THE EFFICIENCY OF BIM FOR BRIDGES

Innovative 3D Designs

A DESIGN CHALLENGE

In 2007, officials announced plans to design and build a bridge across the Tamina Valley in the Swiss Alps. The existing road into the valley was badly in need of repair, as it was often damaged by landslides from the surrounding mountains. The chief civil engineer in the area determined that building a bridge over the valley would be less expensive and safer in the long term than making constant repairs to the roadway at the bottom.

However, this would be no ordinary bridge. When complete, it would span 869 feet across the valley at a height of 772 feet, supported only at the ends. It was an engineering feat that addressed, among other factors, the challenge of the different heights of the two sides of the steep valley wall. The design combined an arch and a superstructure strong enough to withstand wind and earthquakes, yet light enough to create a sleek appearance. In addition, it would be economical to construct due to minimal use of materials.

In the end, the bridge was completed in just four years, one year less than the anticipated timeline. How was this possible? Tamina Bridge was designed in sophisticated building information modeling (BIM) software, which made the slim, elegant, and structurally strong marvel on the next page possible.

With BIM, you can create a three-dimensional model of projects like Tamina Bridge and use it for communication, collaboration, simulation and optimization.

DETAILED DESIGN MODELING

"Initially, the authorities and the contractor weren't sure that the design could be built," says Daniel Bittrich, head of product management at Allplan, and an early proponent of BIM technology. "Therefore, the designer had to provide a very detailed model. This model, created in BIM, allowed for slender cross-sections, which make bridges more graceful while saving materials and cost."

BIM is a far cry from CAD (computer-aided design), Bittrich explains. "With CAD, you use your software like a digital drawing board to create lines, hatching, text and so on. With BIM, however, you create a three-dimensional model and use it for communication, collaboration, simulation and optimization. You design a model and use it for visualizations, cost estimations, structural and energy analysis and more. And you can use this model to coordinate with design partners, the contractor and the owner."

He adds, "Tamina's design dates back into the last decade; the software and BIM processes have evolved even more since then."

WHY BIM?

One of the advantages of designing in BIM is that it frees the user to pursue more beautiful and innovative designs than conventional drawing methods readily allow.

"If all you can do is create your designs based on traditional drawings, they may not be as aesthetically stunning as those done by your competitors, because you lack the cutting-edge design capability of a digital modeling pro-

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cess," Bittrich says. "Your designs will also tend to consume more energy and lead to more carbon dioxide emissions. They will probably allot space for technical installations, space that may end up being wasted at the end of construction because it turns out not to be needed.

Bittrich goes on to explain how not utilizing the latest technology could also harm a firm's reputation. "What may be the worst of all, your consultancy will not attract young talent. Who wants to earn their money drawing lines on a computer, when they can instead create digital models like those seen in video games?"

BIM TODAY

The design process in BIM now encompasses three main components:

- Interdisciplinary coordination
- Constructibility review
- Cost optimization

INTERDISCIPLINARY COORDINATION

Each of the principals in the design process – the roadway engineer, the bridge engineer, the structural detailer and the geotechnical specialists – have different roles and require different information to do their jobs. They usually maintain their own documents to address the things they need to know in their respective businesses.

"The roadway engineer is usually not interested in the details of a bridge's design, nor the challenges that a particular site may bring," Bittrich says. "Yet their separate models and documents all need to describe the same project. Therefore, when you upload these models to a BIM platform like Bimplus, they combine, allowing you to easily detect clashes and inconsistencies. These problems can then be discussed and resolved in a coordination session."

Clashes can be expensive and delay a project while they get sorted out. If precast abutment panels conflict with the installation of bridge bearings or girders, for example,

The design process in BIM can help with interdisciplinary coordination, constructibility review and cost optimization.

that might not be apparent in a CAD-designed project until construction is well underway. In BIM, the issue can be detected and rectified before work even begins, ensuring that each main stakeholder and the trades are all on the same page.

CONSTRUCTIBILITY REVIEW

The analysis of how "buildable" a bridge or structure is can be further enhanced by special software tools designed for that precise purpose. These solutions detect potential issues by analyzing the "federated model," one that combines the various individual plans used by the different stakeholders into a single, connected whole.

Not only does this rule-based checking software discover and report potential clashes within the unified design, it can verify that it meets building codes and governmental regulations.

"BIM certainly helps the contractor receive a design with many fewer errors than usual and makes it easier for him to

meet deadlines and budget," Bittrich says. "This is clearly in the interest of the project owner as well."

The owner will benefit through reduced costs for construction delays, fewer addenda, enhanced code compliance and more accurate bids. Once the bridge is complete, repairs will be easier and inspections less troublesome.

As far as the built environment is concerned, BIM can predict the effect the structure will have on the surrounding area, including disruption from construction and the final appearance of a bridge in situ, both particularly important in densely-built urban zones.

COST OPTIMIZATION

We've seen how BIM can help stakeholders improve collaboration and prevent clashes, all of which contribute to greater cost efficiency. However, one of the objections sometimes heard regarding BIM is the software investment and the learning curve associated with it. Old habits are hard to change.

IS BIM WORTH THE TIME AND EFFORT?

"It's not a question whether BIM is actually worth it," Bittrich says. "The fact is, if a consultancy does not develop BIM capabilities, it will be out of business sooner or later. Non-BIM designs are more prone to defects and cost overruns."

While he says that it's hard to precisely calculate the savings garnered on a BIM project, he adds, "Without BIM, the design could be seriously flawed without anyone noticing it. When these issues come to light on the construction site, it's too late. The design must be changed, which costs time and money, important components may need to be remade and there can be other unpredictable expenses and delays.

"Maybe the structure can no longer be completed before the onset of winter. New codes may come into play at a certain point. The owner may run over budget and request further modifications to cut costs.

"This is how projects get out of control, creating multi-year delays and a price tag several times the initial estimate. BIM significantly reduces the risk that such things will happen. That's the real value of it."

BIM TOMORROW

Where will BIM go from here? Using it beyond the design phase and bringing it into play throughout the entire construction process is a work in progress.

"In the future, BIM will not just be limited to design and construction coordination," Bittrich says. "The digital models created in it will be used directly for manufacturing and construction. Bulldozers will be completely computer-controlled. Robots will weld and perform masonry work. BIM will also be applied to facilities management after construction."

BIM will become more powerful and will be mandated for important projects, as it is now in many other countries, he predicts.

"In 20 years, no one will be able to imagine how construction projects could have been done in our time without BIM."

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Allplan is a leading vendor of OpenBIM solutions for structural and civil engineers, building contractors, project managers, and BIM managers. Our software enables the integration of 3D into preexisting 2D workflows, and allows different disciplines and trades to collaborate in a streamlined, efficient workflow. A key subsidiary of the Nemetschek Group, Allplan solutions are used by over 240,000 engineers, contractors, and AEC professionals in 41 countries.

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