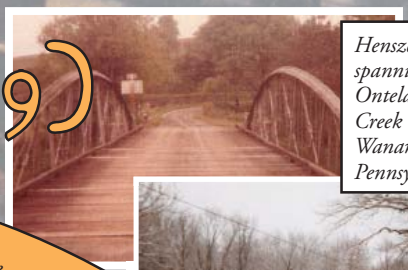
Henszey's Arch (1869)

A Bridge to Success

By Eric DeLony



Henszey's Arch spanning Ontelaunee Creek in Wanamakers, Pennsylvania

Henszey's Arch in winter

I selected Henszey's Arch as a case study for rehabilitating a historic bridge because it illustrates many of the steps engineers will encounter when rehabilitating a historic structure. Because of their rarity and historical significance, many historic bridges deserve a fate better than the scrap heap. Henszey's Arch is a classic all-wrought iron 1869 bowstring arch truss. Though it remained in vehicular service for over 117 years, it no longer is capable of carrying contemporary traffic. Henszey's rehabilitation illustrates the engineering issues, costs and rehabilitation techniques that structural engineers encounter should they become involved with preserving a historic bridge.

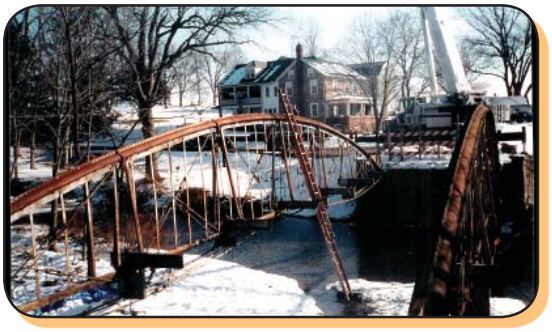
Our story begins six years ago when Todd Milano, president of Central Pennsylvania College, bid $22 to buy a 136-year-old iron bridge from the Commonwealth of Pennsylvania. He then had it refurbished and moved to the Central Pennsylvania campus in suburban Harrisburg, where the bridge found new life spanning a small stream linking the residential portion with the college's new technology center. His passionate pursuit of Henszey's Arch resulted in an extraordinary odyssey.

Milano acquired the bridge through Pennsylvania's 16-year-old historic bridge marketing program through which the state seeks new homes for historic bridges no longer capable of highway use. Henszey's was the third bridge sold under the program.

Before seeking new homes, the state first looks to improve and reuse its historic bridges, including many of the Keystone state's more famous covered wooden spans. "If it can be rehabilitated, we'll rehabilitate it - that's our preference, especially from a historic preservation perspective," according to PennDOT's Kara Russell. "Historically, these truss bridges were made to be moved, so it's still in keeping with their historic nature to move them."

Side view of arch on its abutments before lifting

Pennsylvania has about 400 bridges listed on the National Register of Historic Places, with about 600 more that are eligible. This includes 222 covered bridges of which the Commonwealth has more of than any other state. All 50 states have similar programs that identify and, when possible, encourage the rehabilitation or relocation of historic bridges if they can't continue in vehicular service. Rehabilitation for continued vehicular use is the preferred option since that keeps the bridge in the system enabling it to be maintained and inspected. But, if the bridge no longer is capable of carrying contemporary traffic, many states, like Pennsylvania, have "orphan bridge" or historic bridge marketing programs that advertise the availability of historic spans for relocation or adaptive reuse.



Henszey's Arch at Wanamakers prior to lifting; deck, floor beams and stringers have been removed

