this much camber in it, hoping that, when released from the suspension system a year later, it would retain at least some of it.

The bridge was affected by sag, rack and bow, but remarkably little rot. Our job was to replace and strengthen the lower chords and the upper chords over the central pier, repair and sister any broken or rotted lattice, and strengthen the wind and lateral bracing systems. The job of removing the 8000 linear feet of 3" x 11" and 5" x 11" lower chord members, peppered with 3/4" x 24" bolts, was grueling and convinced those doing it that the bridge was not near failure. The wood (red and white spruce) was generally in excellent condition, and the bolts, while rusted, were sound. The steel plates added to the chords in the 20th century were in terrible condition, having lost approximately half their thickness to rust.

It might be asked why, if the wood was in generally good condition, we were repairing the bridge. The answer is that the bridge is a great bridge, but that its truss was only marginally adequate to its exceptional span and traffic even when built. "Extensive repairs" were carried out by one of its builders, James Tasker, as early as 1887. The 20th century saw almost

The eastern span of the Cornish-Windsor bridge with its suspension system rigged on temporary towers forcing a positive cambor. The suspension wires connected to the needle beams supporting the upper chords cannot be seen in this photo.

continuous attempts to arrest its increasing sag and its alarming rack (9 inches out of plumb over 17' of truss height). Ithiel Town advertised has lattice trusses as requiring "no long or large timber", and since the "string-pieces are composed of two thicknesses of plank ... long, hewn timber is unnecessary" (see Ithiel Town's pamphlet *Wood and Iron Bridges*, New Haven, pp. 5 and 7). The chords at Cornish-Windsor were made of 32-foot-long pieces joined in pairs with breaking joints and with both bolts and hardwood (maple and yellow birch) shear (or packing) blocks transferring the load across joints. Still, with this many joints, and the truss members no stronger at any given point than any other, the chords developed openings at areas of high tension. The upper chords at the middle of each span developed a series of small kinks to accommodate the corresponding compression. There were several points of rot in the upper chords, almost always where roof leakage entered a shear block, and it had spread to the surrounding chord members. There were three compression failures in 3" x 10" members of the upper chords, always occurring at the unfortunate point where a lattice let-in, shear block let-in, and 3 bolts were together (this congruence occurred every 4 feet the whole length of the bridge).

The bridge's rack was attributed to a weak knee bracing system, problem endemic to lattice trusses since there are no vertical posts to mortise a diagonal into. The braces were original to the bridge and affixed with lag screws. Bow was in an upstream direction and amounted to about 10 inches in each span. It may have been there originally by error or design, or been the result of a strong south wind. The lateral bracing systems overhead and below the floor were unable to resist bowing due to a poor length to diameter ratio (4" x 5" x 23'). The overhead lateral bracing was mortised into the tie beams and tightened with a pair of oak folding wedges. These were the only mortise and tenon joints on the bridge. There were no wooden pins anywhere on the bridge, it was entirely bolted and lagged in 1866, and probably represented a rather modern structure at the time. (Although an 1840 article in the *Journal of the Franklin Institute* describes a Town lattice where bolts are substituted for treenails, most surviving bridges of this sort have wooden pins at lattice intersections, even when built as late as the early 20th century See Beard, Ithamar A., "Description of an improvement on the bridge patented by Ithiel Towne (sic)".)

After removing the lower chords, we repaired and sistered the lattice, mostly contended with ice damage. The lattice are 6" x 8" timbers with 1 1/4" let-ins where they cross each other or a chord member. The chords are also notched at each lattice crossing. The timber lattice depends upon the shoulders of these let-ins to resist, in compression, the changes of shape the truss would undergo while sagging. There are slightly over 20,000 of these shoulders. The original joints, while very neatly done, were almost all wedged as well with tiny maple wedges. This wedging may have been in response to the shrinkage of timber between the time the joinery was cut in the spring of 1866, and its assembly in the fall. Timber lattices are a rarity, the vast majority of Town trusses being plank or double plank lattice. The plank lattice has no joinery cut at lattice crossings and depends upon wooden pins in shear (as well as the strength of the chords) to resist distortion of the truss. The lattice was replaced with solid Douglas fir timber (this was also used during the repairs of 1936). After repairing the lattice, we applied new lower chords. The engineer chose to use glue laminated material of southern yellow pine (gluelams) due to its availability in long pieces and its higher design values. Most of our new chord members were 116' or 100' x 8" x 11", allowing us to span all the high tension areas without any joints at all. The gluelam butt joints were located at minimum tension points and connected by metal shear rings and steel plates. I think it remains to be seen whether gluelams and their metal connectors will hold up as well over time as solid wood and traditional wood joinery.

The upper chords were replaced by 88-foot gluelams, but only over the central pier. The highest tension loadings in the bridge occur there, and the old chord system was opening as much as 1 inch per joint, cracking, and denting its shear blocks deeply into the end grain of the spruce. The remaining 3400 linear feet of the upper chords were repaired where necessary (19 points) with 32-foot pieces of Douglas fir, using ash, maple and oak shear blocks and bolts, and can be truly called a "restoration" in terms of technique.

The overhead lateral bracing was strengthened in a very satisfying fashion. The number of tie beams overhead was doubled, and the lateral braces were mortised from the end of one into the middle of the next. This allowed the original braces to be used, but each in two pieces half their former length. This system is actually original to many wooden bridges, and is clearly present in photos of the long-destroyed Tucker Bridge in Bellows Falls, a Town lattice of similar scale. Why the original builders at Cornish-Windsor opted for a lighter scheme will probably never be known. The original 8" x 10" x 24' tie beams were used, plus a nearly equal number of new ones. The new ones were of red and white spruce from northeastern Vermont. The additional tie beams allowed us to double the number of diagonal braces descending from them to the sides of the truss.

