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Jefferson National Expansion Memorial

THE MUSEUM GAZETTE

James B. Eads and His Amazing Bridge at St. Louis

When looking down on the Mississippi River from the top of the Gateway Arch, many visitors remark upon the graceful-looking bridge to the north. It is hard to imagine that this bridge is the product of immediate post-Civil War engineering, that it was the first bridge built with structural steel, or that 15 men died of a mysterious illness while constructing it. Even more amazing is the fact that it was designed by a self-taught genius who had never built a bridge before.

The designer was James Buchanan Eads, born in Lawrenceburg, Indiana in 1820. Eads had scarce years of early schooling due to his father's financial reversals, and in 1833 arrived in St. Louis a penniless, 13-year-old boy who peddled apples on the street. He soon obtained a position as a clerk with a merchant named Barrett Williams, who let the young Eads read extensively in his private library.

As Eads came of age he pondered the problems of steamboats and their frailties. In an era when boats were beset by many dangers - snags, sandbars, exploding boilers and hot cinders, steamboats often sank taking their cargo with them to the bottom of the river. Oftentimes a good share of the cargo survived intact and could be recovered. Businessmen were willing to pay handsomely to get their cargoes back. Soon Eads designed a surface boat he called the Submarine, made with twin hulls and derricks, and a diving bell made with a forty-gallon whiskey barrel with a hose attached to the top so that air could be pumped down from the boat. Eads' salvage company was soon the most successful on the river, and he made a fortune, retiring in 1857 at age 37.

When the Civil War began, Eads was eager to do his part. He advocated the construction of shallow-draft boats capable of carrying large cannon, with bows and sides protected by iron plates, and was awarded a contract to build seven such boats in August 1861. With these ironclad steamboats, Eads created a unique little navy suited to the inland waterways, different from anything that had ever before existed. Eads' ironclads went into action at Fort Henry in February 1862, a month before John Ericsson's more famous Monitor fought the C.S.S. Virginia (Merrimac) at Hampton Roads, Virginia.

At the conclusion of the Civil War long-standing dreams of a bridge across the Mississippi River at St. Louis were revived. Such a bridge was a necessity by the late 1860s. The width of the river at St. Louis had created a problem with commercial transportation after the advent of the railroads. Without a bridge, freight could not be transferred in bulk across river, but instead had to be off-loaded from trains to ferry boats, a procedure which raised costs tremendously. This discouraged shippers from routing their goods through St. Louis, if they could avoid it.

Although Chicago's future as America's heartland rail center was assured by the mid 1860s, a group of Chicago businessmen decided to finish off St. Louis' economic rivalry once and for all. A

Chicago bridge builder named Lucius Boomer, backed by railroad interests, persuaded the Illinois State Legislature to give him exclusive rights to construct a St. Louis bridge. Boomer had no intention of actually building a bridge. He just wanted to prevent anyone else from doing so, in order to assure St. Louis' demise.

But it was not only politics which prevented bridge construction at St. Louis. Prominent engineers said that a bridge a third of a mile in length could not be built to the specifications demanded by the rivermen, which included a 300-foot center span and fifty feet of clearance above the water. This was to ensure that riverboats with their tall superstructures and smokestacks could pass under the bridge with ease. Also, the bridge had to be built without obstructing river traffic.

A group of St. Louis businessmen decided to proceed with a bridge, despite the power of Lucius Boomer. James B. Eads presented a daring plan which was approved in 1867. Although Boomer's company still had the rights to build the bridge, he took no legal action against the Eads project. Boomer had already delayed construction long enough for four new bridges, built further upstream, to serve Chicago's railroads.

Eads' design was radical. The building material, steel, was new, as was his daring solution to the problems imposed upon him. The design of the bridge did not use the popular form of construction, the truss, or even the newer suspension system, but instead hearkened back to the ancient Roman arch for support. Each arch would consist of four ribs, arranged in parallel pairs, rising beneath a double deck roadway. Eads' plans were thought radical by some, mad by others. He had never built a bridge before, and even his supporters wanted him to consult an experienced bridge engineer.

One of the most difficult parts of the construction was not to build the steel superstructure of the bridge but rather to dig the foundations for the stone abutments on each shore and the two massive stone towers or piers in the middle of the river. Eads decided to build the foundations on bedrock, which lay beneath some 80 feet of mud and 12 feet of Mississippi River water. During a trip to France in 1869, Eads consulted with engineers about his project, and they showed him a pneumatic caisson. By October 1869 Eads had constructed a similar but much larger caisson, 82 feet long and 60 feet wide, which was towed by boats to the spot where the east pier would be constructed. When the caisson was anchored in place, workmen began to build the stone foundations of the pier on top of it. Adding limestone blocks and mortar, the weight gradually caused the caisson to sink into the river. Within two weeks the box of the caisson had touched the sandy bottom of the Mississippi.

Seven airlocks were provided for the men who began to work inside the caisson, digging out the mud and feeding it into a sand pump that Eads designed. Workers entered and exited via a circular stairway which led to an air lock, where pressure was equalized with that in the 9-foot-tall caisson-working chamber below. The work crew in the caisson received $4 per day, twice the wage for bridge workers on the surface. The men worked by oil lamps which gave off a dull yellow light. The atmosphere was heavy and a loud hiss of escaping pressurized air was heard constantly in the chamber. Strange tales were told of the interior of the caissons. Normal conversations sounded like high-pitched, squeaking sounds. Men found that it was impossible to whistle. A candle's flame, blown out, would bounce to the roof of the chamber and the candle would relight itself. A telegraph was installed in the chamber with a direct line to the surface.

