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Remote Control Trends in Movable Bridge Operations Case Study – Six Movable Bridges, Local Centralized Control and Operation, in the City of Joliet, Illinois

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Introduction and Overview of General Movable Bridge Automation Concepts

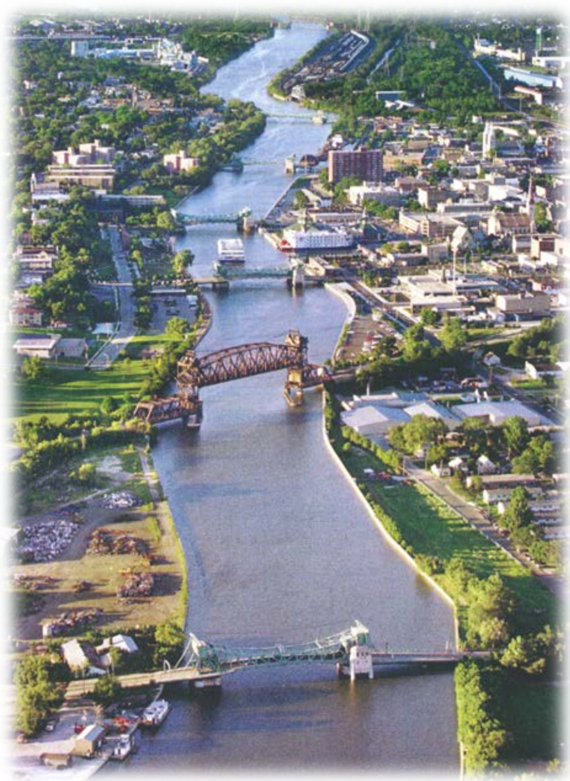
Movable bridges are marvels of engineering, but they are often considered a "necessary evil" by the agencies that own, operate, and maintain them. They are complex and prone to financial, operational, and maintenance challenges. These challenges exacerbate an expensive program of operation, inspection, and upkeep for these bridges that their owners deal with every day. This doesn't even account for public, political, and jurisdictional fallout associated with a bridge stuck in the "open" or "closed" position for any period. It is no wonder the owners of these bridges are continuously seeking ways to make them more reliable, efficient, and less costly to maintain and operate. One such solution gaining traction is remote control operations.

Technological advancements aside, remote control is not a new idea. The railroad industry has been using the concept of remote control for trains and movable bridges for a very long time. Railway movable bridges that carry passenger or freight trains are not controlled by the local operator or "Bridge Department" circuits, but instead by remote "permissive" commands generated by the railroad's "Signals Department" circuits. This system is responsible for determining if the movable bridge is ready to safely allow train traffic to proceed. The bridge may be operated locally, but the control of its openings is dictated remotely. Automation of the "local operator" role in the control of the bridge has also been employed by the railroad. Based on Modjeski and Masters' experience working with Class 1 railroad clients, several factors come into play when they consider converting a bridge, or multiple bridges, from "local" to "remote/centralized" control.

The railroad industry has been utilizing this concept for some time now, but this idea is rather new for highway and pedestrian movable bridges in the United States. Advancements in network reliability and speeds and other technologies now allow us to seriously consider the idea of remotely controlling these complex bridges in a safe and reliable manner. Many movable bridge owners are seeing the benefits inherent in the centralized control of multiple bridges on their system. In some cases, Modjeski and Masters has found the return on investment predicted warrants a closer look in any case.