The final element in the scheme to strengthen the bridge was increasing the significance of the bed timbers. The bed timbers on any wooden bridge serve to both protect the chords from ground contact and, by canterlevering out a few feet (held down by the self weight of the bridge where it sits on the abutment), to reduce the span somewhat. Cornish-Windsor's bed timbers were pairs of various large pieces of wood, typically 10" x 16" x 14', some original and some relatively new, and they canterlevered 7 feet. One was even a section of chord from, I believe, the 1824 bridge on the site, complete with much larger chord members, shear blocks, and the dap for a large, rafter-like chord member. We replaced the old bed timbers with new white oak pieces of the same size. To the inside of these the engineer specified the placement of immense (11" x 35") gluelam timbers that canterlever out 13 feet, and are tied to a concrete footing. These, in turn, carry a beam that can support the chords when they deflect beyond a certain point. As the bridge sags over time, these bolster beams will probably always be engaged.

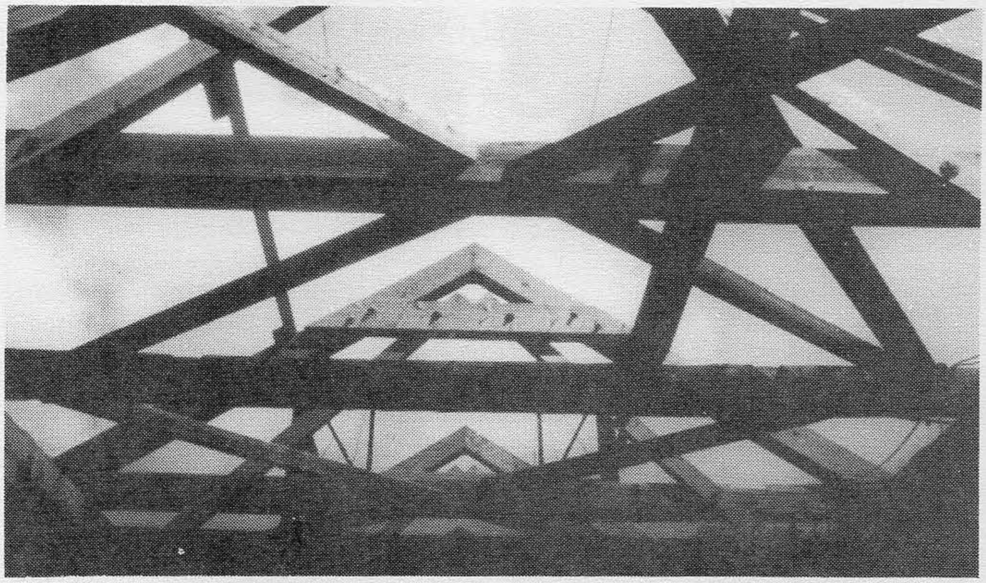
In addition to the structural work, the bridge was treated to a new deck of 4-inch Douglas fir (probably its fourth or fifth deck), new 6" x 18" deck joists (at least the third set), pine siding, new spruce rafters, and a galvanized metal roof (its fourth roof, second time in metal).

When the bridge was let go from its suspension system in October of 1989, and the towers taken down, it lost only 4 inches of its 24-inch camber in the first week, A month later it had lost only 2 more inches. Needless to say, everyone involved was elated by this, expecting the bridge to have sagged far more based upon its track record. It may continue to sag, but hopefully it will never break or be carried away by ice. The height of the truss (17') is small for the length of its span (205'), and it receives an average

Installing the gluelams on the Town lattice.

traffic of 2500 cars per day. A 6-ton weight limit has been posted for years but is difficult to enforce so that vehicles weighing 30 tons are regularly seen crossing the bridge. According to modern engineering standards, the bridge as built in 1866 should be unable to carry its own dead load, but at 120 years it is outlasting all the steel and concrete bridges in the country. Perhaps the spruce originally used in this bridge, if tested, would have much higher design values than spruce currently available. Perhaps new engineering models are needed for timber-frame structures, since not just this bridge, but most older roof trusses, church steeples and barns are found inadequate when quantitatively analyzed today. Fortunately, both the engineer and the general contractor on this job were sympathetic and interested enough in historic framing to allow us to come up with a model and calculations for the use of wooden shear blocks in creating long beams out of several members. The results of these calculations found the original shear blocks to compete favorably with metal connectors in many situations.

As I have described above, the Cornish-Windsor Bridge had to be altered somewhat to be saved. It could have been preserved unaltered as a footbridge with a new concrete bridge next to it, but I think there is some virtue in having this wooden structure remain as the only crossing at this point. As an artifact from the mid-nineteenth century, the bridge testifies to the durability of wood, if kept covered, and the inherent strength of a design first patented by Town in 1821 but previously used by unknown carpenters in bridges spanning the Otter Creek in western Vermont as early as 1813.



The overhead lateral bracing system strengthened by doubling the number of tie beams. The braces were mortised from the end of one to the middle of the next.

