THE FUTURE OF BRIDGE DESIGN

A Bentley White Paper

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INTRODUCTION

Design, modeling, and analysis are keys to the success of today’s bridge projects. The next generation of bridge modeling software requires that it be purpose-built for bridge designers and contractors who need to create, construct, maintain, and document a wide variety of bridge information throughout the lifecycle of the asset. Sharing information in an information-rich 3D model increases data quality, collaboration, constructability, and operational aspects including asset management. Reduction in the project’s overall costs for the entire ecosystem are important for all stakeholders and the availability of intelligent 3D models are a key component in providing accelerated project delivery and information mobility.

The purpose of this paper is to provide an overview of how technology can provide cost savings with the ability to interoperate with all stakeholders during design, construction, and beyond on bridge projects of all sizes.

INFORMATION MODELING

In just a matter of a few years, the industry has shifted focus to what it means to provide an intelligent and data-rich 3D model that connects design, construction, inspection, operations, and maintenance. How much is too much information and to what is our goal? Can we shorten the construction schedule? Are we designing for construction and can we meet the expectations of the travelling public during construction with the proposed design? A true data model addresses these questions and progresses the integrity of our engineering profession. This is when vision meets reality when vision meets reality with the creation of an information-rich data model that can be used throughout the life of the bridge asset.

Build it better trends – Driven to Innovate

Engineers, detailers, and contractors are under increased pressure to find the solution that promotes better designs resulting in smarter and reliable construction methods. A disconnect between project and asset stakeholders is no longer acceptable in our industry and is driving the need for data interoperability throughout the lifecycle.

Still, imagery of pretty picture models doesn’t lead to reality when constructability is at stake. The days of bidding on infrastructure projects has evolved into the owner-operator setting higher expectations for minimizing allowances, omissions, and errors as added risks on the project.

This has led to a situation where the market demands greater and better methods for reducing construction costs (materials and time of construction) and minimizing the economic impacts. The MAP-21 compliance requirements, Every Day Counts (EDC) legislation, and the growing popularity of design-build and Public Private Partnerships (P3) has set the stage for bridge project delivery expectations.
These initiatives with design/construct/rehabilitate contracts are driving the owner demand for faster, more cost effective and constructible means of building our transportation assets.

**Traditional Bridge Design Process**

Unfortunately the bridge design and construction workflow is often a fragmented and linear process, with very little automation or exchange of data in a useful and integrated manner. The ability to reuse data across disciplines is challenging and it creates an environment prone to data re-input among multiple programs not to mention spreadsheets as a byproduct – resulting in the introduction of error-prone results.

These processes traditionally involve centralized automation (roadway does roadway, bridge does bridge, inspectors do inspection) and there is minimal exchange of critical project and engineering data among key disciplines.

Picture a common scenario of designing a facility over a facility and all of the conflicts and challenges this presents. The instantaneous access and ability to tweak pier placement as you evaluate existing conditions is critical in these situations and common in design-build projects. Typically, geometric information transferred from the roadway design team is a manual and repetitive data entry process – change management likely does not exist in a manner that is efficient. There is simply no time to waste when alignments require shifting to keep a project moving forward. With errors, re-dos, model translations, multiple spreadsheets, and shortened delivery timeframes communication lines often breakdown while working under deadline pressures. This causes data to be dropped and, in most cases, it is not reused.

In addition to the above challenges mentioned, the business case challenges are also immense. Dealing with the communication among teams and error-prone workflows, or just dealing with multiple software products from different vendors, can exasperate the disjointed design process. Lastly, but certainly one of the more important in our traditional project delivery, is plans production. Often, this is not an automated process or at least not one that is either efficient or automated in a manner to which we are accustom.
Advancements in the Bridge Design Process

There are tremendous advantages in connecting the project team members with a 3D approach and technology.

The benefits of having geometry that is relevant and the most current will tie the roadway and bridge engineers together from the onset of the project and throughout design revisions in a bi-directional manner. Not only are they working in a connected manner they are working geospatially for improved accuracy.