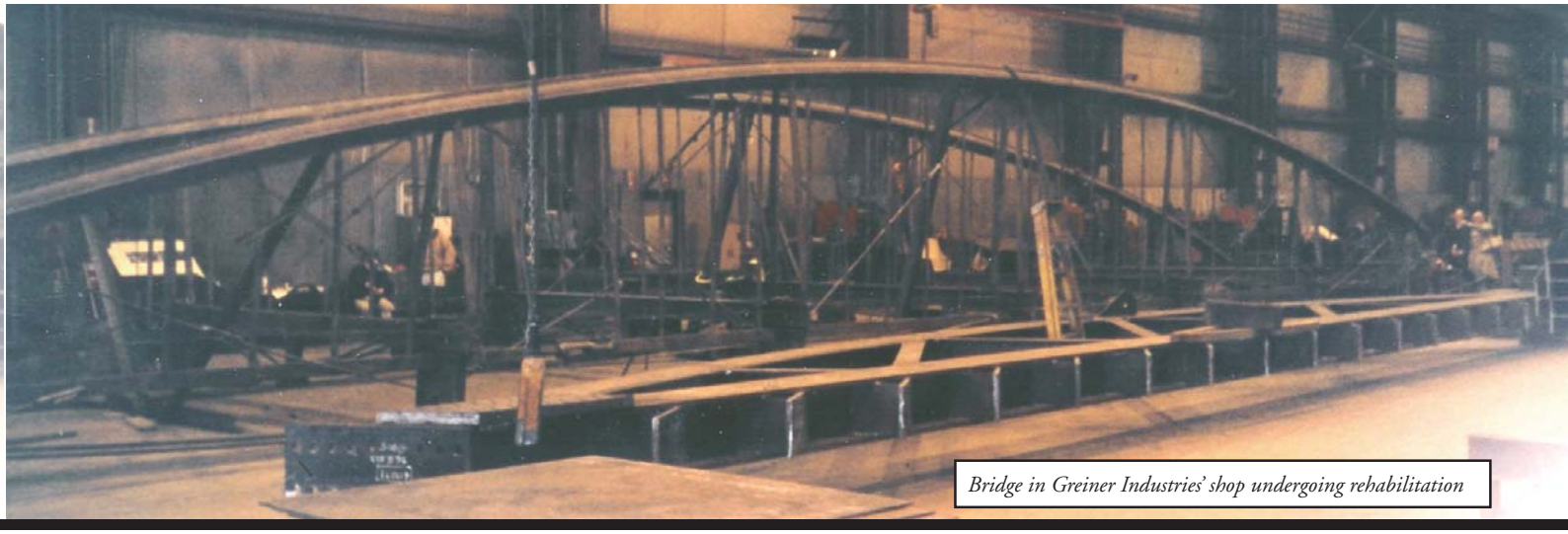
Milano bought the bridge at state auction where he was the only bidder at $22. The state had put the bridge on the auction block, specifying that the buyer would have to restore the structure to Secretary of the Interior standards.

Henszey's is a classic example of an all wrought iron bowstring arch, also known as a tied arch. It is 92-feet long, 17-feet wide, and 9-feet high. The bridge superstructure is held together by rivets and rests on masonry piers and abutments. Henszey's Bridge was designed for 19th century loads – primarily horse and buggies and an occasional farm wagon. Though removed from service in 1986, the bridge functioned for nearly 80 years carrying automobiles and an occasional milk truck – loads much heavier than originally designed for, thus attesting to its design efficacy.

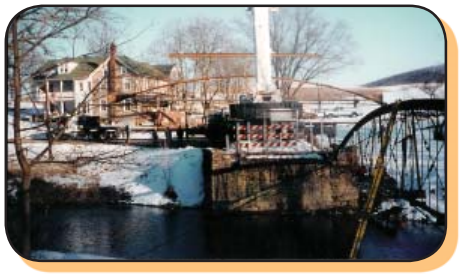
Henszey's is a classic example of one of the earliest all wrought iron bridges dating from that brief twenty year period following the Civil War when bridges were made of wrought iron. The bridge was invented by Joseph G. Henszey, a hardware merchant in Philadelphia, who received a patent for "Henszey's Patent Wrought Iron Arch Bridge" in 1869, the same year that it was built. The bridge was fabricated by the Continental Bridge Company, also of Philadelphia, a business he established to fabricate his patented spans.

There is no evidence that Joseph Henszey was an engineer. Though engineers were available in the years following the Civil War, there were not enough to keep up with burgeoning and fiercely competitive market for small to intermediate farm-to-market road bridges. Instead, many of these bridges were built by crafters, millwrights and mechanics like Joseph Henszey. These unschooled "apple-tree engineers" recognized a need and sought engineering solutions to span small streams. Bridges like Henszey's were built by the thousands and exemplify fundamental American values of craft, entrepreneurship, and creativity. They helped Americans cross thousands of streams and rivers, enabled farmers to get their produce to market, and helped sustain new businesses as the frontier moved west.

Arch No. 1 lifted from its abutments; with braces to keep the members from warping



Bridge in Greiner Industries' shop undergoing rehabilitation



Arch number 1 being lowered onto trailer; arch number 2 being prepared for lifting

In the same sense that the Henszey bridge was not designed by an engineer, few states had state bridge engineers in the decades following the Civil War, much less engineers at the county level. Bridges were the responsibility of local jurisdictions. Through local records, we know that Henszey's was sold to the Lehigh County commissioners by Daniel Beidelman, described in local directories as a bridge contractor. This was standard operating procedure for procuring bridges until the states established highway departments during the first two decades of the twentieth century. Once highway departments were established, counties started hiring county engineers. Beidelman served as an agent for Joseph Henszey and sold the bridge to the Lehigh county commissioners through a catalog issued by the Continental Bridge Company. We refer to these bridges as "catalog bridges". Here's what the catalog had to say about Henszey's bridge:

"The HENSZEY PATENT WROUGHT IRON BRIDGE we claim has decided advantages over many others now in use, for the reasons: Firstly, that the bridge is WROUGHT IRON throughout. Secondly, that the combination of iron is such as to insure strength to a GREAT degree. Thirdly, that the different parts are arranged as to be easily reached for painting. Fourthly, no nuts and bolts REQUIRING CONSTANT attention. Fifthly, DURABILITY. Sixthly, neatness of appearance. Seventhly, for the real value furnished, the CHEAPEST. The PATENT WROUGHT IRON ARCH, the great element of strength, is formed of sections of the PHOENIX IRON COMPANY'S COLUMN IRON, so put together that while handsome in appearance in STRENGTH it is BEYOND QUESTION."