The fact that this large bridge and its falsework begun in April of 1866 and completed that same fall by men using hand saws, chisels, mallets, slicks, occasionally an adze or hatchet, and hand-powered augers (to drill more than 10,000 1'' x 24'' holes) gives rise to reflection about organization, experience and skill within a craft tradition. To modern eyes, Cornish-Windsor appears as a hand-crafted relic representing an antique and different way of building, and this is partially true; it was built largely out of wood using hand tools. However, compared to most of the bridges, barns, town halls and churches of the century prior to 1866, and to some rural structures built after that date, this bridge was an example of modern industrial thought. The pre-industrial timber framer in northern New England, building a bridge or a roof truss, would choose his timber piece by piece, aiming for a hierarchy of sizes according to function, and for great length and size wherever possible. The great lengths (65-foot sticks were not uncommon) necessitated hewing of timber since they exceeded the capacity of the sawmills. Major members might then be shaped, tapered, or hewn to camber, responding to where strength was or wasn't needed, or to placement of joinery. Buildings like the Udall-Boyd barn (ca. 1790) in nearby Quechee, Vt. or the Castleton Federated Church (1835) in Castleton, Vt., have hardly a single major timber that is not hewn or adzed to a non-rectilinear shape. The subtle aesthetic and intellectual impact of this proportioning should not be overlooked.

Ithiel Town's bridges, on the other hand, were recommended by him (see the 1821 pamphlet mentioned above as well as Town's article in *Silliman's Journal of Science*, No. 2, 1840) as suitable for mass production by less skilled labor, inexpensive, and redundant, i.e., composed of a multitude of similarly-sized, relatively small pieces of lumber, each carrying a little bit of the load, much as in modern framing. Town's claim for his truss that ''Suitable timber can be easily procured and sawn at common mills, as it requires no large or long timbers'' (1821 p.7) became increasingly attractive as the century progressed and the stocks of timber in the east declined. The complete absence of wooden pins in the bridge, the avoidance of mortise & tenon, and scarf joints and the lack of a hierarchy of mighty timbers to carry the great loads (also making the functioning of the truss less obvious to the eyes of non-engineers), separate Cornish-Windsor and other lattices of this sort from the main stream of timber framing in New England up to that time, but indicate the direction that it was going in.

The Cornish-Windsor bridge was reopened to traffic on December 8, 1989.

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Article

The Moseley Iron Arch Bridge: a Study in Rehabilitation

Progress Report

Introduction

The Moseley iron arch bridge built across the North Canal in Lawrence, Massachusetts, in 1864 is shown in Figure 1 by a large arrow. The bridge is the earliest surviving bridge constructed to provide access to the mills for workers who were to live in the nearby company housing as well as for deliveries and shipments by horse-drawn wagons. It is also the oldest extant iron bridge in the Commonwealth of Massachusetts and one of the oldest bridges in the United States built entirely of wrought iron. It is one of only three bridges built by Moseley still in existence. One of these, located in Claremont, N.H., is a bowstring but with the web members in a diagonal pattern. It was a foot bridge accross the Sugar River and is in danger of imminent collapse. The other Moseley is reported to be in Eppingham County, Illinois.

Thomas W. H. Moseley was issued patent no. 16572 on February 3, 1857 on a "truss bridge." This bridge was fabricated entirely of wrought iron plate, bar and strap stock at a time when Squire Whipple, the premier iron bridge builder of the time, was constructing bowstring trusses, patented in 1841, made of cast and wrought iron. Whipple's and Moseley's patent drawings are shown as Figures 2 and 3. Both are tied arches with

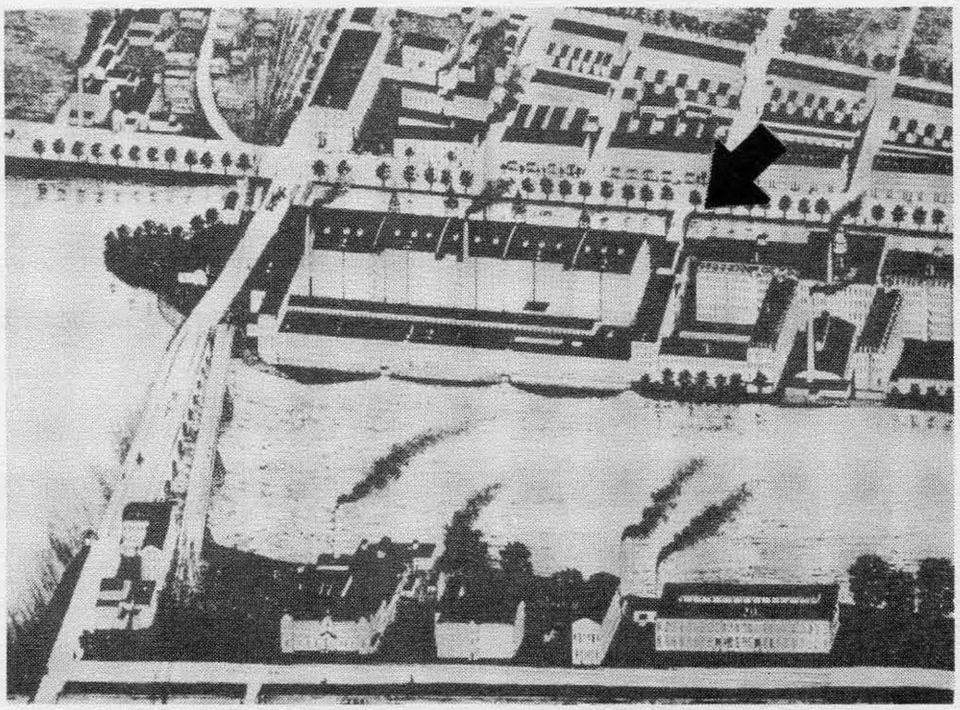

Fig. 1. *The Great Stone Dam, North and South Canal, Moseley Iron Arch Bridge.*

the string (lower chord) being in tension and made of wrought iron. Whipple's top chord, however, consists of cast iron segments, while Moseley's is made up of continuous riveted wrought iron plates arranged in a triangular pattern. The main visual difference between the two, however, is in the diagonals. Whipple makes use of what, at the time, were called "braces" and "counterbraces", while Moseley's diagonal pattern defies description, being a series of straps on something approaching a radial pattern. We all know (well, most of us know) that Whipple has been called "The Father of Iron Bridges" and that he wrote the first book anywhere to describe methods for analyzing a truss. But who was Thomas Moseley, and what was the significance of his bridge?