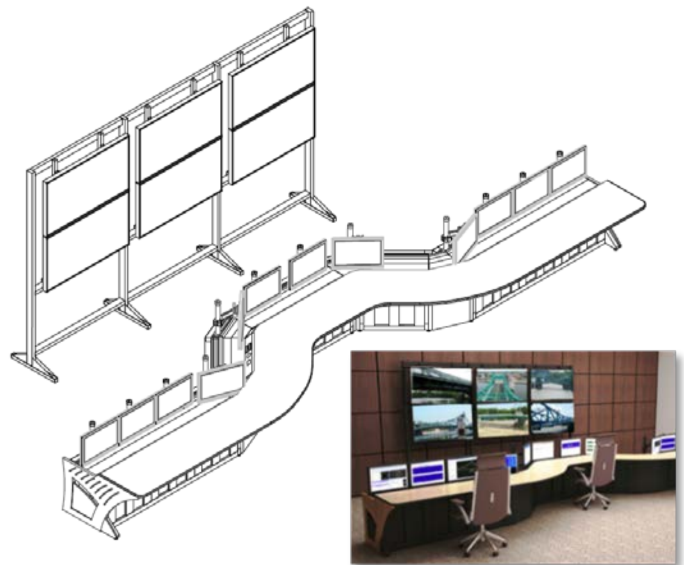
Case Study – What are the Motivating Drivers Behind the IDOT City of Joliet Illinois Project?

So, let's look at the process, from feasibility study into construction, of the Illinois Department of Transportation project to convert six movable bridges, located in the City of Joliet, from local to centralized control. First consider this, on any given busy movable highway/pedestrian bridge, a trained local operator is needed 24 hours per day, seven days per week, and in some cases depending on where the bridge is located (some owners close their bridges during the Winter season as permitted by the United States Coast Guard), 365 days per year. This is typically done in three 8-hour shifts or two 12-hour shifts where the operator is alone the entire time. Salary costs, overtime, holiday pay, and training costs are substantial to maintain this skilled staff. The bridge operator position can be a very stressful job considering the safety that the travelling public put in their hands every day. The operational dynamic on these highway movable bridges is much more complex than that on a comparable rail movable bridge. The "permissive" on a highway movable bridge is solely the call of the local operator. This operator must assure all vehicular traffic has stopped at the gate points and the bridge is clear of all bicycle and pedestrian traffic prior to beginning the bridge opening sequence. There are typically various safety interlock measures built into the bridge controls that would not allow the operator to move the bridge unless these conditions were met; however, the decision is up to the operator. They rely heavily on their visual and auditory senses during a bridge operating sequence, so understandably, there are multiple challenges involved with controlling these movable bridges from an off-site location. However, from an owner's standpoint, the reduction of staffing costs and the added benefit of increased employee safety from not being alone the entire shift is significant.



The Illinois Department of Transportation owns, maintains, and operates six bascule type movable bridges along the Des Plaines River in Joliet, Illinois. These bridges are relatively close to each other along the waterway, starting with the Ruby St. Bridge to the north and ending with the Brandon Road bridge about six miles south. The bridges are similar structures with the four center bridges Jackson St., Cass St., Jefferson St., and McDonough St. being almost identical. IDOT also maintains a local bridge office near the Jackson St. Bridge, lending itself to a convenient bridge control command center. The proximity of the bridges, the availability of a potential central control building, the increase in motoring and marine public safety, and the attractive potential operating cost savings made this an excellent candidate for consideration. However, this did not mean it was going to be easy. The engineering services phase required for development of contract documents, began in December of 2011. The project is currently under construction and in the bridge start-up phase. As is often the case, it has been a long road from design start to construction and there are various reasons for this. First, it is important to understand some key aspects of this project.

The purpose of the project was to provide the centralized control and operation of six drawbridges on the Des Plaines River from the IDOT bridge office in Joliet. Doing so increases the safety of the motoring public on the river and roadway by introducing camera, communication, and detection systems, as well as for the local bridge operators by not having to work long shifts alone. Additionally, a centralized control set-up decreases the yearly operation costs, which results in a strong return on project investment.



Case Study – Project Details, Progress, and Future

As for the project details, the IDOT bridge office in Joliet will be renovated and fit out to serve as the Central Bridge Control Center. Three bridge operators will control two bridges each from their respective station and there will be three 8-hour shifts. Operators will have visual, voice, and radio communications to replicate local operation, along with a common video wall that will illustrate what is happening at each command center.

