# State of Historic Bridges in America Compared to the World

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ABSTRACT: Changing awareness and appreciation of historic bridges during the late-20th and early-21st century has made people realize the impact infrastructure has on the cultural environment. Highlighting efforts of the historic bridge world regarding regulations, codes, bridge engineering best practices, education, and how saving old bridges represent *sustainability*, the intent of this paper is to summarize what's happening in the US regarding public advocacy, Interstate bridges, landmarks and World Heritage, comparing America's experience with Europe and other parts of the world.

## INTRODUCTION

Historic bridges are threatened in America despite national, state and local preservation laws, including public interests. I can say this because of my former career as Chief, Historic American Engineering Record (HAER), a federal program established in 1969 to create a national archive of America's engineering, industrial and technological heritage, http://lcweb2.loc.gov/ammem/collections/habs_haer/.

### International

The historic bridge situation in Europe, though parallel in many ways to the US, is different. France for instance is trying to reconcile the imperative of economic development and associated infrastructure vis-à-vis adulterating bridge heritage. It is the first country to address this international challenge by organizing a "ponts table ronde" dedicated to bridges old and new, their recognition and protection, rehabilitation and maintenance, authenticity and integrity, their impacts on the cultural landscape and, aesthetics. One hundred people, composed of engineers, preservationists and bridge scholars attended.
Ponts table ronde was a who's who of France's top bridge engineers, preservationists, cultural landscape and bridge scholars. Presentations provided an historic overview of France and the worlds historic spans over millennia; rehabilitations such as the Pont Faidherbe, Saint-Louis, in the former French colony of Senegal; maintenance, restoration, and the loss of historic bridges like Louis Harel de la Noë's Viaduc de Souzain (1904, demolished 1995) in Brieux; the eternal debate of authenticity/integrity; costs and technical feasibility vs. contemporary requirements; replications like Stari Most, Bosnia-Herzenegovia; whether to build a new bridge and risk losing UNESCO World Heritage status like the Waldschlosschen Bridge that Germany proposes to build in the World Heritage Site of Dresden's Elbe Valley; new bridges in protected natural and cultural sites like Santiago Calatrava's footbridge over the Grand Canal in Venice or Marc Miriam's Passarelle Solférino over the River Seine, Paris; continued vehicular or rail use, adaptively reused bridges (transformé utilise), like the Roman aqueduct, Pont du Gard; threatened bridges like America's late-19th, early 20th century metal trusses (Figure 1 Laughery Creek Bridge), swing (revolving), vertical lift (Figure 2. City Waterway Bridge), transbordeur, railway, and canal bridges.

I spoke on World Heritage bridges identifying those that have been designated; why the United States hasn't listed any globally-significant spans like the Brooklyn, Eads or the Golden Gate; success of the UK's campaign to designate World Heritage bridges under the theme birthplace of the industrial revolution and, suggesting possibilities of national and globally significant French bridges with the caveat that most countries can and should identify their "better than average bridges." (Figure 3 Brooklyn Bridge)
I was surprised to discover that France, the UK, and other countries in Europe, like America, don't have a national perspective of its historic bridges. According to an engineer working with France's roads and bridges department, individual states have done an adequate job identifying and evaluating its state or provincial bridges. In the US, every state can tell you its historically significant bridges but, as far as I can tell, no nation has developed a national context or gone to the higher level of identifying globally-significant bridges.
The concept of a historic bridge context is not embraced by the bridge construction industry, bridge engineers or transportation authorities. The only exception in America is the Interstate highway.. Because of ramifications that a 75,000 kilometer (47,000 mile) linear system might be eligible for listing in the National Register of Historic Places when the Interstate turned fifty. FHWA prepared a national context and listing of nationally-significant and exceptional Interstate features including bridges. Though developing a context for the interstate, FHWA has yet to support a national context of individual historic bridges.
One can argue that though a national context seems to run counter to the way transportation policy is established – delegated to state departments of transportation (DOTs). A national context would make it easier to save "better than average" bridges, something no one can argue against.