Thomas W. H. Moseley

Moseley was born in Mt. Sterling, Kentucky, in 1813 [1,2]. His first exposure to the iron business came when he served as assistant manufacturer at the first iron furnace built on the Ohio River at Irontown, Ohio. He was fascinated by iron the rest of his life, writing in 1963 that: "It may be confidently asserted that, except the Gospel, Iron has been the most potent of all agents in the civilization of mankind. It cannot but be observed, that, exactly in proportion as communities, tribes, and nations have learned the uses of this bounteous gift of the Creator, they have advanced in science, in culture, and in Christianity"[3]. He later studied Civil Engineering and became interested in bridges, saying: "Almost every individual, who

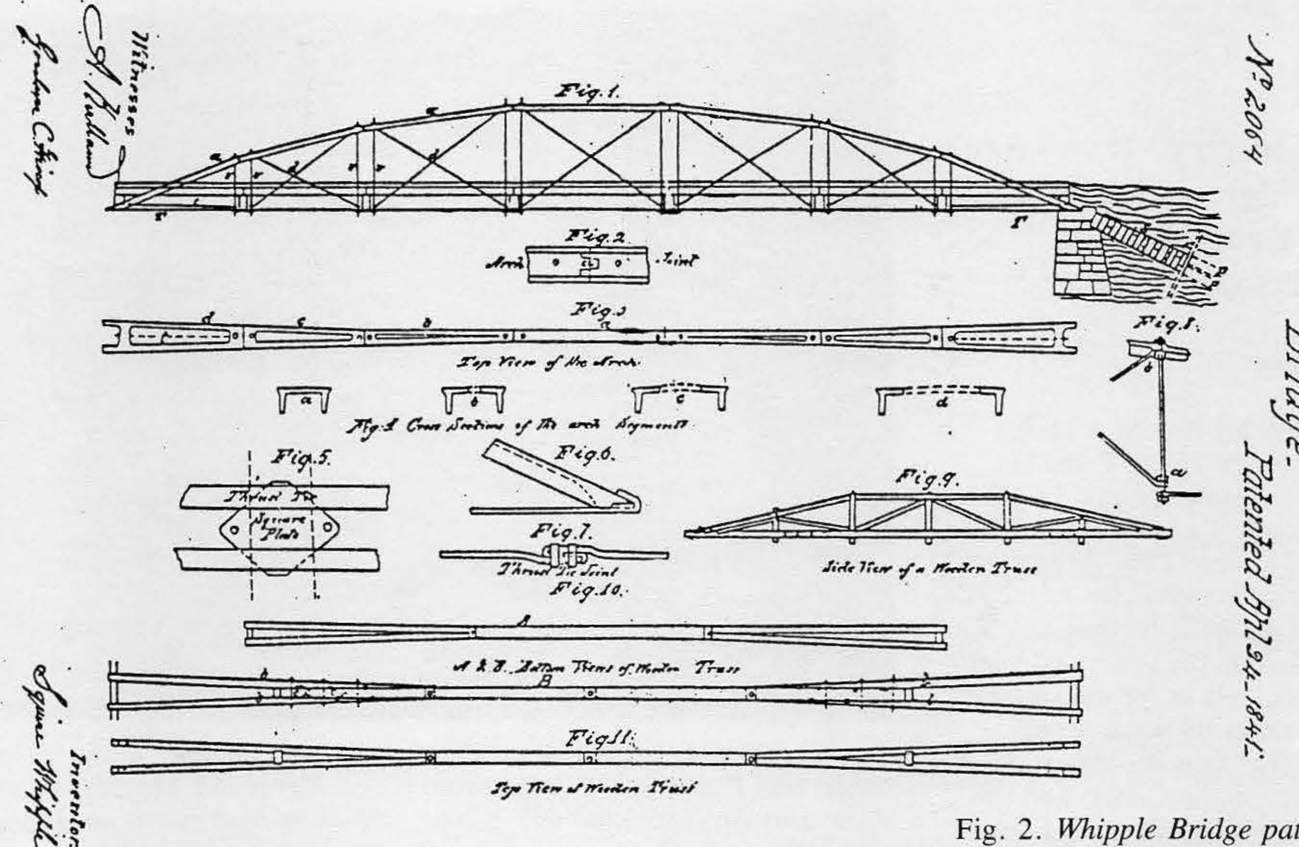

Fig. 2. *Whipple Bridge patent drawing.*

as its engineer, has made ten miles of road, has at one time or another conceived a new plan of bridge; for of all the troubles which beset an engineer in constructing and operating a road, its Bridging is the greatest''[3]. He was first exposed to wooden bridges built by Lewis Wernwag and Theodore Burr who used arches extensively. He also knew of Capt. Delafield's cast iron arch bridge on the National Road at Brownsville, Pennsylvania, built in 1839. He had, in fact, superintended the weighing and shipping for the iron used in that bridge. In 1853, while building a road in Kentucky, he hit on his idea of a wrought iron riveted plate tied arch as a solution to the bridge problem. He built his first bridge, a 60' span, using hand iron working tools, across Bank Lick Creek on the Bank Lick Turnpike seven miles

