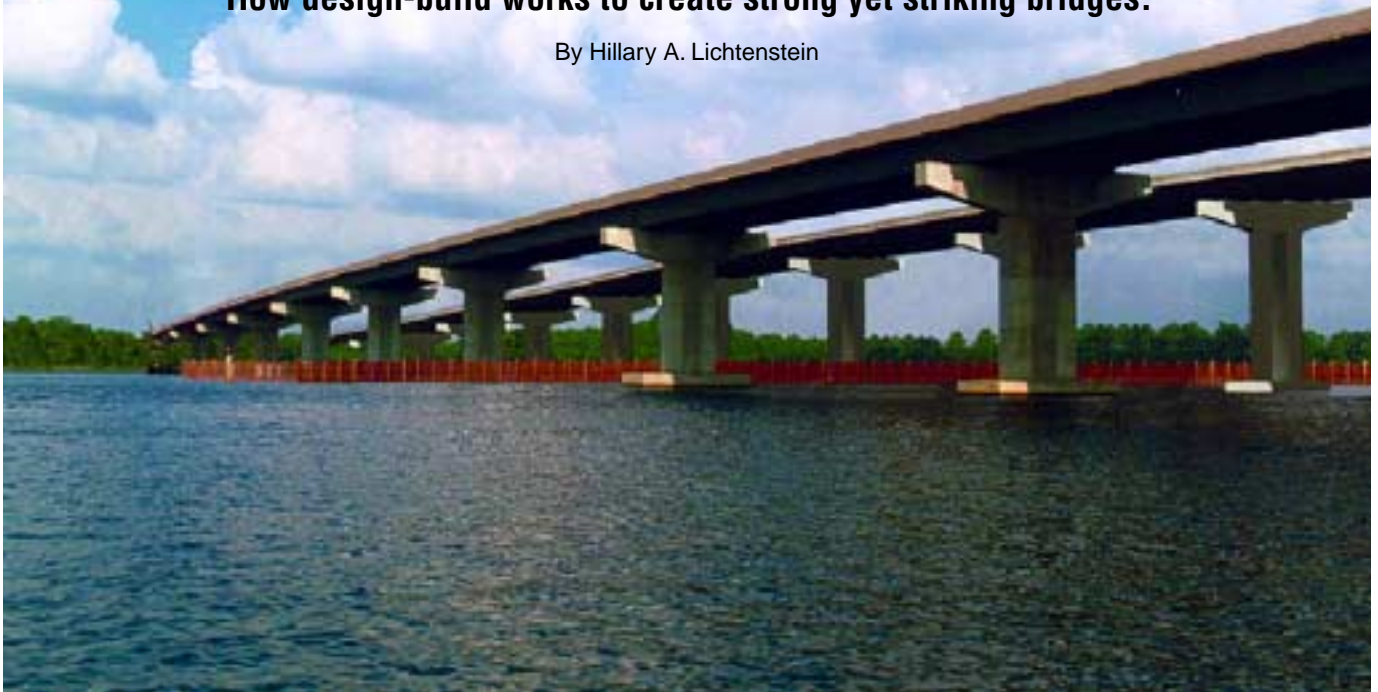


Look at Them Now!

How design-build works to create strong yet striking bridges.

By Hillary A. Lichtenstein



Winds of change: a hurricane's aftermath swept a new look over Florida's I-10 Bridge.

While mixing design with construction isn't always easy, the success of numerous projects demonstrates the advantages of design-build. *Modern Steel Construction* editors recently spoke with engineers, fabricators and architects to find out how design-build effectively worked for them and their partners on new bridge projects.

Popular Practice in South Carolina

Design-build is already off and running at the South Carolina Department of Transportation (SCDOT). According to Bobby Clair, director of SCDOT's engineering and special projects, the SCDOT has already completed six design-build projects. The SC170 road and bridge project is on the way, and the Interstate 85 project is in a proposal state. The construction of the Cooper River Bridge in Charleston brings the number of their design-build projects to a total of nine. Each of the six completed projects has been finished early and below budget, and the Cooper River Bridge project is on track to do the same.