**PUBLIC ADVOCACY/TRANSPARENCY**

Though there has been progress, we have little transparency at the state and county level in terms of what transportation planning officials and engineers are contemplating with historic bridges. Pontist usually are five years behind the eight-ball when they begin advocating saving an historic bridge. The decision to replace was made five years ago if not longer. Pontists must become more sophisticated understanding the process about how DOTs and transportation planners decide which bridges are replaced. State and local engineers and planning officials use the lackadaisical unawareness of the public knowing that notification about projects will be neglected. "If you don't know what's happening, you don't have a voice and you can't stop it." Though adhering to the letter of the law in public notifications offering the opportunity to participate, notifications are often short and hidden. "As the public becomes more familiar with what we're doing, they'll become more involved - it's the secrecy that breeds suspicion." Community involvement should be ensured, not half-heartedly tried. Elected officials knock on the doors for votes, why not for notification?
Public officials counter that no matter what they do, people are not going to be satisfied and there's much truth to that observation. "We follow what's in the statutes. We don't subvert or convert." Public suspicion has arisen from people's perception that they were left out, a perception for which local, state and federal agencies should share the blame. Dialog back and forth should be the aim of all involved. Officials should take stakeholder groups and give them standing.

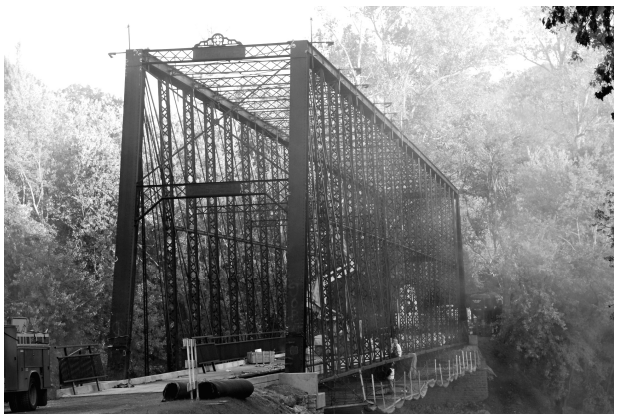

Figure 1(left): Laughery Creek Bridge (1878, rehabilitated 2008), Aurora vicinity, Indiana. Not a typical American metal truss, but a one-of-a-kind triple-intersection Pratt fabricated by the Wrought Iron Bridge Company (WIBCo), Canton, Ohio. This nationally-significant bridge stood derelict for over thirty years until rehabilitated in 2008; (Dave Michaels, photographer, 2008)

Figure 2 (right): City Waterway (Eleventh Street) Bridge (1913) spanning Thea Foss Waterway in Tacoma, Washington. An early example of a vertical lift bridge, designed by Waddell and Harrington, is one of America's first historic bridges to benefit from President Obama's "stimulus" package to improve infrastructure and put people to work; (Jet Lowe, HAER photographer, 1993, HAER Collection, Library of Congress)

**PENNDOT (PENNSYLVANIA DEPARTMENT OF TRANSPORTATION)**

Even before the American Revolution, Pennsylvania embarked on infrastructure improvements that would not be complete until the Commonwealth was knit together by a series of turnpikes, canals, railroads, and highways. And all needed bridges. Its ever-expanding population and consequent transportation requirements made the Keystone State a pioneer in transportation innovation, particularly in the design of bridges.

I use Pennsylvania because the Commonwealth illustrates the dilemma between the public and transportation officials. Although the majority of Pennsylvania's bridges date from the twentieth century, some of the older routes have bridges built in the early colonial years. America's oldest stone arch bridge, constructed in 1697, while Pennsylvania was an English colony, still carries Frankford Avenue, also known as the King's (Charles II) Highway over Pennypack Creek, on present day U.S. Route 13 northeast of Philadelphia. At least five eighteenth-century stone arch bridges remain.

Wooden covered bridges are usually the first type that comes to mind when American's think about historic bridges. They are dark and mysterious, quaint and romantic. Their settings along pastoral streams provoke nostalgia, as do their material and texture. Many covered bridges are also outstanding examples of wood construction technology. The United States has more covered bridges than any other nation, approximately 750. Pennsylvania currently claims one hundred and ninety-seven covered bridges, a loss of twenty-two since 1982, the last count I had. Attrition rates of three bridges per year are due to acts of nature, arson and occasional demolition.