Fig. 3. *Moseley Bridge patent drawing.*

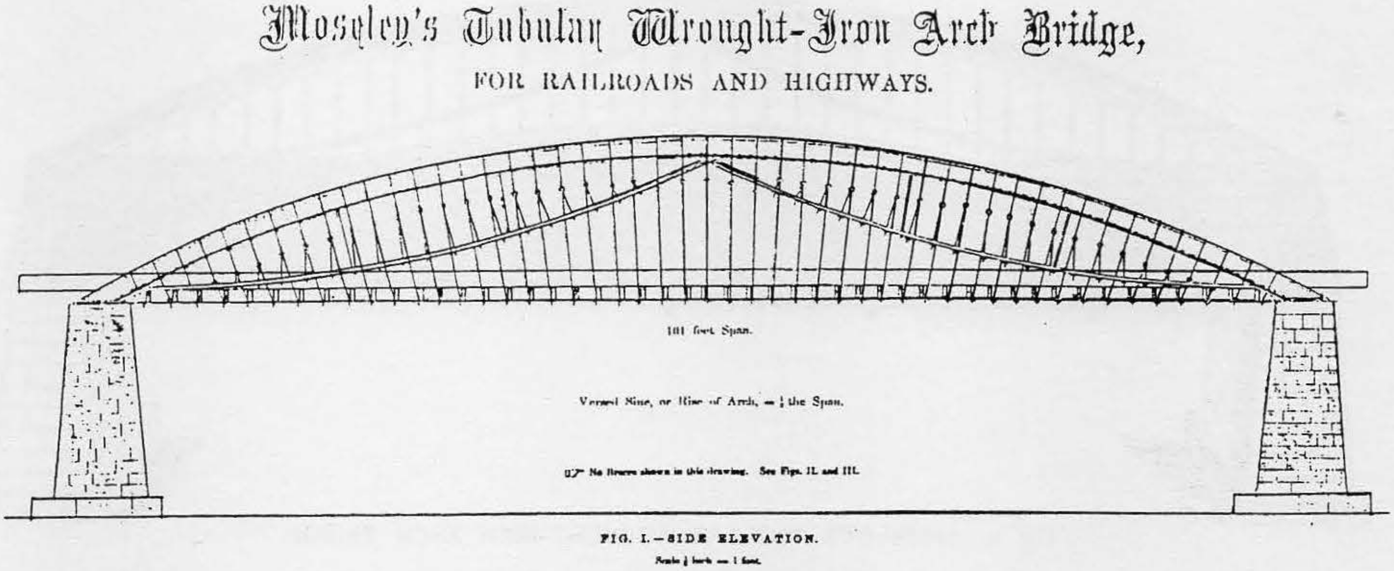

Fig. 4. *Moseley Iron Arch Drawing - 1863.*

outside Covington, Kentucky, for the sum of $2100. After being issued his patent, he set up a factory in Cincinnati to build his bridges in 1858. He was to move his business to 53 Washington Street in Boston, Massachusetts, during the early part of the Civil War. His new plant was completed in October 1861, and he began to successfully build iron bridges and buildings throughout New England. He built over 200 bridges in the nine years that he was in Boston, including the bridge in Lawrence. He later sold his interest in this plant in 1871 to the New England Iron Company. He moved to Scranton, Pennsylvania, in 1875 and, according to his obituary, ''lived in style''[1] until his death on March 10, 1880, of pneumonia.

The Moseley Iron Bridge

Brock[4], in his fine series on early bridge patents, describes Moseley's bridge as follows (see Figure 3): ''The Arches A A of this bridge are of compound character and are built up of wrought iron in such a manner to give the arch very long spans without excessive weight. A transverse section of this arch exhibits the form of an isosceles triangle, the base B of which is the chord of the arch. The plates P of the arch break joints with each other for the purpose of strength. For the purposes of additional strength to the triangular arch, a vertical plate R is used dividing the triangle, and bolted thereto. Moseley asserts that under a strain exerted in any direction upon this compound arch there is less risk of buckling of either of the plates than in any other structure for the purpose. In order to prevent all risk, however, of buckling, loose pieces or saddles s-s are used, resting, upon the plates B, and also bearing against the plates P, supporting each other by their edges, which come into contact as seen at T. Over the upper edges of the saddles, and receiving part pressure thereof, are the stirrups E of the suspension rods F. The floor of the bridge rests upon the chord M, supported by the suspension plate D. This plate is not fastened to the lower chord M, and the effect of which is that every load draws upon the whole arch in consequence of the sliding movement of the suspension plate under the chord.''

We next see his revised arch in his 1863 prospectus[4]. This version is shown as Figure 4. He stated in his article that ''In 1859, a radical improvement was made in the bridge, greatly increasing its strength and stiffness.'' This improvement was the addition of the counterarches which are evident as well as an additional short piece of iron running from the bottom of the loop over the top chord to the counterarch. What this was for is not known, either now or probably then. The saddles, s-s, are gone, and the stirrups are now round bar stock. His suspension straps are now made of 5/8'' wrought iron bar stock which were hooked by a loop to the saddles. He built several of these new improved bridges in Ohio and in Boston, Massachusetts, in the late 1850s and early 1860s.

