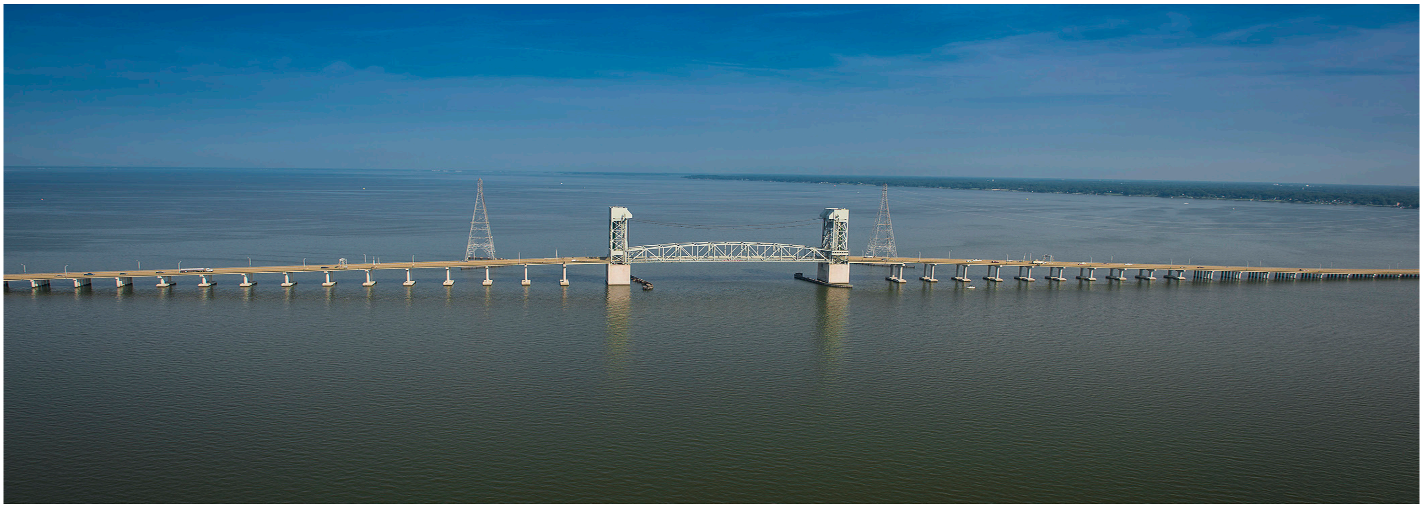

EXPERTS TALK

Movable Bridge Solutions with Robert Moses

Enhancing traditional movable bridge designs by applying innovative materials, standardized materials and modern technologies can benefit owners and users alike.

Movable bridges aren't simply bridges that open for boats. These complex machines that carry traffic give engineers the distinct opportunity to marry traditional practices in bridge design with highly innovative concepts. While contemporary structural designs may mimic their predecessors, employing modern operating mechanisms and construction techniques help to minimize the impact of the project on both bridge owners and its users.

Based in our Newark, New Jersey, office, Robert Moses serves as our national movable bridge program leader. He describes movable bridges as "more tthan bridges that must simply open for boats, they behave like complex machines that carry traffic." His innovations have influenced design, inspection and rehabilitation of more than 200 bascule, swing and vertical-lift bridges, and other movable structures, including retractable stadium roofs. He is recognized for his ability to match owners' goals and budgets with the technical needs and stakeholder coordination requirements associated with multidisciplined movable structure projects. Contact **Robert Moses** for more information on movable bridge solutions.

Q. What is the greatest opportunity for technical solutions for owners of movable bridges?

A. The greatest opportunity is to apply modern concepts to traditional elements of movable bridge design, improving constructability, maintainability and user mobility while reducing the owner's capital and operating costs.

Modern structural designs, while nodding to the historical innovators from the last century, typically accommodate aggressive construction staging by building around the existing bridge while maintaining traffic and bridge operation or by utilizing float out/float in techniques for rapid span replacement. Bridge operating systems can be designed to be shop assembled, aligned, palletized and adapted to accelerated bridge construction methods, thereby reducing impacts to bridge users. These innovative approaches can facilitate bridge replacement and minimize impacts to stakeholders.