Pennsylvania boasts many milestones - and, naturally, "firsts" in American bridge-building technology. The isolation of its western counties prompted a Fayette County judge, James Finley (1756–1828) to invent America's first suspension bridge in 1796. Finley built a seventy-foot, chain-link suspension bridge over Jacob's Creek, near Uniontown, in 1801. The Pennsylvania Historical and Museum Commission (PHMC) recently dedicated an official state historical marker in Uniontown commemorating the bicentennial of the first U.S. suspension bridge patent granted to Finley. Though none of Finley's bridges remain, America's oldest surviving parallel wire-cable suspension bridge (1848) spans the Delaware River between New York and Pennsylvania. It originally served as an aqueduct carrying the Delaware and Hudson Canal over the Delaware River at Lackawaxen, the only kind of its type in the world. (Figure 5. Delaware Aqueduct)

Because the heart of the iron and steel industry was in Pennsylvania, many iron-bridge manufacturing companies operated here. While Andrew Carnegie's Keystone Bridge Company in Pittsburgh and the Reeves brothers' Phoenix Bridge Works in Phoenixville were two of the largest, dozens of smaller firms existed. None of these bridge-fabricating businesses survive, but their products still dot the countryside by the thousands.

Pennsylvania's counties and townships and, most states, are replacing metal truss bridges with new construction. These usually are old one-lane truss bridges that come up nightly at community public meetings. The usual scenario is a debate between highway officials and residents who would like to see the historic bridge preserved. The DOT wants to replace it new construction. Residents stand their ground in an effort to preserve the truss which often sits in the heart of the community. The bridge, usually one of the few remaining trusses in the state, is a piece of community history. Alternatives were proposed, but the most important alternative to the community, rehabilitation of the historic span, was the least likely considered. All alternatives except replacement had been eliminated.

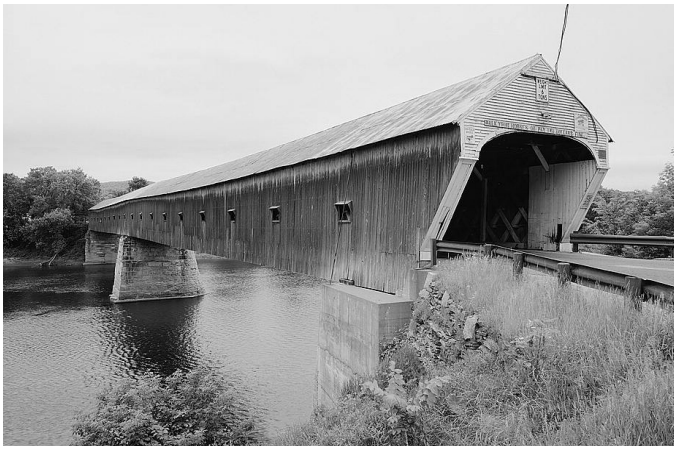

Figure 3 (left): Aerial view of Brooklyn Bridge (1883) Tower looking East; (Jet Lowe, HAER photographer, 1982, HAER Collection, Library of Congress.)

Figure 4 (right): Cornish-Windsor Bridge (1866, rehabilitated 1989), spanning Connecticut River between Cornish, New Hampshire and Windsor, Vermont, is an excellent example of the work of James Tasker and Bela Fletcher, two prolific New England bridge builders. It is the second longest double-span covered bridge in the USA. The longest is the triple-span Medora Bridge (1875) in Indiana. The bridge was rehabilitated by New Hampshire in 1989 at a cost of $4,450,000. The ASCE designated Cornish-Windsor a National Historic Civil Engineering Landmark in 1970; (Jet Lowe, HAER photographer)

"This is an alternative you are presenting as a plan," an attendee says. "Listening to what everyone has had to say, I think we would like an equally comprehensive look at rehabilitation. Something you consider with the same seriousness and consideration you have given to tonight's display." The DOT recommends replacing the bridge with a 28-foot wide, two lane concrete slab. Several DOT representatives present listen to public input. Alternatives included rehabilitating the existing bridge, constructing a new bridge upstream, downstream or just next to the existing structure – or do nothing.

Because of safety issues and deteriorating conditions, the "do nothing" option was eliminated. Moving the bridge up or downstream was also eliminated due to environmental concerns and the location of an existing business which would have been impacted by moving the bridge upstream. However, the alternative most in attendance clearly wanted to discuss was never given detailed consideration. DOT project leaders explain that one-lane bridges are simply not an option. Safety precludes the DOT from considering it. The historic bridge is 280-feet long with a metal truss covering 120-feet of the span. The new $3.6 million replacement consists of a concrete slab stretching 305 feet across the river. The choice of alternatives for the audience was whether support beams should be built along the river bank or in the water. Community members in attendance argue that historic preservation and community preference should supersede departmental policy – especially considering rehabilitation could cost significantly less than new construction.