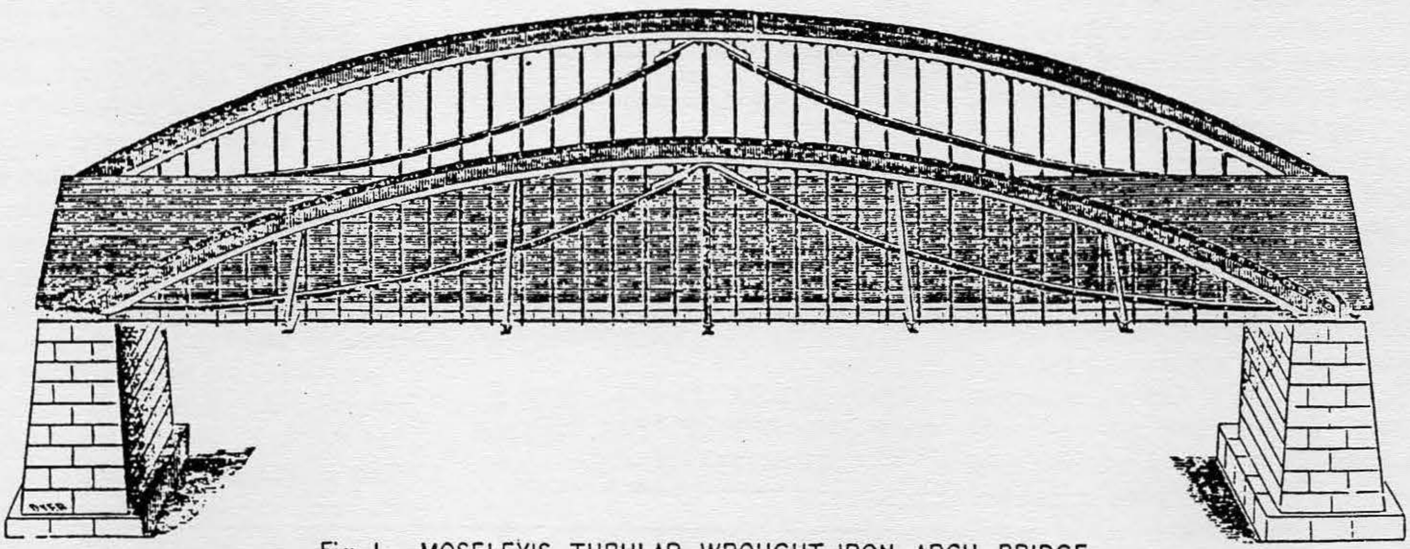

Fig. 5. *Moseley Iron Arch drawing - 1867 [Fig. I].*

His next improvement is shown in his 1867 catalog[5]. He describes his tubular wrought iron arch bridge in part as follows:

"The supporting parts of the bridge are two arches, one on each side of the highway. These arches are hollow, and are triangular or three sided made of wrought plate or boiler iron, by riviting three plates together at their edges. [See Fig. IV on the diagram (Fig. 6 in this article), which shows the hollow arch, with suspension bar passing through it.]

"From foot to foot of each Arch goes the Chord [See Figs. I, II, V.]. This is double, and binds securely the feet of the arch to each other, so that there is no thrust or outward pressure of the arches to require heavy abutments. The only pressure upon the masonry is verticle. In Highway Bridges, the cross-section of the chords has one-third the number of inches in that of the Arches; and in Railroad Bridges, one-half the number of inches in cross-section. The tensile strength of an inch of iron averages 60,000 lbs.; but, as will be seen, our calculations are based upon a tensile strain of 21,000 lbs. per square inch (in Railroad Bridges 14,000 lbs.), for four times the actual burthen (Burden).

"The Chords are held level, or in line, by Suspension Bars. [See Figs. I and IV.] These pass through the Arches; thence downward between the Counter-Arches (to which they are rivited), and support the Chord. They are placed at intervals of about 23 inches, giving 54 Bars in a fifty-feet Bridge. The same calculation governs the dimensions of these, as of the other parts of the structure, —viz.: to provide for eight or ten times the actual burden.

"The Counter-Arches are of angle Bar, doubled; and, varying with the span, corresponding to the dimensions of the Main arches and Chords. [See Figs. I and IV.]

"The Floor rests upon the chords, — a floor beam at every Suspension Bar. In common Highway Bridges of 16 to 20 feet wide, the floor beams may be of 3 x 4 inch lumber, covered with 2 1/2 or 3 inch plank.

"These earlier Bridges lacked the Counter Arches which, as now constructed, correct all undue elasticity.

"Later still, the present Suspension bars, which enter the Arch, and are rivited into its comb, were adopted, in lieu of the former Rods, which were connected with the Arch by means of a stirrup passing over it; and which failed to give compact union of the parts now secured.

"While, for all purposes of a Bridge, the tubular-Arch principle is unsurpassed, we claim that, for certain uses, it cannot be approached in economy and security by any other". (Figures 5 and 6.)

The Lawrence Moseley was cataloged[7] by the Merrimack Valley Textile Museum and Historic American Engineering Record (HAER) in 1976 as follows:

"The bridge was built to span the North Canal and connect the Pacific Mill with Canal Street. It was built in 1864 by the Moseley Iron Building Works of Boston. The designer was Thomas W. H. Moseley of Cincinnati, Ohio, who held 2 patents on the upper chord design, dating from 1857 and 1858. The bridge is a bowstring truss, and contains 5 panels. There are no diagonal members. The vertical members are pairs of parallel 3'' rods which are riveted to the upper chord and bolted to the lower chords. There is a curved member which is riveted to the upper chord and bolted to the intersection of the upper and lower chord. It is probably intended to stiffen the truss. The upper chord is a series of triangular iron sections riveted at 8 foot intervals. The lower chord is a system of parallel iron plates riveted in sections. There is no upper lateral system. The lower lateral system consists of girders similar in style to the upper chord, and wooden stringers. The bridge has been supplemented by a modern wooden system of piers and girders and stringers. Span is 100 feet, depth is 10 feet and width is 18 feet.'' (Figure 7.)

The Present

In the summer of 1989 the bridge's wooden under structure partially collapsed and caused the eastern arch to buckle at about the third point (Figure 8). The owner, Atlantic Enterprises, was instructed by the City Engineer to either repair the structure or replace it with a new bridge. Atlantic Enterprises, being the landlord to many companies on the Island, was under lease obligations to provide pedestrian access across the canal and had decided to replace the bridge. What follows may be hard to believe but is absolutely true. On Sunday July 9, 1989, I said to my wife ''let's go over to Lawrence to see how the Moseley was doing''. When we got there, I discovered the collapse and that someone was

DETAILS.

