

Bridgescape: A Leader in Aesthetic Engineering

Bridgescape LLC owner Fred Gottemoeller stresses attractive designs without sacrificing function, integrity, or budget—and he encourages engineers to unleash their creative side.

by Craig A. Shutt

Gottemoeller worked to refine the aesthetics of the St. Croix River Crossing in Stillwater, Minn., which connects to Wisconsin. The bridge features an extradosed design with stayed, post-tensioned concrete box girders. Photo: Minnesota Department of Transportation.

Fred Gottemoeller's one-person aesthetic consulting firm, Bridgescape, stresses the impact that aesthetic design can have on a bridge's reception and success. The author of a 2004 book for engineers, *Bridgescape: The Art of Designing Bridges*,¹ he rejects the notion that an aesthetic design must cost more and encourages engineers to make aesthetics a priority in every project.

"Engineering education gives no guidance on aesthetic elements," Gottemoeller says. "It focuses on creating functional structures, with the appearance resulting strictly from engineering design parameters. We need to encourage engineers to express their aesthetic ideas during design. They often don't feel qualified to do so, but they are. Some of the best aesthetic ideas I see come from engineers."

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Five Fundamental Ideas

Gottemoeller's book outlines five fundamental ideas that often are overlooked or disputed but stand as core

truths. Fifteen years after the book was published, he believes those elements remain the same. "They're common concepts that trace back to the Greeks," he states. "That's one reason I haven't felt it necessary to update the book."

All bridges make an impact.

"The bridge will make an impression: of excitement, appreciation, repulsion, or perhaps boredom," Gottemoeller wrote. This holds true whether or not the engineer intentionally plans that impact.

People can agree on what is beautiful for bridges.

Beauty may be in the eye of the beholder, but, Gottemoeller argued, that does not mean people can't agree on what is attractive. Key elements for bridges include simplicity of elements, thinness, continuous lines, and shapes that reflect the magnitude of forces (that is, the thickest shapes indicate where forces are greatest).

Engineers must take responsibility for the aesthetic impact of their bridges.

"Engineers are used to dealing with issues of performance, efficiency, and cost, but they must also be prepared

to deal with the issues of appearance," Gottemoeller wrote. They can't avoid these issues by focusing on structural elements and leaving aesthetics to others, he stressed. "The appearance is dominated by the shapes and sizes of the structural elements themselves, not by details, colors, or surfaces."

Engineers should consider good appearance to be co-equal with strength, safety, and cost.

Some engineers believe achieving compelling aesthetics automatically compromises other core requirements or adds cost because aesthetic designs add features such as color or special finish materials. "In fact," Gottemoeller wrote, "The greatest aesthetic impact is made by the structural members themselves. If they are attractive, then the bridge will be attractive." Details, colors, and surfaces add aesthetic interest, but they may not always add sufficient aesthetic impact to justify the additional cost.

Aesthetic ability is a skill that can be acquired and developed by engineers, as well as anyone else.

"Engineers can learn what makes bridges attractive, and engineers can

develop their abilities to make their own bridges attractive," Gottemoeller stated.

Aesthetics in Practice

Gottemoeller puts these five concepts into practice in his work, having served as an aesthetic design consultant for a variety of signature bridges. One of his most recent projects, on which he refined the aesthetic concept during the final design, is the St. Croix River Crossing in Stillwater, Minn., which opened in August 2017. It spans the St. Croix River, which is designated as a National Wild and Scenic River.

The extradosed bridge features stayed girders consisting of 18-ft-deep post-tensioned concrete segmental box girders with curved sides (see article on extradosed bridges in the Summer 2015 issue of *ASPIRE*®). The pier shafts have a split design tied together at the top and bottom. The split creates flexibility that allows the bridge to react to temperature variations and makes the piers nearly transparent. The structure was built with high-performance concrete and high-strength reinforcement. "It [the extradosed bridge concept] is a huge improvement on other concepts," Gottemoeller says. "I expect there will be more use of this option in the 450- to 600-ft range. It's a very attractive and exciting concept, and it's been very well received locally."

Concrete's Aesthetics

Gottemoeller remains "agnostic" about materials for bridges. He advocates for using whatever materials can



The five-span Rich Street Bridge in Columbus, Ohio, is supported on four lines of post-tensioned precast concrete arches. Photo: Randall Scheiber.

accomplish the structure's goals with the best combination of features. But he sees advantages to working with concrete, especially from an aesthetic viewpoint. "Concrete bridges don't need to be painted, and they can retain their light, reflective coloring for long periods," he points out.

A key, but often overlooked, benefit of concrete derives from its inherent mass, which can dampen traffic sounds, especially beneath the bridge. "People who live near concrete bridges have a better opinion of them because their living experience is better," he says. "The material can affect sound levels,

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Gottemoeller always keeps an eye on concrete technologies to consider how changes can affect his designs. "Materials such as high-performance concrete and self-consolidating concrete are exciting to consider when the situation is right," he notes. Stayed girders are the most recent concrete concept that he has incorporated into his designs.