DOT representatives argue that if the division proceeded with rehabilitation of a one-lane bridge, the option for federal funding, which covers 80 percent of costs, would be lost. Everyone wants safety, and everyone talks of costs. But even if rehabilitation costs another half million, that pales in comparison to the history of this area and what it means to the people and the future of the community. The construction engineer finally admits that no detailed look at rehabilitation was explored, but he could get some numbers together. He looks to his boss, the division engineer, for permission to move forward with a study.

The division engineer at first hedges by telling the audience there were unknown qualifiers like, how long did they want the bridge –10, 20 or 30 years. "We do understand this bridge is an icon to this community," he said. After another 20-minutes discussion, the division engineer agrees that they will conduct a study on rehabilitation. "The push is that something will need to be decided and done sometime soon, or one day the bridge rater is going to come out and close it. What I hear tonight is that we are going to have to get some numbers together, explore standards on one-lane bridges. We have to look at whether or not there are even any funds that can be spent on a one-lane bridge."

The audience was appeased by the final decision but some questioned why, when the overwhelming response from the community was a desire to keep the bridge. Why wasn't this option considered in the first place? Several engineers in the audience offered different scenarios for possible consideration. One engineer said he had worked both sides of the argument in his career. "If I was standing where these guys are, I would have planned what these guys planned without taking into consideration what the bridge means to the people. The DOT is following policy and cites safety as their primary concern. All audience members agree they want the bridge safe and not in threat of collapse. Whether or not this bridge will remain standing, however, is a question the DOT will have to go back to the drawing board to answer. This case study is based on a recent public meeting all too familiar with to both engineers and public. Certainly, there's a better way of doing business?

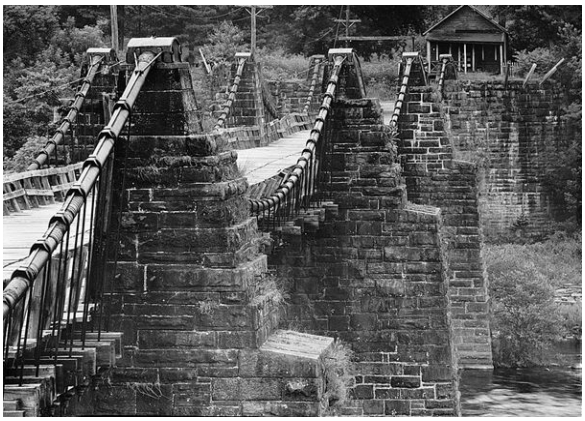

Figure 5 (left): Delaware Aqueduct (1849, restored by the National Park Service in 1985 and the 1990s, as part of the Upper Delaware Wild & Scenic National River, though for vehicular, not canal use. Designed by John A. Roebling, it is the oldest suspension bridge in the US; (David Plowden, photographer, 1969, HAER Collection, Library of Congress)

Figure 6 (right): Gothic Arch, Bridge No. 28 (1862), separates pedestrian from equestrian traffic in Central Park, New York. Designed by Frederick Law Olmsted and British-educated engineer Jacob Wrey Mould, the bridge is one of five surviving decorative cast-iron arches in Central Park, and the best example of this rare bridge type in the US; (Jet Lowe, HAER photographer, 1984, HAER Collection, Library of Congress)

**INTERSTATES: BRIDGES OF THE RECENT PAST**

June 29, 2006, marked the 50th anniversary of the Interstate Highway System in the United States. Imagine the angst in highway departments across America when several state historic preservation offices (SHPOs) determined that portions of the 75,000 kilometer (47,000 mile) Interstate System might be eligible for listing in the National Register of Historic Places. As portions of the system approached 50 years in age, FHWA and state transportation departments were concerned about how the system would be managed if segments and individual features were determined historic under American preservation laws.

Under these laws, eligibility would mandate painstaking and potentially expensive review of any proposed changes that might affect the integrity of eligible sections of highway or of structures such as bridges. I am not aware that countries, other than Germany, are grappling with the historicity of their interstate, motorway or Autobahn systems. At the recent Second International Congress on Construction History held in the UK, German bridge scholars read papers on Autobahn bridges expressing concern for preservation of historically significant spans.

One option discussed by FHWA was to leave it to the states to determine National Register eligibility for their own segments of the system, as they had done with historic bridges 20 years ago. Ultimately, FHWA concluded that addressing the historical character of the Interstate as a whole from a national perspective would be more efficient.