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Most bridge owners favor standard equipment that's readily available so they do not have to rely on sole-source vendors to maintain critical bridge components. There is a misconception in the movable bridge practice that operating systems are inherently complex and understood by few, but the reality is that many custom components in bridge operating systems can be replaced with off-the-shelf components that are common in other applications and industries. Many movable structures present opportunities to standardize components, allowing owners to easily inspect and maintain them, and to stock equipment to efficiently control life-cycle costs.

Even if bridge replacement or major rehabilitation is not in an owner's immediate capital plan, applying modern devices to enhance bridge control and monitoring systems can enhance reliability and improve mobility for bridge users. The design of redundant devices in control systems, and the application of intelligent sensors and surveillance equipment to monitor bridge systems and bridge users, can minimize service interruptions brought on by equipment malfunctions. These modern design techniques can improve safety and mobility, even on legacy structures, with relatively little investment.

Q. How do the unique operation and maintenance cycles for movable structures drive innovation?

A. More than bridges that must simply open for boats, movable bridges behave like complex machines that carry traffic. Their operating systems contain components that are subject to wear. Even robust components require routine and periodic maintenance. Movable bridges are also staffed, in many cases, 24 hours a day. These unique operating and maintenance requirements result in increased life-cycle costs when compared to fixed infrastructure assets. Consequently, many innovations result from a desire to reduce costs. I'll give two examples: 1) the implementation of remote control; and 2) the adaptation of intelligent asset management systems.

The motivation for implementing remote control is to reduce labor costs by creating efficiencies in the number of staff required to operate a movable bridge inventory. Of course, this inventory must be greater than one bridge to reap maximum benefits. By having one tender operate multiple bridges, owners can reduce costs over the life of the structures. After a few years, the savings typically offset the cost to implement remote control. Applying modern advances in surveillance equipment and communication technology can enhance control of movable bridges from a remote site (frequently another movable bridge). Bridge tender visibility and controls are enhanced in the remote environment. Once movable bridge owners learn of the cost savings offered by these innovations, they typically endeavor to implement them as soon as possible.

Intelligent asset management systems integrate inspection and maintenance cycles, and thereby reduce long-term maintenance costs. Commonly dubbed "bridge management systems," these innovative tools allow inspections to be documented in a geographic information system database; movable bridge components are uniquely identified and inventoried according to requirements defined by the American Association of State Highway and Transportation Officials, better known as AASHTO. Component conditions are recorded over time, and trends are identified that inform preventative and predictive maintenance planning for the life of the structure. Component-level intelligence generates efficient, targeted work orders. This shift in maintenance philosophy can greatly reduce costs when contrasted with traditional routine maintenance which typically programs labor cost on a predetermined schedule, independent of component condition and system needs. Movable bridge management systems are proving to be a cost-effective innovation that complements federally mandated inspection programs.

Q. When is it feasible to consider remote control systems for existing movable bridges?

A. Realistically, it is feasible to adapt virtually any existing movable bridge for remote control as current technology provides a cost-effective means to replicate the surveillance and situational awareness afforded a local bridge tender. The factors considered for implementing remote control center on a commitment to investing in the system upgrades required to safely operate remotely and providing a secure network to transmit the data to the remote site. The latter requirement is typically achieved through private fiber optic networks that are deployed by railroads or traffic management agencies as part of a dedicated signal system or intelligent transportation system network. The ability to securely carry this communication network is of paramount concern for safe remote control of movable bridges.

Q. Which emerging technologies will have the greatest impact on movable bridge design?

A. Three dimension design tools developed during the last 20 years have greatly improved the design process, particularly with regard to coordination of mechanical and electrical systems within structural and architectural disciplines. While 3D tools are not new, using them in a Bridge Information Modeling environment is a recent phenomenon that streamlines the design process as well as construction and asset management. Pairing BrIM with 3D tools simplifies collaboration among project stakeholders. It allows owners to visualize their movable bridges before they are built. It lets contractors examine structure detailing or even the need for maintenance personnel, to assess their work areas on the bridge — and long before a shovel is put in the ground.

