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# ROADMAP TO A COMPLETE BRIDGE WORKFLOW

## *Parametric Modeling Provides Up-To-Date Project Information from Beginning to End*

Advanced building information modeling (BIM) technology is quickly becoming standard procedure for bridge design and construction projects. This change is sure to stick, as stakeholders continue to find value in dynamic 3D design that promotes efficiency and collaboration through the entire bridge workflow. This shift away from traditional 2D paper plans, or CAD drawings, to BIM provides unprecedented benefits; advanced parametric modeling capabilities now allow for dynamic design modifications throughout the drafting process.

Parametric modeling is the process of building a model by specifying parameters,  and then editing those parameters to dynamically modify the design. Parametric modeling tools use equations to develop a design that will meet any needs specified. Adjustments made to the model's parameters automatically flow into all documentation, saving time with reworks, eliminating oversights and errors, and holistically aligning all design and construction information for the bridge. When a 3D BIM model is enhanced by a comprehensive, dynamic, data-sharing platform (also known as a common data environment or CDE), all project members know precisely what is happening  every step of the process.

"It used to be, 'How do I make a model?' Now, it's 'How do I attribute a model?' and 'How can I use those attributes to do something more powerful?'" says Connor Christian, Transportation BIM Program Manager for international engineering firm, HDR. He adds that people are finally beginning to understand the power of parametric software tools.

A parametric modeling tool such as Allplan Bridge can provide the information needed for a true end-to-end workflow,

*A parametric modeling tool can provide the information needed for a true end-to-end workflow. Its automated design capabilities provide enhanced coordination among stakeholders, which can reduce costly rework, minimizes conflict and eliminate waste.*

allowing a firm to win a bid, create a workable bridge design concept, generate drawings, coordinate with outside contractors, and much more—with a single solution.

### FIRST: THE BID PHASE

Accurate and viable bids require design options, cost estimates, and preliminary scheduling for construction staging. Planning the staging can be made easier with 4D-capable software (the 4th dimension being time) by accurately estimating how long each phase of construction will take.

BIM software doesn't require a manual check to ensure details are up to date and fully-factored into the design, so the estimates it produces are remarkably accurate. Real-time

modifications can provide users with significant upfront cost savings during the bid process. BIM eliminates the need for constant recalculation of the design or project requirements, ensuring that time and material costs are not understated.

This software can also be used to verify the viability of projects with unique design needs. In one recent example, Allplan software was used to create the winning bid for the Tamina Bridge project, built high in the Swiss Alps. This structure consists of a visually striking arch and superstructure combination that was also economical to build. However, authorities were initially skeptical about the viability of the project, since the unique project requirements would make it challenging to design. Consequently, the designer had to provide a very detailed model allowing for the slender cross-sections. Not only did this fine-tuned bid convince the local authorities that it was possible—the bridge was completed a year ahead of schedule.

## INITIAL DESIGN

After a bid is won and the project proceeds to the next stage, BIM users typically would have between 15 and 20 percent of the necessary deliverables calculated. At this point, with an advanced solution like Allplan Bridge, the user would be able to share data derived from the 3D model directly with subcontractors and outside consultants, depending on the project's size and scale. By way of comparison, non-BIM users would typically take twice as long, and may spend twice as much to get through this stage of bridge design development.

*The Tamina Bridge project, built high in the Swiss Alps, presented unique design requirements. A detailed model, developed in Allplan software, proved the viability of the slender cross sections and helped secure the winning bid.*

## FINAL DESIGN: QA/QC

Once the design is complete, the bridge project moves into the quality assurance/quality control phase. Here, the focus shifts to structural engineering and the physics of the bridge, as engineers ensure the design is correctly mapped to the original drawings and verify that overall structural integrity is maintained. BIM software can perform a structural analysis to determine that the design adheres to the intentions, standards, and requirements of the project.

Another important benefit of BIM is its ability to minimize clashes among the various stakeholders. Will Sharp, Director – Highways for HDR, says, "Reducing conflicts between disciplines is a big advantage. There's a lot of different disciplines concurrently working on different components of the design." But with 3D, HDR can create a federated model that combines them all. "From that federated model, we can do automated interdisciplinary coordination checks and clash detection," Sharp adds, enabling them to resolve any issues before the project is let.

Should the alignment of the bridge need alteration at this stage, the model can be adjusted accordingly, recalculating the load and any changes to the construction sequence, as necessary. This process ensures accuracy in the deliverables that will pass next to the contractor—enhancing the safety, economy, and overall quality of the finished design.

## CONSTRUCTION SERVICES

When the integrity of the design and any structural modifications made on this basis have been validated, the project passes to the contractor. Visualizations can then be generated and subsequently passed to the other disciplines and project members. Allplan supports most common data formats for easy assimilation by the various stakeholders. The software's interoperability ensures that collaboration with outside parties and their contributions won't affect the accuracy of the design.

Bridges with complex geometry and variations in cross-sections and curvature have unique needs for reinforcement. A

*During the construction phase, modifications can be communicated using a common data environment (CDE) interface. Drawings and reports can be generated and shared immediately, which can reduce cost, time loss and potential for error.*

3D BIM software tool can generate reinforcement automatically, making what could be an arduous task—particularly in the case of pylons—vastly more efficient. In addition, as the model changes, the reinforcement changes, dramatically reducing manual effort.

Any modifications made at the construction stage based on scheduling, sequence of operations, or necessary last-minute modifications can be communicated via the CDE interface. The 2D drawings, reports, and other deliverables can be generated directly from the model and shared immediately. This greatly reduces the cost, time loss, and potential for error associated with a more manual process.

## AS BUILT

Once the bridge is complete, a 3D scan can be performed and compared to the BIM model. This verifies the accuracy of the construction process and serves as proof of concept to the client. Particularly successful design elements and lessons learned throughout construction can then be leveraged for future bridge projects.

## MAINTAINING THE FINISHED STRUCTURE

One of the more interesting benefits of BIM after construction is the ability to create a "digital twin" of the structure. By incorporating sensors within the physical bridge, the owner can pull up the virtual version on a smart device anywhere in the world and access real-time data about the bridge in three dimensions, including maintenance information.

## LOOKING AHEAD

Even though 3D models have been used in the past for visualization purposes, flat drawings have remained the deliverable for many projects. However, there is significant progress in moving to BIM. Forward-thinking agencies are seeing the benefits of parametric modeling's automated design capabilities and the dynamically updated information afforded by CDE. This process saves costly manual reworking, minimizes conflicts, reduces waste, and affords enhanced coordination among stakeholders, increasing efficiency.

At the time of writing, the Federal Highway Administration and 15 U.S. states are in the process of making BIM a standard for bridge construction. The Pennsylvania Department of Transportation, for example, is developing an initiative to require that all of its construction projects be managed by BIM by 2025.

Connor Christian predicts that BIM capabilities are the way of the future, saying "We can provide owners the ability to make data-driven decisions based on information that they never would have had before."

Certainly, the next decade of development and bridge projects will reveal whether or not BIM is here to stay.

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Allplan is a leading vendor of OpenBIM solutions for precast companies, project managers, civil & structural engineers. Our software facilitates the integration of 3D into preexisting 2D workflows, and allows different disciplines and trades to collaborate in a streamlined, efficient workflow. Allplan is committed to developing programs that enable the designing and building of sustainable infrastructure for the future of the US and the AEC industry. Currently, our solutions are used by over 240,000 engineers and AEC professionals in 52 countries around the world.

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