All six bridges must have a reliable and robust network and communication connection to the central command center. Because the bridges are close in proximity, it was feasible to install a redundant self-healing fiber optic ring connecting the bridges to the command center serving as the primary communication method. The bridges must be equipped with technology capable of simulating on-site controls, visual, and audible cues from the operator station at the central command center such as Closed-Circuit Television Systems (CCTV), Two-Way Public Address Systems (PA), and boat detection systems. A wireless radio transmission system will be installed to back up the fiber-optic network, adding another level of redundancy. Furthermore, all six bridges must have updated local controls (PLC) capable of working with the overall control scheme SCADA system and must have reliable electrical and mechanical components to maximize bridge operational reliability. Safety and reliability enhancements also include the replacement of all the electrical systems on all six bridges. This included the replacement of all bridge control limit switches and instrumentation.

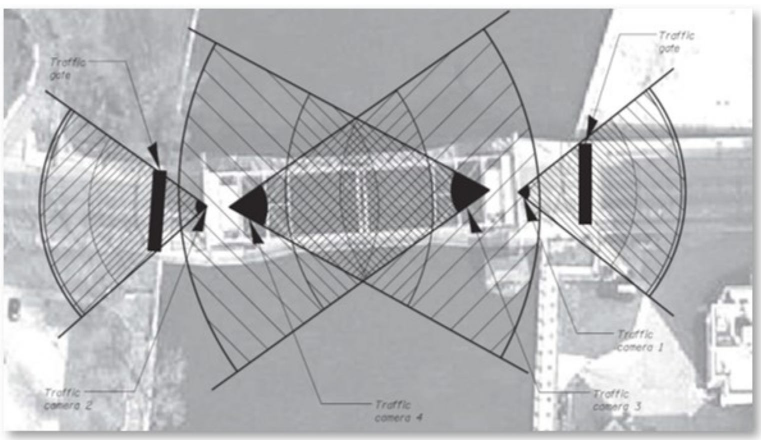
The Code of Federal Regulations (CFR) which mandates the operational procedures for the movement of all six bridges is maintained and enforced by the US Coast Guard (USCG). Because we were changing the operation procedures for the bridges from “manned” to “centrally controlled” this also required edits to the bridge CFR. These proposed changes required review and acceptance by the USCG which was a lengthy process from start to finish.

The central command control platform (or SCADA system) is the heart of the project, and the fiber optic networks connecting the bridges to the command center are the arteries. The logistics required for routing this fiber optic network crossed different jurisdictional boundaries. Extensive coordination was required with the U.S. Coast Guard, U.S. Army Corp of Engineers, Illinois Department of Natural Resources, and the City of Joliet. Permits were required from the U.S. Army Corp of Engineers and the Illinois Department of Natural Resources. A public open house was held for the proposed operations rule changes to allow the traveling public to comment and there is an upcoming operational trial period imposed by the USCG after the bridges go to remote operations to ensure consistent, reliable, and safe remote operations.

These are often overlooked factors when considering a project of this type, and care must be taken to build time into the project schedule to accommodate them.

The six local bridge houses associated with this project are registered with the state historic preservation society. This must be taken into consideration when making any changes affecting the house appearance, and a review with approval must be obtained. This is another aspect that has the potential to delay the project start and schedule.
As this project proceeds through construction, start-up, then day-to-day usage, IDOT and Modjeski and Masters will need to monitor all aspects such as reliability, conformance with USCG bridge operating regulations, maintenance costs, ease of use for operators, public perception, and of course, the important return on investment numbers.

Highway Movable Bridge Remote Control Projects Now and Into the Future



Network reliability, speed, and bandwidth are key. Each movable bridge can require up to a dozen or more cameras to adequately simulate the visual feed to safely operate the bridge from the command center. This alone requires a tremendous amount of data transmission to maintain the desired video feed quality. The connection plays a significant role, and many networks are not robust or reliable enough. Leased fiber connections, direct licensed wireless connections, and unlicensed wireless frequencies all face challenges such as security, reliability, and limited bandwidth capabilities to handle system requirements. Fiber optic connections and leased cellular are other options, but with 5G here, and greater availability on the horizon, it may be possible to accomplish this with leased hotspot locations. These new and emerging technologies could enable us to consider larger and more widespread movable bridge centralized control projects.

In the future, bridge owners and operators will likely be able to use a combination of connection methods. And soon, we may even see Virtual Reality and Augmented Reality technologies applied in the control of movable bridges from a remote location.