The bridge that now spans the small stream on the Central Pennsylvania campus originally saw service at two locations: first as a two-span structure carrying Main Street over Trout Creek and a railroad line in the far northeastern corner of Lehigh County in the town of Slatington, and then in the opposite corner, at Wanamakers over Ontelaunee Creek.

Cast iron strut block and iron sag rod added to brace bottom chord

It was at it's original location in Slatington that Henszey's developed problems. A curious cast iron strut block and sag rod system was added to strengthen the lower chord. Engineers and historians did not understand the reason for this bracing system until an old photograph materialized showing a pier at mid-span. We know that the bridge originally was intended to be a single span of 92 feet; however, old photographs show a pier at mid span at its original location in Slatington. Slatington gets its name from the slate quarries that were active in this part of Pennsylvania.

One plausible explanation for the pier and bracing is that the bridge may not have been strong enough to carry heavily laden wagons of slate. Another is that the bridge needed strengthening when the Allentown & Slatington Street Railway installed a trolley line down the middle of Main Street where the bridge was located. A third is that the bridge superstructure was weakened by the deleterious effects of years of noxious exhausts from steam locomotives carrying the Slatedale branch of the Lehigh Valley Railroad. Even though insertion of the center pier completely changed the behavior of the trusses by altering the forces in the members, it worked for thirty years.

In 1900, Lehigh County Commissioners decided to replace the Slatington bridge and one of the trusses was moved cross county to Wanamakers to augment the local network of farm roads. As found at Slatington, the road crew built a stone pier under the center of the span — a pier that an engineer who examined the structure in 1932 exclaimed was, "reversing all the stresses in the top chord and web members." The pier eventually was removed in the 1930s, but the bracing appliances remained. The bridge continued in vehicular use till 1986, when state engineers closed the bridge and built barricades to block traffic at both ends.

Rehabilitated bridge enroute to Summerdale Campus

In 1991, because of its rarity as one of the few surviving all-wrought iron metal truss bridges in the country, Henszey's bridge was recorded by the Historic American Engineering Record (HAER), a documentation program of the National Park Service. (Henszey's bridge initially was documented following its closure in 1986 by

Berger Burkavage, Inc. of Clarks Summit, PA, for the Pennsylvania Department of Transportation, Harrisburg.) The HAER team produced measured drawings, large-format photographs and written data for the national collection at the Library of Congress. You can find the HAER record for Henszeys at **www.loc.gov**.

92 x 14 fooot bridge was backed down Valley Road so it could be backed into the Tech Center parking lot in the proper orientation for lifting

Engineering & Rehabilitation

The first engineers for the bridge's rehabilitation were four senior civil engineering students at Bucknell University located just upriver from Summerdale in Lewiston. Using the HAER documentation, the students made numerous trips to the bridge to verify the HAER measurements and plugged their findings into structural-analysis programs.

The engineering firm of Clough, Harbour and Associates of Albany, New York took over the project from the Bucknell students. In calculating how much load the bridge could carry, the engineers calculated its capacity as a simple bowstring arch and as a truss with a curved upper chord. The bridge was found to be sound, in either scenario, for pedestrian traffic.

Crane waiting for bridge to be backed into Tech Center parking lot

On January 22, 2002, a crew from Greiner Industries of Mount Joy, Pennsylvania, arrived on site with cranes and a 90-foot flatbed trailer. It had been decided that the bridge would be severed down the middle of the deck – the oak flooring, deck beams, and stringers removed since the rehabilitated bridge needed to be narrower to fit at its new site. It also was impossible to move a 92- by 17-foot bridge down rural Pennsylvania roads. Repairs, fabricating missing parts and applying new paint was easier in the comfort and convenience of an enclosed metal working and paint shop rather than in the open air.

The upstream arch was first lifted from its abutments and, after a brief but graceful flight over Ontelaunee Creek, was loaded onto the flatbed trailer. However, during the first lift, the bottom chord began to buckle. This is a common mishap by inexperienced contractors working with 19th century bridges. As the arch was lifted by the crane, the forces were reversed, the ends sagged, and the bottom chord began to warp. Crew leaders conferred quickly beneath the bridge deciding that the entire framework had to be braced, thus alleviating any dangerous warping or damage. There were no mishaps during the second lift and the arch was safely lowered onto the trailer. Thirty tons of trusses were hauled to Mount Joy traveling via a roundabout route, avoiding sharp turns along the way.