Bridges can be developed and modeled in a real world manner and referencing existing conditions becomes easy and meaningful. Models can become the immediate mechanism for design and analytics. Imagine the time and cost savings of easily developing an intelligent model in the preliminary stages of a project – and carrying this through to design and analysis without the time or expense of re-engineering. Most 3D modeling technology does not allow for a direct link to analytics without some re-entry of data; nor do these models contain the level of detail required for today’s projects.

The ability to link the physical model directly to the analytics would allow for alternate design options to be realized initially in the office as you are saving time and effort by previewing alternatives, constructability issues, and conflicts in the earliest development of the bridge. Much of the design is for construction of course, but at what point do we begin to insert intelligence into the design so that we can predict and plan for construction? When does the design take into account construction steps? Today, that is a post-design process, where the design is passed to a construction engineering team, who dissects the design and reassembles it into construction plans.

The question we should consider is, when does the modeler and engineer assume the responsibility of constructability and designing to build? A small tweak of geometry can determine where a skewed pier can impact potential field issues and can be tackled in the beginning of the project. With the massive amount of intelligence available between disciplines, it is only logical to collaborate and leverage it in a seamless workflow. We are here today with the industry solution and the tools available to make intelligent bridge design and analysis a reality. We need to take advantage of these tools and speed construction with little effort on the front end. Small steps will ensure big efficiency and accuracy as we advance through the information flow. We do it in manufacturing, we do it in civil construction. It is part of the evolution we must set as achievable goals to meet the industry demands for bridges.

From design/analytics, we can move to construction modeling – where is the crane location, can I maintain traffic? How am I going to build it?

An efficient bridge design process allows you to directly connect and reference existing and proposed conditions, as well as civil data to perform constructability analysis – key to maintenance of traffic – facility over facility. By allowing you to visualize, render, perform clash detection, generate quantities, and evaluate clearances with the information-rich model, you can be assured of reliable construction methods from the onset.
OpenBridge Modeler is purpose-built for bridge designers and contractors who need to create, visualize, analyze, construct, maintain, and document a wide variety of bridge information throughout the lifecycle of the asset.

**Bridge Modeling for Constructability and Beyond**

Bridge modeling technology should provide engineers with the ability to create a workflow that promotes true information modeling and mobility. There needs to be an interoperability component that allows all project disciplines to evaluate and share critical data from the planning/bidding phases all the way through to commissioning, operations, and maintenance. The true value of a model doesn’t solely reside in its aesthetic appeal, but also in the usability and life of the data associated with it.

Bentley’s OpenBridge Modeler addresses the challenges we face with complex geometry needs, parametric updating of changes, and evaluating constructability early in the process, including conflicts not seen in a 2D workflow. This enables us to easily work on a bridge project, share engineering-rich data, and make more informed decisions within a 3D model of the bridge project. OpenBridge Modeler is your key to today’s design-build projects, P3, and accelerated bridge construction.

The advantage of all disciplines (roadway, utilities, bridges, existing conditions, and so on) operating in a single modeling environment with no re-creation of critical project data is vital in meeting the challenges of the 3D deliverable by industry standards. OpenBridge Modeler provides a workflow specific to the needs of the bridge engineering software that model bridges not buildings, yet facilitates collaboration and integration with other disciplines, such as civil engineers, utilities, and others to ensure everyone has the data they need when they need it.

3D bridge models provide the ability to reference related designs that connect or affect the project. Subsurface utilities, rebar detailing, bridge element placement, and traffic maintenance are all key construction issues that, in an integrated and interoperable workflow, can be detected and resolved upfront in the office rather than in the field. This ability enables you to meet the owner’s expectations for minimizing omissions and errors.
Summary

With a focus on operational excellence, sustainability and the economic impacts of a bridge not being available, it has never been more important to evaluate our processes. Bridge design and construction processes are evolving and 3D deliverables are imminent.

Interoperability and collaboration are keys to the success of bridge projects of all sizes and construction methods. Leveraging complex geometry from the beginning to generate physical bridge models and preparing the design and analytical requirements is essential to moving to a more fluid and seamless reality modeling workflow. With intelligent as-designed models and as-built data, engineers can provide operations and maintenance value for the entire life of the asset.