To assist the states, FHWA prepared a national context statement for the Interstate. This study explores the development, evolution, and operation of the Interstate as a comprehensive system from a national perspective. The Interstate System's physical influence and impact on the evolution of the United States during the late 20th century was unquestionably of exceptional significance, and this significance reaches far beyond individual bridges, right-of-ways and exit ramps. According to some historians, the most compelling manifestation of the Interstate is its socio-economic and political impact. FHWA acknowledged that overarching perspective, but the written context focuses on the high-speed, trans-continental network of Interstate highways linking the country's urban and rural areas - the physical manifestation of the Interstate itself: the roads, bridges, tunnels, interchanges, and ramps located within the right-of-way.

FHWA, state DOT's, and preservationists ultimately achieved consensus on how to address the impending crisis that a 75,000 kilometer linear, historic property would generate among FHWA, state DOTs, State Historic Preservation Officers, and the National Trust for Historic Preservation. The agreement was that most of the roads, bridges, tunnels, interchanges, and ramps were exempt from consideration as historic properties under national preservation laws. With this exemption in place, Federal agencies are not required to consider the vast majority of the Interstate Highway System as historic and subject to review under the National Historic Preservation Act (1966) and the U.S. Department of Transportation Act (1966).

However, certain elements of the Interstate clearly are of major historical significance and worthy of the protections afforded by these laws. To address this fact, features such as bridges of national or exceptional significance were excluded from the exemption. Under National Register criteria, a structure less than 50 years old is normally not eligible for listing, but such a structure may be determined eligible if it can be shown to possess "exceptional significance." States submitted their own lists of exceptional bridges and other Interstate resources of exceptional significance to FHWA in 2005, a year before the interstate celebrated its fiftieth anniversary.

Figure 7 (left): Pontcysyllte Aqueduct (1805), the great aqueduct across the valley of the River Dee in Wales by Thomas Telford and William Jessop will be inscribed World Heritage in 2009; (David Kitching, photographer.)

Figure 8 (right): Eads Bridge (1874), spanning Mississippi River, St. Louis, Missouri. With three spans, 200-500-200 feet, its construction was a significant engineering feat; (Jet Lowe, HAER photographer, 1983, HAER Collection, Library of Congress).

This list includes elements that were previously listed or determined eligible for the National Register, as well as others identified of national or exceptional significance, and will continue to be subject to review and protection under federal laws. FHWA viewed this list as a work-in-progress, and intended to refine it based on public input received up until July 17th, 2005. I assume that the list continues to be up-dated as scholarship continues and new features identified. Although hundreds of Interstate features were suggested, some states did not identify any of either national or exceptional significance.

Passage of the National Historic Preservation Act in 1966 has given us 40 years of experience in dealing with historic resources, including bridges, things rarely turn out neatly in accordance with pure engineering logic.

As the lead federal agency, FHWA attempted to look at the Interstate holistically, doing all planning possible so that states have a promise of being successful in continuing to administer and maintain the system. Efforts by FHWA and the states to deal with historic Interstate resources provided a great opportunity to see how engineers' deal with the preservation of historic highway infrastructure, including bridges. Managing our primary, secondary and interstate bridges will continue to evolve and change over time.

The challenge for historians compiling this list was to decide which of the 55,000 bridges built in the decades following World War II as part of Ike's Autobahn would qualify as nationally or exceptionally significant. Historians have only recently begun to study bridges engineered with welded and continuous steel beams, cantilevers, concrete slabs and girders, reinforced and pre-stressed concrete beams, and other bridge types that highway departments developed for short, intermediate and long spans.

These have turned out to be the most common historic bridge types, numbering in the thousands, and superseding the once ubiquitous single-intersection Pratt and Warren through and pony trusses. (See Parsons Brinkerhoff, Engineering & Industrial Heritage, PC. A Context for Common Historic Bridge Types, National Cooperative Highway Research Program, Transportation Research Council, Washington, D.C., 2005),

**Interstate System Bridges**

While construction of the Interstate Highway System was based on standards established and revised over time at the federal level, individual state departments of transportation assumed responsibility for the actual design and construction of Interstate highways within their jurisdiction. Interstate highway bridges reflect the design intent of the individual states while simultaneously meeting the minimum federal design standards. Interstates created the need for all types of bridges, bringing about many advances in material technology, bridge design, and construction.