"The big risk is making changes to construction plans during the building process," said Clair, "but with design-build, the entire process saved us \$150

million [on the Cooper River Bridge], with the end cost coming to \$531 million for construction. The traditional way would have taken a few more years, and the risk of design changes would have been great because of the complexity of the project, high speed hurricanes in the area, and because it is a busy shipping port."

The bridge, having to withstand shipping, designing and constructing, would have been expensive to construct without design-build. Clair explained that design-build eliminated the ongoing process and challenges of the design plan. "We wanted a state-of-the-art and technologically sound bridge that would work for both the builder and designer. By working with High Steel Structures, we were also able to create something that was construction friendly." The project, which was given a five-year

timetable for completion, finished in four years and allowed the use of the bridge to begin ahead of schedule.

During the project, meeting sessions between team members took place quarterly. Every three months, teammates formally took two days of partnering to enhance communication and find out forecasting work. In addition, teammates worked out the correct answers to any design questions before becoming a hindrance to the people doing the work out in the field. "Excellent communication," said Clair, "is the absolute key necessity in design-build. By having a design review team, all of our questions find answers."

While part of this design-build team was scattered throughout Europe, Canada and the U.S., 85% of the team met on site. Video and teleconferences



Above: It's the eye of the tiger (sort of)—at the Bridge of Lions, St. Augustine, FL.

Below: Picture this: an artist's rendering of the Cooper River Bridge, Charleston, SC.



aided in connecting the team, and team members were only called in to a face-to-face meeting if a problem could not be immediately expedited.

When it comes to the look of the bridge, Clair said it's not always up to designers. "You turn over a certain amount of authority to the builder to cover aesthetic touches. The public also helps fine-tune the aesthetics, suggesting any changes or recommendations, including lighting and other details."

Public Works

The process of creating a bridge with great aesthetic impact often calls for the participation of the public. In the case of the Bridge of Lions in St. Augustine, FL, the Florida Department of Transportation (FDOT) first had to comply with the National Environmental Policy Act (NEPA) prior to completing the final design of the bridge. NEPA required the FDOT to coordinate and plan improvements to this historical structure with agencies, including the State Historic Preservation Office (SHPO), which had jurisdiction over the structure.

According to federal law, the outcome of the bridge project needed an environmental impact statement. The statement summarized alternate possibilities and coordination of whether to rehab or rebuild the bridge. Once the decision was made to rehab the bridge, a final design contract was chosen and implemented. Reynolds, Smith and Hills, Inc. was awarded the restoration project, with their contract beginning at end of the NEPA process.

"The DOT led an effort to create public involvement opportunities, such as meetings and taking opinion polls," explained David Sweeney, P.E., bridge service group leader of Reynolds, Smith and Hills, Inc. "The public was able to

indicate their attachment to the bridge and take time to speak about the general feeling they had regarding the impact of whether to rehab or replace the structure. The outcome was controversial, but in the end, the decision was made to move ahead with rehabbing the bridge."

Historic structures must possess certain attributes as outlined in the federal guidelines in order to meet the criteria of the National Register of Historic Places. In this case, two characteristics of Bridge of Lions contributed significantly in establishing it as part of the Register in 1982:

- Its appearance blends well with St. Augustine's historic downtown.
- The bridge led to the development of Anastasia Island.

The bridge connects St. Augustine—the oldest continuously inhabited city in the country—to barrier island Anastasia.

The appearance of bridge, coupled with the development of the island, made it a landmark.

Still, controversy loomed. Although the bridge was considered historic, "certain facets of the public believed it did not meet the current needs of traveling public," explained Jack Haynes, head engineer of the Jacksonville Bridge Group (part of Reynolds, Smith and Hills, Inc.). "The two-lane bridge was deteriorating and could not handle traffic capacity. This all factors into the disposition of the bridge."