Specialized concrete mixtures were a key ingredient in the design of the Rich Street Bridge over the Scioto River in Columbus, Ohio, which was completed in 2013 and featured in a project article in the Fall 2012 issue of *ASPIRE*. The bridge's appearance was conceived as a visual unifier for two nearby bridges, combining the span arrangement of the Discovery Bridge with the open appearance of the Main Street Bridge,

Gottemoeller developed the overall concept and the architectural details for the Rich Street Bridge over the Scioto River in Columbus, Ohio. Photo: Randall Scheiber.





The lighting design of the Rich Street Bridge over the Scioto River in Columbus, Ohio, was developed by Gottemoeller. Photo: Randall Scheiber.

a tilted through-arch design completed in the style of Spanish architect-engineer Santiago Calatrava.

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The five-span, 568-ft-long Rich Street Bridge is supported on four lines of custom arches, with both arches and girders consisting of precast concrete segments using high-strength, lightweight concrete. The arches consist of three precast concrete segments: two identical arch legs and a keystone segment. A fourth standardized beam segment spans over the piers between the arch crowns. The segments were connected with short closure pours and then post-tensioned to function as a single five-span unit. The bridge came in below the city's budget for the project and at approximately one-third the cost of the Main Street Bridge.

Gottemoeller developed the overall design as well as the architectural details and the lighting concept for the Rich Street Bridge. Since opening, it has won multiple awards, including recognition from the American Council of Engineering Companies, the American Society of Highway Engineers, and an award from the Columbus Landmarks Foundation.

Cost Effectiveness Is Key

Gottemoeller disdains high-profile

architects whose designs demonstrate little regard for budget. "They get photos of their 'works of art' in magazines, but the structures are not cost-effective or engineered well," he states. "The only thing they accomplish is to persuade agencies and engineers that aesthetics must be expensive." To the contrary, Gottemoeller emphasizes that "good aesthetics don't have to break the bank." Some departments of transportation, notably Minnesota and Colorado, understand this point and make budget and aesthetics equal priorities.

"A tight budget can and should act as a spur to creativity, encouraging a search for new approaches with both cost and aesthetic advantages," Gottemoeller wrote in his book. "Improvements in appearance should be sought just like improvements in any other area of concern: safety, durability, or maintainability."

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Leading by Example

Gottemoeller's role as consulting aesthetic engineer on projects gives him an opportunity to disseminate his concepts. For example, in 2004, he served as aesthetic and urban-design consultant for the Memorial Causeway Bridge over Clearwater Bay in Clearwater, Fla. The bridge, which replaced a design with a bascule span, features cast-in-place concrete segmental, haunched, trapezoidal box girders. The girders have tapered sides that minimize the width of the tapered piers, allowing the girders and

piers to flow together in a single sweep. The design provides 330-ft spans that avoid obstructing scenic views. White concrete was used to reflect the water color and evening sunsets. The vertical spaces within the four split-center piers are illuminated to create a memorable nighttime appearance.

A more recent project reflecting Gottemoeller's commitment to aesthetics is the Virginia Street Bridge over the Truckee River in Reno, Nev., which was built to allow more clearance for flood waters. Completed in 2016 near historic buildings, the single-span bridge features a pair of cast-in-place, post-tensioned concrete through arches, paying homage to the two-span arch design of the original structure. The tie beams of the thin floor system are connected to the low arches with steel cables to create a low profile, which is enhanced by aesthetic lighting at night.

Gottemoeller worked with the engineering team and the historical review committee to create the architectural and structural concept for the Virginia Street Bridge and developed the architectural details. "Structurally, the bridge is a hybrid of a tied through-arch and a rigid frame," he explains.

Design-Build Aids Aesthetics

Creating aesthetically pleasing designs becomes easier as more bridges are designed aesthetically in cost-effective ways, Gottemoeller says. The openness of owners to considering new delivery formats advances that process. "The expanded role of design-build formats is changing how bridges are designed," he says. "The relationships between owner, engineer, and contractor change and can make it easier to suggest and incorporate aesthetic concepts. It creates more conversation among the parties and brings more ideas to the table."

Construction manager-at-risk formats especially help drive new ideas, he adds. "That delivery method produces an ideal setup, since ideas suggested early in the design phase can be quickly costed out by the contractor. Aesthetic concepts shouldn't be added after the fact to dress up a design."

Owners' attitudes are critical to



The single-span bridge on Virginia Street in Reno, Nev., consists of a pair of cast-in-place, post-tensioned concrete through-arches that support a thin floor system, allowing high floodwaters to pass while minimizing the vertical profile and impact on adjoining historic buildings. Photo: Vance Fox.

achieving high-quality aesthetics, Gottemoeller notes. If owners set aesthetics as a goal, the team will get behind it. The emphasis on short timetables does not necessarily hinder the process. "Doing everything quickly limits the ability to consider all of the options." But that does not give quickly constructed projects a free pass, he stresses. "Speed and cost can be used as excuses, but they aren't good reasons to not consider appearance. If aesthetics is a priority, an attractive bridge can be created with any budget or timetable."