The Interstate called for rapidly constructed bridges and encouraged simple, cookie-cutter designs that let local roads pass over the new controlled access highway. As a rule, these were short structures typically moving four lanes over two-lane roads or vice versa. As the Interstate grew and traffic volume increased, bridge design, materials, and construction had to change to meet the challenge.

To accommodate more vehicles and increased capacity as America switched from rail to truck haulage, wider bridges, longer spans, and more durable, low-maintenance bridges were demanded. Attempting to stay abreast of explosive growth, bridge engineers had to design bridges with more lanes and longer spans. Precast and pre-stressed concrete girders were developed, allowing longer spans so that the piers and abutments could be moved away from road shoulders both for safety and to allow for future widening. High-performance steel and concrete made longer spans and shallower girders possible while providing more economical and less obtrusive bridge profiles.

As an engineered system designed to carry people, goods and materiel safely at high speeds with limited access, the Interstate has many individual features that have required restoration, rehabilitation, or resurfacing at some time since their original construction. The ravages of constant use by increasing numbers of vehicles, the effects of freeze-thaw, and the life cycles of the materials used during construction have rendered portions of the Interstate unsafe, warranting repair or replacement. Growing population and greater traffic volume have also necessitated the widening of much of the original roadway and the expansion or replacement of various structures, such as bridges, culverts, signs, lighting, etc.

As noted in the original design guidelines for the Interstate System, Interstate highways comprise a living and evolving system whose principal feature consists of its ability to adapt over time while maintaining its functional role as the principle overland transportation network in the US.

In recent years, the focus of Interstate bridge work has been rehabilitation, replacement, or widening - all while traffic continues to roll. Of the 55,000 Interstate bridges, 3,000 (six percent) are structurally deficient. Fortunately, catastrophic failure only has occurred a few times since the Interstates were created 50 years ago.

To minimize traffic disruption, project delivery is paramount in today's bridge industry. "Design build," where design and construction are phased together, has developed along side the traditional concepts of design/bid/construction. The engineer has to understand the construction method to give the contractor what's needed. The cost of the bridge comes up front.

Rapidly increasing cost of materials - steel and concrete - as well as site restrictions, and unique design details have challenged new design build methods. Some bids have come in at 20 to 50% over the engineers' cost estimates. In a volatile price market, bid price histories are no longer valid for general cost estimating, particularly on special designs. Bridge engineers are challenged to develop constructible concepts that stay within an owner's specified budget.

Engineers also must consider "context-sensitive" design, which integrates aesthetics, public involvement, and historical and environmental awareness into straight engineering. Many communities want to save historic bridges for the same reason that they desire to have distinctive "signature" bridges. Cable-stayed bridges have become almost a cliché, whereas an historic bridge is often dramatically unique.

In February 1994, the American Society of Civil Engineers (ASCE) designated the Dwight D. Eisenhower System of Interstate and Defense Highways as one of the seven engineering wonders of the U.S. The Interstate system has been called "the greatest public works project in history," not only linking the nation, but boosting productivity and sustaining a tenfold increase in the gross national product since the program began in 1956. It is the backbone of America's economy. However, the story of the Interstate System is really the story of its individual segments, many of which are engineering wonders in themselves. Thirty-one of the features identified by the states were segments, such as Glenwood Canyon in Colorado or the Franconia Notch Parkway in New Hampshire, because they were designed to respond to particularly sensitive environmental issues

Interstates are a transformation that took place during the "baby boom" generation. Many of the engineers, bridge builders and transportation decision makers now responsible for maintaining this system globally are of this generation. The lives of those born as the Second World War ended coincide with the construction of interstate systems throughout the modern world. I can remember driving trips before the Interstate. For example, a 1448 kilometers (900mi) trip that my family made every summer to Alabama took three days. Today, it takes 15 hours - half the time. Saving time is one of the immediate benefits of the Interstate.

Figure 9 (left): One of the Three Sisters Bridges spanning the Allegheny River at Seventh Street, Pittsburgh, Pensylvania. Seventh Street (Andy Warhol) Bridge (1926), is one of three similar self-anchored suspension bridges, and one of the first self-anchored suspension spans built in America. They are among the only surviving examples of large eyebar chain suspension bridges in America, unusual for having been erected using cantilever methods. The bridges' design was viewed as a creative response to the political, commercial, and aesthetic concerns of Pittsburgh in the 1920s. The bridges were designed under the auspices of the Allegheny Department of Public Works, by T. J. Wilkerson, consulting engineer; Vernon R. Covell, chief engineer; A. D. Nutter, design engineer; and Stanley L. Roush, architect; (Jet Lowe, HAER photographer, 1999, HAER Collection, Library of Congress.)