Although Reynolds, Smith and Hills, Inc. could not always accommodate the public's suggestions, the company was pleased that the public at least had an open forum to discuss the bridge's progress. The process of collecting public opinion feedback, both positive and negative, continued throughout the bridge's restoration process. "The public had its



Pillars of strength replace the I-10's scoured piers over the Black Water River in Florida. The piers were damaged in 1995 during Hurricane Erin.

making it all work is team member communication."

When choosing a bridge building material, a major consideration is the long-term cost of the project. Giardina said that, time and again, aesthetics are critically important, especially in major river crossings or historical areas. "Steel offers flexibility and strength, and in terms of aesthetics, there is a certain beauty of steel trusses, haunch girders and cables. Still, modern design and aesthetics change with the wind—designs can flip either way, with the look of bridges varying over time."

However, Giardina believes the look of steel in bridge design can maintain a timeless facade. "It seems to me steel bridges would be the dominant choice when aesthetics is an issue. Steel is flexible and has been in longer use. So, if people wanted to recreate a look, they'd use steel to mimic older bridge styles."

Florida Experience

The first design-build project completed by Tensor Engineering required making repairs to the Interstate 10 Bridge over the Black Water River in Florida. Immediate repairs to the bridge were needed due to damage incurred by Hurricane Erin in 1995. The hurricane had scoured the piers on the bridge, and the state of Florida placed an emergency call for a design-build project.

Put up for bid in the beginning of November, the project needed bids turned in and processed within weeks. Three bids to use concrete were considered for the project. Although the concrete bids came with a lower first cost than steel, they each held a longer construction schedule. In this case, the time factor in completing the project was more critical than its cost. In fact, penalties for work exceeding the allotted time came at a cost of \$30,000 per day. "Here, A plus B bidding, where A = cost and B = time, took precedence," explained Walter Gatti, president of Tensor Engineering.

Although the bid from Trayler Brothers of Evansville, IN, wasn't the lowest proposal, steel for their bid had a shorter delivery time than that of the concrete bids, and Trayler was awarded the project. The total cost for the Black Water River project came to approximately \$32

opportunity to speak and give their opinion," said Sweeney. "However, as in any situation, you won't please everyone."

Grappling with how to define and evaluate aesthetics is ongoing. "Aesthetics is a hard thing to measure," said Sweeney. "It is important to have already assessed preliminary public opinion before moving ahead with a design-build project." He explained that public opinion must be exercised beforehand so that the requirements of the public can be built into the design of the bridge, rather than fighting with contractor to include those details (requested by the public) at later date.

The reality, according to Sweeney, is that in the design-build arena, the contractor wants to provide transportation that meets requirements but also create a project that is at or under cost. Trying to balance economics while incorporating aesthetics can get tricky—and costly. "The contractor is the economy-driving force," said Sweeney. "Incorporating curved features is an expense to him, so you must bid that upfront—you can't let them win the bid without having them tied down aesthetically."

While public opinion was taken into consideration during the rebuilding of the bridge, final decisions concerning bridge rehab details were ironed out between the city of St. Augustine, the State Historic Preservation Office (SHPO)—part of Florida Department of Transportation (FDOT)—and the Federal Highway Administration (FHWA).

Luckily, some significant aesthetic features of the bridge were preserved, including the bridge's arched steel plate girders and two-girder open system, which make up this steel superstructure. "When creating or maintaining aesthetics of a bridge, the bottom line is that people don't like their view of the water blocked," said Sweeney. "They believe it's important to maintain steel spans and

arch shapes, which enhance the look of the water."

Fast Results in Ohio

A recent noteworthy project is the Pickaway County State Route 22 Bridge over the Scioto River near Columbus, OH. A design-build project, the bridge was built at a cost of \$2.7 million—\$500,000 below the next lowest bidder—and was completed in 47 days—which allowed the bridge to open 10 days earlier than expected. "The Scioto River project was a really great design-build project for both the contractor and us," said Jay Giardina, assistant VP of sales for Stupp Bridge Company.