Stakeholder Input Grows

Increased sensitivity to stakeholder input, especially from the community, can add challenges to bridge design and construction, but owners today are more willing to take this on. "They're not as scared to solicit opinions, and that can help create acceptance for a design," Gottemoeller notes. Conflicts among various ideas often can be overcome with clear communication, he says.

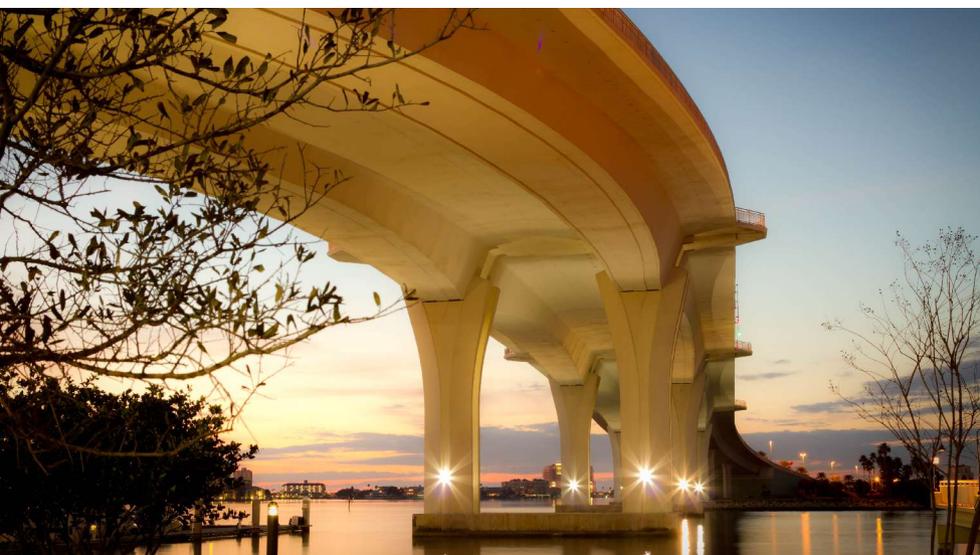
"Many of those involved [in discussions of a bridge project] aren't engineers, so it's important to communicate and educate, and it's also important to listen to community concerns and adapt where possible," he says. "Everyone pays taxes, so they realize some requests are going

to be too expensive to accomplish." Aesthetics will continue to be at the forefront of Gottemoeller's designs, and he encourages owners to solicit ideas and prioritize this element. "Owners should encourage engineers to express their opinions and offer suggestions." The split-pier concept for the St. Croix bridge was suggested by the engineers, he notes. "I just got on their bandwagon."

Encouraging engineers to give input will help them realize their ideas have merit. "Every time we ask, we get good ideas from them," he says. "I can never predict what will come up, but I know something good will arise if we encourage them and listen to their ideas."

References

1. Gottemoeller, Fred. 2004. *Bridgescape: The Art of Designing Bridges*. Hoboken, NJ: Wiley.
2. Transportation Research Board Subcommittee on Bridge Aesthetics. 2010. *Bridge Aesthetics Sourcebook*. Washington, DC: AASHTO.
3. Chen, W. and L. Duan, eds. 2014. *Bridge Engineering Handbook*, 2nd ed. New York: CRC Press. 



Bridgescape's Driving Force

Fred Gottemoeller is both an engineer and architect. He began his career with Skidmore, Owings & Merrill in 1967 and later worked in management positions with the Maryland Department of Transportation and Maryland Highway Administration as well as A. J. Properties, where he served as director of design and construction. In 1988, he created Frederick Gottemoeller & Associates, which became Rosales Gottemoeller & Associates in 1998. He formed Bridgescape LLC, his one-person firm, in 2005.

"My goal in starting Bridgescape was to focus on providing advice on aesthetics and community participation to engineers," he says. "The engineering side of my background helped me understand what engineers were trying to accomplish and the language to communicate with them in their 'native tongue,' so to speak. Much of what I do is translating engineering words into architectural and community terms and vice versa."

Gottemoeller has helped develop bridge aesthetic guidelines in Maryland and Ohio. He also has contributed to the *Bridge Aesthetics Sourcebook*,² the aesthetics chapter of the *Bridge Engineering Handbook*,³ and a bridge aesthetics handbook for the Society of Engineers of India.

He served as chair of the Transportation Research Board Bridge Aesthetics Subcommittee for many years and has presented seminars on bridge aesthetics under its auspices. He regularly provides aesthetic commentary on bridge designs for projects featured in *ASPIRE*.

The Memorial Causeway Bridge in Clearwater, Fla., features two cast-in-place concrete segmental, haunched, trapezoidal box girders with sloped sides. Gottemoeller was aesthetic and urban-design consultant and developed the architectural details. Photo: Saegrande.