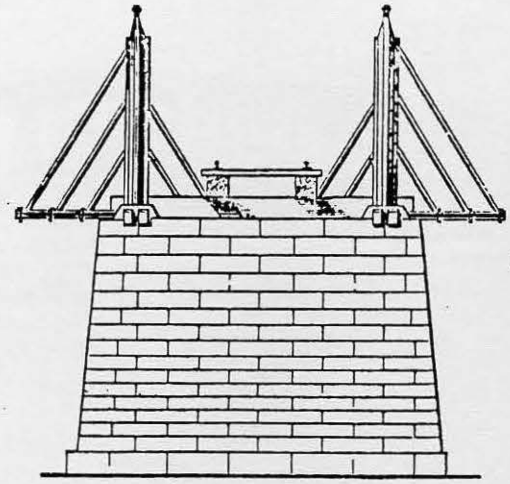

Fig. III. Section of Railroad Bridge.

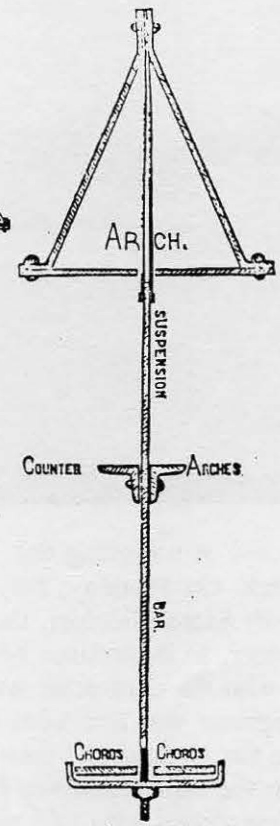

Fig. IV.
Section of Arch, Chords, &c.

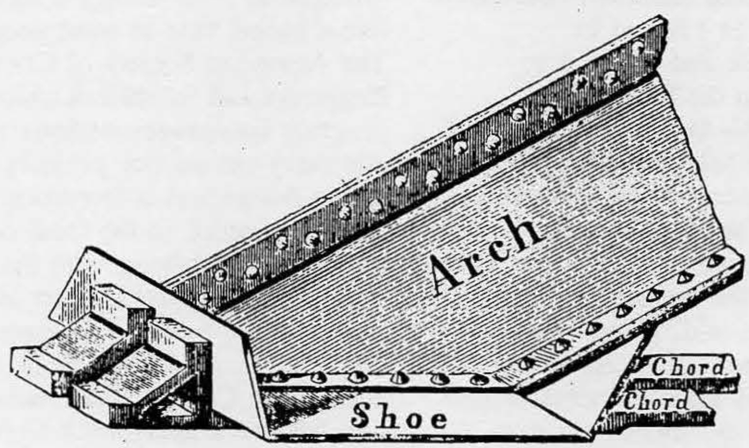

Fig. V. Part of Arch, with Shoe and Chords.

Fig. 6. *Moseley detail drawings, [Figures III, IV, & V].*

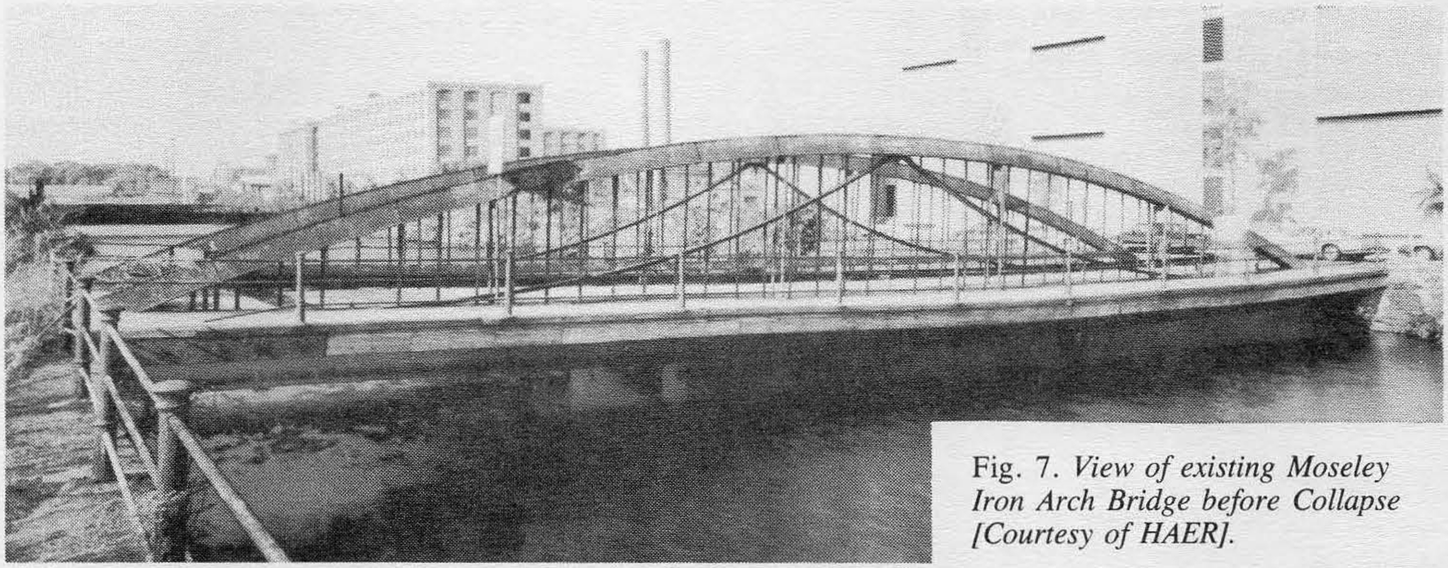

Fig. 7. *View of existing Moseley Iron Arch Bridge before Collapse [Courtesy of HAER].*