Featured in the June 2004 edition of *Modern Steel Construction*, the Scioto River project included fabricators who worked with the designers early on in the project. By participating in the design aspects of the bridge, fabricators were able to help increase profit and decrease errors. "It is significant that the two parties be in constant communication with each other and with other partners. It's all about communicating and getting answers. The owner needs to reply promptly, otherwise the project doesn't move," said Giardina.

During the project, face-to-face meetings did not occur because the team was not centrally located, and fabricator time on site was minimal. Instead, meetings were held by phone and e-mail. The ability to transmit plans electronically was also critical in speeding up the building process and helped knick issues one by one.

"If we (fabricators) can offer a recommendation," Giardina explained, "the consultant or general contractor can make the changes right away. Overall, design-build is a very positive experience—it definitely reduces errors and improves efficiency. The biggest part of

Woah, Nelly! The Pickaway County State Route 22 Bridge over the Scioto River near Columbus, OH was completed in 47 days and opened 10 days ahead of schedule.

million and finished 30 days earlier than anticipated.

The Trayler Brothers, working alongside designer R. Craig Finley, president of Finley McNary Engineers of Tallahassee and bridge fabricator PDM Bridge, won the bid December 2 and immediately began establishing procedures for design and detailing. Tensor Engineering created design drawings from engineer calculations. Next, the design drawings were used to create shop drawings, and 4,000 tons of steel was ordered in four units to begin the job.

The designs were reviewed as soon as they were completed, and any changes that needed to be made quickly took effect. "It had all been worked out," said Gatti. "The five-day turn-around made the approval process quick and easy."

By the end of January, the shop had designs to fabricate the steel currently in stock. The first 1,000 tons of steel arrived in March, and the bridge was erected in April—a mere five and a half months after the job first began. Total completion of the job occurred in less than a year.

"This was our first taste of design-build," said Gatti. "It took a lot of cooperation, but if the designer is willing to let the detailer and general contractor voice their ideas, everyone's in it to get job done. You'll get great results with good team effort."

Olympian Effort

One of the largest design-build projects occurred when the Olympics came to Salt Lake City in 2000 and all the bridges on Interstate 15 were re-built. Out of the 125 bridges that covered the entire length of Salt Lake City, nearly half were constructed with steel (65,000 tons in all). The contract for this design-build project was awarded in 1997 and finished with a total cost of \$1.2 billion.

Clark Olson, president of fabricator Utah Pacific, put the project into motion and was the lead member of an LLC created to coordinate the project. Olson used his imagination to form a team of four fabricators and one detailer. He worked with the detailers and showed them what the final bridge design would look like before the start of the job. All the fabricators received standardization upfront, thus making construction of bridge as efficient and economical as possible.



During construction, the fabricators teamed up several times on the job site. For the most part, however, the team was spread out all over the U.S. and Canada. Working hand-in-hand with 120 designers in Salt Lake City and general contractor Kiewit Pacific, the team completed the entire project in less than two years.

"Generally," said Gatti, "the bridges were built from womb to tomb in about six weeks." With a new bridge being built every 10 days, nearly 60 bridges were completed in two years. Fabricators delivered everything ahead of schedule, and the entire project ended a month early. Because the bridges were completed ahead of schedule, the general contractor was awarded a \$20 million bonus. Furnishing and designing the 65 steel bridges totaled \$140 million.

So, how do you get the job done as quickly as possible and stay within the requirements? "It's a team effort," explained Gatti. "Basically, if everyone sits down to discuss the most economical and timesaving factors, the team will stay on the same page and do what each member does best."

According to Gatti, design-build won't work if it isn't managed properly. "The general contractor must be a strong leader who can dictate which role suits each team member best. You must try to intertwine everyone's energy, find a plan of action and stick with it! The key is to form a strong team to drive the job. The fabricator has to take the lead and must be cooperative because a lot of changes occur during a design-build project."