Backing into Tech Center parking lot

Greiener Industries of Mt. Joy was responsible for removing the bridge from Wanamakers, rehabilitation in their shops, and installation at the Central Pennsylvania campus in Summerdale.

By February 15th, rehabilitation work was well underway at Greiner's shop. The trusses were sandblasted and primed with a rust proof coating, and new floor beams and stringers were installed. Metalworkers added new brackets angled to brace the top of the arches to keep them vertical.

The original wrought iron floor beams were replaced with new steel I-beams when it was discovered that the beams couldn't be safely welded back together when the width of the bridge was narrowed to 14 feet to fit the new location.

"Flight of the Phoenix" — rehabilitated bridge being lowered into place

Bridge needled into place adjacent to steam separating residential portion of campus from new Tech Center — cranes are in place

The only tricky part in the rehabilitation was tightening the diagonal rods bracing the panel points between the various truss members – much like fine tuning a Steinway piano. Some of the bridge's many turnbuckles were hard to loosen. The final touch was an acrylic coating.

While the bridge was undergoing rehabilitation in Mt. Joy, Lobar Associates of Harrisburg was fabricating the new steel piers at the college campus. Steel rather than stone or concrete was selected for cost and aesthetic reasons. It was felt that the bridge would blend into its new setting with lighter, less obtrusive steel piers rather than poured concrete or stone.

Bridge being lowered into place

The bridge was moved to the Central Pennsylvania campus on May 6, and lowered into place the following day. The dedication ceremony was held three days after the bridge landed – May 10, 2002. It was a beautiful spring afternoon and a sizable crowd filled the terrace outside the new Advanced Technology Education Center, itself dedicated only the day before. Total cost of rehabilitation was $549,500.

Epilog

Older bridges like this are vanishing rapidly from the cultural landscape. Statistics reveal that over half the historic bridges identified by statewide historic bridge surveys have disappeared in the last twenty years, two decades highlighted by increased sophistication, appreciation and awareness for historic structures of all types. Despite this enlightenment, the assault on old bridges has been lethal.

We are in a race against time to preserve examples of our Nation's historic bridges. Aside from saving the obvious bridge icons such as the Brooklyn Bridge, the Golden Gate, or our covered wooden spans, we are beginning to save the not so obvious examples – such as the metal trusses and concrete arches that still dot the countryside by the thousands. These more ubiquitous spans maintain the scale of our countryside and lifestyle of our communities, often slowing traffic to safer speeds and maintaining the character and feeling of our scenic highways and byways.

While no one is advocating that every historic bridge must be saved, few can argue that the more significant and representative examples shouldn't be saved. The vision and effort behind Henszey's bridge is nothing short of heroic. It was not easily accomplished. Purchasing a bridge for twenty-two dollars may sound like a neat idea, but this was only the beginning. The easy part was the logistics of moving the structure along narrow Pennsylvania roads, repairing and strengthening, and preparing the new site to receive this national treasure.

Henszey's Arch has landed

The hard part was dealing with the state bureaucracy and keeping the project on tract. This is understandable, since few state highway departments are familiar with preserving historic bridges. But, this too is changing. Several of the more progressive states recognize that historic bridges have cultural values important to defining the character of their state. Rehabilitation can be less expensive than new construction.

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I claim that bridges are the single most visible icon of the civil engineer's art. For the last three decades, highway engineers have been working to rid the nation's highways of "structurally deficient and functionally obsolescent" bridges. As these bridges are being replaced, we also are losing our stock of historically significant spans. While we are not quite to the stage of saving the "few surviving examples," we are fast approaching that point. Historic bridges are engineered structures, thus requiring the expertise of engineers if there is any hope of saving them.▪

Eric DeLony recently retired from the National Park Service, where he worked 32 years for the Historic American Engineering Record (HAER), a federal program responsible for creating a national archive of America's engineering and industrial heritage. Mr. DeLony is an authority on American bridge building with a book, ***Landmark American Bridges,*** *ASCE Press, 1993, and many publications to his credit.*

Central Pennsylvania College President Todd Milano being congratulated by Prof. Perry Green (University of Florida, Gainsville, Dept. of Civil Engineering)

PennDOT's web page for its historic bridge marketing program:
www.dot.state.pa.us/penndot/bureaus/Cultural%20Resources.nsf/infoHistoricBridges?OpenForm&AutoFramed
The web address for Secretary of the Interior Standards for Rehabilitating Historic Structures: **www.cr.nps.gov/hps/tps/tax/rhb/**