As the caissons sank deeper, the water pressure on the outside walls increased and had to be counterbalanced inside. Eventually, the workmen were working at pressures twice as high as that inside the tires of an automobile - 50 pounds per square inch. After a day of work, men began to complain of stomach pains. As the pressure increased, some were even paralyzed briefly after returning to the surface. They began to suffer what they called "the Grecian Bend," after a contemporary fashion in women's posture. The cramps made it difficult for the men to stand upright, thus the origin of the term "the bends." Today we know that the bends is a medical condition caused from the expansion of nitrogen in the bloodstream due to high pressure at great depths. What was happening to the bridge workers was that nitrogen from the air dissolved in their blood at high pressure, and when the workers quickly returned to the surface and normal atmospheric pressure, these bubbles began to work their way out of the blood, veins and tissue. Eads was concerned by the health problems. He shortened the shifts of the men and hired a physician named Alphonse Jaminet to investigate. Jaminet found that a decompression period was helpful, but his calculations for the amount of decompression were too low. Altogether, fifteen men died, two were permanently disabled and 77 others were severely afflicted. The mysterious ailment was one of the major problems of construction.

The caisson for the east tower was driven to bedrock 93_ feet below the river on February 28, 1870. Cannon were fired and steamboats blew their whistles when the news was announced. The caisson for the west pier was launched on January 3, 1870 and reached bedrock on April 2, 1870, at 77_ feet below the surface of the river. The new regulations to prevent "caisson disease" (as the doctors called it) prevented all but one death on the west side. All work beneath the surface of the river was completed by May 8, 1870.

Other problems plagued the project. Spring floods caused the men to work desperately to stay ahead of the rising waters. Then a tornado struck on March 8, 1871, crumpling the superstructure of the east abutment. The tornado was so powerful that it picked up a locomotive weighing 25 tons and threw it onto a 15-foot embankment. One hundred men were working above the surface when the tornado struck, and somewhat miraculously, there was just one fatality and eight serious injuries. A few weeks later, in mid-May 1871, the damage was repaired and the abutment was finished, with 45,000 tons of masonry.

Stone piers for the bridge were anchored to the bedrock by 1872, the towers were completed, and the construction of the steel superstructure began. Initially, Eads had to fight Andrew Carnegie for the type of steel he needed. Carnegie insisted that this type of steel, which had never before been used in a construction project, would fail under stress. Steel could be used for structural purposes only after the perfection of the Bessemer and Siemens-Martin processes in the 1850s and 60s. So the building material itself was quite new. Eads won his fight with Carnegie, and the superstructure was begun.

Temporary cantilevered towers of wood were built above the granite piers, from which the iron members were suspended. This kept river traffic moving, since no cofferdams or scaffolding were needed to erect the structure. A total of 4,780,000 pounds of steel and 6,313,550 pounds of wrought iron were used in the bridge. Although other engineers worked on the day-to-day details of the construction, they ran into trouble when they deviated from Eads' original instructions. Finding themselves at a loss in several instances, they brought Eads back into the project, and in each case he found a solution to their difficulties.

As the bridge neared completion, the people of St. Louis saw a graceful structure with three huge arches of steel, more than 500 feet long. The central arch spans 520 feet, the two side arches 502 feet each. The upper deck was for carriages and horsemen; the lower deck was for the railroad. The bridge was "overdesigned" by Eads to appear strong to the layman. The confidence of the public was important, and would ensure that the bridge was used. On July 2, 1874, in a dramatic and highly publicized test of strength (just two days before the official opening of the structure), Eads ran 14 large locomotives out onto the bridge. The bridge was supposed to hold 3,000 pounds per lineal foot, but to this day can carry 5,000.

July 4, 1874 opened with a 100-gun salute (50 on each side of the river). Then, with 150,000 people looking on, Gen. William Tecumseh Sherman drove the last spike, completing Eads Bridge. The bridge was dedicated amid fanfare, marching bands and an enormous fireworks display. A parade 14 miles long wound through St. Louis' streets. The Eads Bridge was the world's first steel arch bridge and the biggest bridge built up to that time. It was the first important steel structure of any type in the world, leading a revolution in construction.

The great bridge at St. Louis was not the last of Eads' projects. He was later instrumental in building the first permanent mouth of the Mississippi into the Gulf of Mexico, by using a system of jetties which guided sediment deposition. This task was completed in four years time, between 1875 and 1879. In 1884, James B. Eads was presented with the Albert Medal by Queen Victoria - the first time that award was ever given to a foreigner. Eads spent his final years working on a project to cross the Isthmus of Panama. He opposed Ferdinand de Lesseps' project of a Panama Canal, advocating instead a ship railroad over the isthmus. Eads died suddenly in 1887 while in Nassau, the Bahamas, in the hopes of regaining his health. In 1927 the deans of America's engineering colleges were asked to vote on history's five greatest engineers; they selected Leonardo da Vinci, James Watt, Ferdinand de Lesseps, Thomas Edison and James Buchanan Eads.