The devil, of course, is in the details. "Design drawings," said Gatti, "must be made and reviewed as the project progresses. If you stumble along, you'll realize something doesn't work and end up wasting time tracking over a lot of drawings. Rather than waiting months to be given the design, everyone should be on board while it's being developed so they

have a say-so and make changes before it is too late."

Work of Art

In design-build, aesthetics sometimes take a back seat. A certain amount of design has to be done, but what's economic isn't always the most artistic. "Unless the owner lies down guidelines," Gatti explained, "aesthetics won't receive a high priority level."

Certain times, however, aesthetics—rather than economics—take precedence on a project. The Sundial Bridge in Redding, California, (designed by Santiago Calatrava), for instance, went from an original budget of \$6 million to \$23.5 million by the time the project was completed. "This bridge is a sculpture," said Gatti. "It's really a work of art."

Brent Brubaker of PDM Bridge has seen positive results in design-build projects. "Design-build projects run fairly smoothly, but you must hammer out design at the beginning. I believe all but five states do design build, and Florida loves them!"

In Brubaker's experience, he found communication to be crucial for the engineer and other partners in the design-build team. "Discussing aspects of the job helps control cost because everyone is able to find out what the most economical option is for their team. That way, the team isn't boxed into plans that the state may try to assign."

"Typically," explained Brubaker, "design-build is used in very large projects and almost every design build project comes in at cost or under budget. North Carolina jobs are usually 10% below the engineer's cost estimates. Scheduling of a job depends on which factors, such as environmental impact, will go into building the bridge. Still, with design-build, you'll save 20% more time than with a standard bid time project. It really speeds up entire process,



Dazzling steel cables splash a bit of flash into one of Salt Lake City's pedestrian bridges.

from the time when the DOT says they want a bridge to the financing, bidding, awarding, and building of the job."

The visual aspects of a bridge also come into play during construction. "If you do it right, steel can be very attractive. You can make it look very appealing," said Brubaker. "Painting steel is also great because the paint can blend it into the environment. Weathering bridges also get that nice orange/brown color and fit in well with rustic or wooded areas. Colors on concrete just don't come out as vibrant." In addition, Brubaker said it is easier to weld designs, such as a lion head, onto steel. "With concrete, you can attach steel designs, but the look simply won't blend in as well."

Imaginative Ideas

Creating an artistic end result for a bridge project requires the blending of ideas from design-build partners. "Interaction between designers, aesthetic consultants and fabricators is a key issue," said Frederick Gottemoeller, chief architect of Gottemoeller & Associates, Inc. He explained that the aesthetic advisor is most interested in simplifying how the bridge works structurally. As an architect, Gottemoeller takes interest in the use of haunch girders, simple bracing and fastening details to bring out the structural function of the bridge while creating a visual palette.

"Simple bracing and fastening details have more visual impact than people give them credit for. Plus, using fewer box girders with more torsional capabilities makes it possible to create both an economical and aesthetically handsome bridge," said Gottemoeller.

One criticism of design-build is that it emphasizes economics over aesthetics. However, not everyone agrees with this implication. As stressed by Gatti, it is up

to the owner to define the program. The design-build process can result in a bridge with a striking appearance, if the owner is willing to pay for aesthetics (as with the Sundial Bridge). "The design-build tendency toward (aesthetic) mediocrity," Gottemoeller concurred, "is not a cost issue. Attractive things deviate from the standard approach, and unless the client wants it, it's unlikely to happen."

Adding color to steel also helps to create the bridge's overall image. "Painting is a great opportunity to add visual to a bridge, and the brighter the color, the better. A lot of thought must be given to the bridge's environment. If the bridge is made of weathering steel, you can add detail with a complementary color."

Gottemoeller explained the bottom line of a bridge's aesthetic touches—"in order to get the quality that's possible with steel, you need self-confident designers, fabricators and contractors willing to apply their knowledge and skill. They must be willing to do things differently (without necessarily taking a risk) in order to create a beautiful bridge."★

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