Figure 10 (right): Poughkeepsie Cantilever Bridge (1889, 1906, burned 1974, rehabilitated 2008-2009), spans the Hudson River, Poughkeepsie, New York. A major 19th-century cantilever bridge designed by Charles McDonald and AB Paine. A third line of trussing was added in 1906 by Ralph Modjeski. The bridge discontinued rail service after the western landed spans burned in 1974. To massive to destroy, the bridge remained derelict till Walkway Over the Hudson, under the leadership of Fredrick Schaffer, succeeded in securing federal and local funds for rehabilitation as the longest pedestrian bridge in the world. When it reopens in October 2009, commemorating Henry Hudson's quadricentenniel sail up the Hudson River, New York State Parks will assume maintenance responsibilities as part of the Hudson River valley trail system. It is the largest bridge rehabilitation project to date in the US; (Jack Boucher, HABS/HAER photographer, 1978, HAER Collection, Library of Congress)

**LANDMARKS**

Many countries are just establishing landmark designation programs. America has a landmark program that may be a model for others. America's National Historic Landmarks program, under the administration of the National Park Service, is centered on the development of 'theme studies'. These provide a national historic context for specific topics, allowing nationally-significant sites to be judged on a number of related properties. Some theme studies are mandated by Congress, while others are determined by the National Park Service. While landmark staff historians write theme studies, others are prepared under cooperative agreements or contracts with other government entities or private organizations. Partnerships with the academic community, independent scholars, and others knowledgeable about the subject enable professional standards to be followed in the preparation of theme studies. They provide a context within which the most appropriate properties can be identified, enable evaluation of historic properties at all levels and can be used to educate the public about the nation's heritage. (Figure 6. Gothic Arch)

**WORLD HERITAGE BRIDGES**

Would any engineer ever expect his or her bridge to be designated world heritage - probably not? As a matter of fact, I doubt if many bridge engineers are aware of world heritage. One purpose of this article is to get CHS and its members, especially the engineering community, involved with evaluating and nominating the best of the world's bridges to this distinguished list.

World-heritage properties must meet one or more of the following criteria and pass the test of authenticity. For example, a world-heritage bridge should: Represent a unique artistic achievement, a masterpiece of the creative genius; have exerted great influence, over a span of time or within a cultural area of the world, on developments in engineering theory, technology, construction, transportation and communication; and be an outstanding example of a type which illustrates a significant stage in bridge engineering, material or technological developments.

A world-heritage bridge, like other properties, must meet the test of authenticity in design, materials, workmanship, or setting (reconstructed bridges are acceptable if carried out on the basis of complete and detailed documentation of the original artifact and to no extent on conjecture). The criterion of authenticity was applied to the reconstructed Stari Most. It would apply to Kintaikyo Bridge and Palladio's Bridge over the River Brenta at Bassano-a-Grappa near Venice. Clearly, bridges and aqueducts surviving from the Roman Empire have been rebuilt many times over millennia. In the same context, some bridges have been moved when unable to function at their original location. It is not unusual in the United States, for example, to relocate a metal truss bridge to a less-traveled road when it no longer serves modern traffic. The same holds true for other countries. This is within the functional tradition of some bridge types and should not be viewed as a negative factor in determining the integrity of relocated structures.