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And pairing the BrIM database with the Bridge Management System creates a cradle-to-grave asset management model that serves to inventory all relevant design, construction and maintenance information in a single platform. Over the life of a typical movable bridge, it is common to enhance features or modify major systems in order to accommodate user needs. Having all relevant information in a single database simplifies the evaluation process, allowing us to more quickly and cost effectively assess a structure's ability to tolerate these changes.

Beyond design, applying modern materials on movable bridges can add performance and value, especially when rehabbing existing structures. Many older movable bridges employ open-grid steel decks, which do not offer an optimal surface for users, especially cyclists. Lightweight, solid-surface decks such as fiber-reinforced polymer, closed-cell aluminum and sandwich-plate decks can replace open-grid steel while managing total dead load. These solutions are useful, especially amid trends to add bicycle lanes to existing movable bridges.

Probably the greatest potential emerging technology is the proliferation of the Internet of Things. While there may not be a significant benefit to monitoring your toaster from your smartphone, we see great potential in monitoring movable bridges from mobile devices; real-time monitoring will improve mobility in many communities. Maintenance personnel would be alerted to a faulty sensor and motorists would be notified of impending bridge openings that could potentially delay their commutes. A boater could check his or her social media feed to learn when the next bridge opening will occur. Technology is currently available to support this concept, and we are working with several progressive movable bridge owners to implement it in the context of their traffic-operations-enhancement initiatives. This emerging technology has the potential to "rebrand" last-century drawbridges as modern transportation assets that enhance quality of life in the communities they serve.

Q. What is HDR's approach to determining whether a movable bridge should be rehabilitated or replaced?

A. While many factors go into this decision, the primary driver is the availability of funds to achieve the owner's goals. Our philosophy is founded in preserving the asset and extending the life of the bridge where possible. Life-cycle cost management is at the forefront of every assessment we perform, and we educate the owner about the options available. When funding and goals are prioritized, the most logical option — rehab or replace — becomes apparent. Of course, there are inherent limitations to what can be done to rehabilitate a movable bridge approaching the end of its service life. In this case, we thoroughly vet the replacement options with the owner to help guide the most cost-effective solution over the projected bridge life cycle.

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Inspiration & Advice

Q. What inspired you to become a bridge engineer?

A. As a young boy, I routinely took road trips with my family from North Jersey into Manhattan to visit my grandparents. From as early as I can recall, I've always been fascinated by how many cars and trucks the George Washington Bridge could accommodate (especially while it bounced in bumper-to-bumper traffic), and how all the tall buildings in the city could stand up. As I scoped every drawbridge over the Harlem River while riding down Harlem River Drive, hoping one of them would be opening for a boat, I never imagined I'd be working on those same bridges during my lifetime.

Thousands of Legos and a few engineering books later, I was destined to become an engineer. Truth be told, as a degreed electrical engineer, I never contemplated becoming a bridge engineer, but given that movable bridges are electrically operated, I found myself qualified to apply for a very specialized "drawbridge electrical engineer" position right out of college. And I haven't looked back. I'm still fascinated every time a movable bridge opens, just like I was during those rides down Harlem River Drive.

Q. What advice do you have for bridge designers who are new to the profession?

A. In a (hyphenated) word: cross-train; and in every sense of that word. Learn as much as you can about the disciplines related to structure design — civil, geotech, traffic, environmental and the like. Identifying with the objectives and coordination requirements of these related disciplines will inherently make you a more effective bridge designer. Spend time in the field. During a six-month construction inspection stint on a bridge project early in my career, I learned more about bridge design than I probably would have learned in six years in the office. And finally, take the time to learn about our clients' programs and the way we conduct business in our company. You may be the greatest bridge designer in the world, but you need to know how to deliver as well as design — otherwise, your greatest bridges will remain a figment of your imagination.

Experts Talk is an interview series with technical leaders from across our Transportation program. Each interview illuminates a different aspect of transportation infrastructure planning, design and delivery. Contact HDRTransportation@hdrinc.com for more information. ***Visit www.hdrinc.com/insights regularly to gain insights from specialized experts and thought leaders behind our award-winning, full service consulting practice.***

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