in the process of removing the wooden deck. On Monday, July 10, I talked with Santo Nicolosi, the City Engineer, to determine: who owned it, who the contractor was, who its engineer was and what the plans were for its future. I then talked with the representatives from Atlantic Enterprises who told me that they were going to replace the bridge. I asked them if I could have the bridge, as I hoped to rehabilitate it and return it to Lawrence in the future. They agreed to this but told me they had no funds to help move it to the campus of Merrimack College. I then talked with Grasso Construction Company, the contractor, about their plans for the bridge. They were, I was told, planning to cut it up and dispose of it. As luck would have it once again, Vincent Grasso was one of my former students at Merrimack. After some discussion, he agreed to remove the bridge as carefully as possible, and transport it to campus. The lift went well, but as each arch was lifted from its supports it became clear that the ends of the arches, which had been buried in soil and concrete for over a century, had deteriorated badly. On Saturday, July 15, 1989, the arches were transported to the college after having been cut in half.

The Rehabilitation

Now that the bridge was saved, what would be the next step? I could see that the bridge was surely salvageable even though it looked like a basket case to most people. The American Society of Civil Engineers and its student chapter program encourages students to plan and carry out service projects such as the design and construction of facilities needed in the local community. After talking with the officers of the student chapter and the Chairman of the Civil Engineering Department, as well as the President of the College, the rehabilitation became a Merrimack College student project. Over the past several months, we have received support from Flametek Steel Corporation, the Boston Society of Civil Engineers section of the ASCE, George Henderson Construction Company, The Structural Steel Fabricators Association of New England, The Grasso Construction Company and Merrimack College.

After searching over a wide area for one-quarter-inch-thick wrought iron plate and finding none, we decided to use steel as replacement for the deteriorated plate. To date, we have carefully measured the entire structure and made templates of parts that must be replaced. Material tests have been run on the wrought iron. These tests indicate that the wrought iron has very similar characteristics to A36 steel such that the 21,000 psi working stress Moseley called for was still appropriate. The students have placed the structure on a CAD drawing and are in the process of performing structural analysis on the bridge. They are looking at the curved counter arches to determine their function. As noted above, Moseley said the counter arches were added to his original plan to "correct all undue elasticity"[5]. This statement doesn't tell us much about the elasticity (deflection?) the original arches had or why he chose to add the counter arches. In addition, Moseley's description states

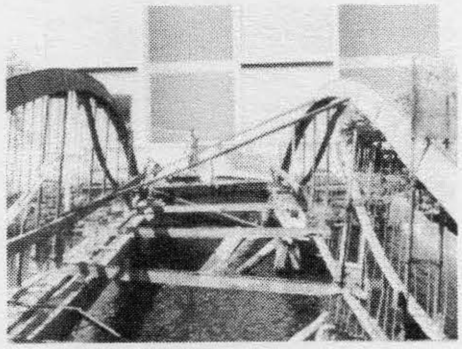

Fig. 8. *View showing right arch with deck removed and temporary lateral support in place.*

that the vertical straps are riveted to the counter arches: "these pass through the arches; thence downward between the counterarches (to which they are riveted), and support the chord"[5] (also indicated in Fig. 4 of Moseley's description). In our bridge, the straps were not riveted to the counter arches. We are running analyses to determine the structural effect of riveting vs. not riveting the straps to the counter arches. We also found as described in the HAER report that triangular shaped riveted beams had divided the arch into 5 panels with the wooden deck being supported on wooden stringers. This framing system does not show up in any of Moseley's accounts of his bridge. Moseley states that "The floor rests upon the chord, - a floor beam at every suspension bar"[5]. This framing system makes sense as it results in a more uniform loading on the arch. We have decided to restore the bridge following Moseley's original floor framing plan using a floor beam at each strap.

Our tentative time table would have us placing the bridge back across the North Canal in the late spring or early summer. We are working with the Heritage State Park organization and adjacent mill owners to find a location near the visitors center in Lawrence. I will be describing, in a subsequent paper, the actual reconstruction of the bridge. It is indeed a challenge and an opportunity to be able to work on a bridge such as this. I tell my students that this will be a project they will remember the rest of their lives. Moseley would be proud of them!

References

1. Obituary. General Thomas W. H. Moseley. *Boston Journal*, March 16, 1880, page 4, col. 6.

2. Obituary. General Thomas W. H. Moseley. *Boston Traveler*, March 12, 1880, page 3, col. 1.

3. Moseley, Thomas W. H. *Iron, New enterprise in its manufacture and application to Building.* 1863.

4. Brock, F. B. *An illustrated historical description of all expired patents on truss-bridges, which under the law are now public property and free to be used by anyone.* Engineering News and American contract Journal, March 10, 1883, page 120.

5. Moseley, Thomas W. H. *IRON BRIDGES-ROOFS, BUILDINGS &c. -Manufactured by- MOSELEY IRON BUILDING WORKS.* 1867.

6. Moseley, Thomas W. H. *IRON BRIDGES-ROOFS, BUILDINGS &c. -Manufactured by- MOSELEY IRON BUILDING WORKS.* 1870.

7. *The Lower Merrimack River Valley: An Inventory of Historic Engineering and Industrial Sites.* Merrimack Valley Textile Museum and Historic American Engineering Record. 1976.

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