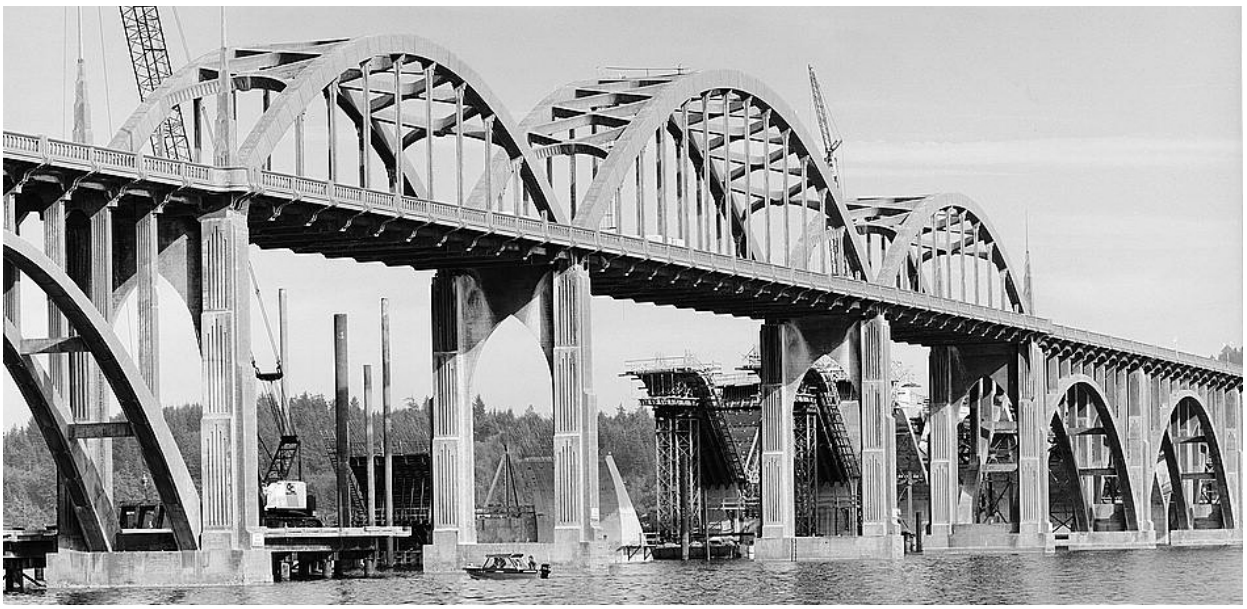

Figure 11. Alsea Bay Bridge (1936, replaced 1991), Waldport, was one of five large spans built along Oregon's Coast Highway between 1934 and 1936. One of America's foremost state bridge engineers during the Depression, Conde B. McCullough, oversaw design and construction. Alsea Bay, along with the other coastal spans, was considered one of the finest families of reinforced-concrete and steel bridges in America, all designed in an ornate Art Deco style. Construction of a replacement bridge began in 1988, and was completed in 1991. Replacement of Alsea Bay resulted in a state DOT program to save the other McCullough coastal spans; (Jet Lowe, HAER photographer, 1990, HAER Collection, Library of Congress.)

Bd&e (Bridge Design & Engineering) is an international quarterly of the bridge industry published in the UK) featured the bicentenary of one of the 19th century's greatest engineers, Isambard Kingdom Brunel (1806-2006), in issue No. 43, Second Quarter 2006. The engineering achievements of Brunel were celebrated throughout the United Kingdom in 2006, during which English Heritage chairman, Sir Neil Cossons, announced that segments of Brunel's Great Western Railway would be proposed for world heritage designation at a future date. This would add some of the UK's most significant bridges to the world heritage list such as Wharncliffe Viaduct, Maidenhead Bridge, and other major railway engineering works such as Paddington Station, Box and Middle Hill Tunnels, bridges and right-of-way through the City of Bath, Temple Meads Station, and the Great Western Dock in which the iron-hulled SS Great Britain is berthed. In addition to Great Western Railway features, two other Brunel-designed bridges - Clifton Suspension and Royal Albert, are likely to be considered according to the recently published consultation booklet, written by Keith Falconer, coordinator for English Heritage's world heritage steering group. Presently on the UK's tentative list and scheduled to be put forward for inscription this year is Pontcysyllte Aqueduct (1805). (Figure 7. Pontcysyllte Aqueduct)
In the United States, there are 21 world heritage sites - 9 cultural and 12 natural. There are no bridges on the "tentative list," an inventory of properties suitable for inscription to World Heritage. The United Kingdom revised its list in 2006, America updated its list two years later in 2008. In America, application must be made or approved by property owners. This means that the owners of Brooklyn, Eads, and the Golden Gate (City of New York, St. Louis and San Francisco), would have to apply or approve to be included on the tentative list. Actual inscription for World Heritage would come later. (Figure 8. Eads Bridge).

## CONCLUSION

So, where are we now? Are we owners of antique roads with problems of congestion, insufficient capacity, deteriorating bridges and pavements that confronted Eisenhower 53 years ago? Today's bridge engineer, transportation planner and preservationist, cultural landscape scholars, the interested public and historic bridge enthusiast, not only will have to grapple with these challenges, but with the problems of increased cars and trucks, congestion, fuel sources, and historic bridges.

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