BIM: THE RIGHT TOOL FOR LARGE INFRASTRUCTURE PROJECTS

Collaborative Environment Provides Benefits for Complex Builds

The scale and timeline of large infrastructure projects set them apart from other builds. The scope of these massive projects often requires multiple teams collaborating on design and construction, often with different software tailored to each specialty. The building cycle of large-scale infrastructure projects is also longer, necessitating many updates to the original design as the project evolves—sometimes over the span of several years.

Coordinating these extensive projects can be a challenge. Changes to any part of the project require that new drawings be made and distributed to each of the project's stakeholders, of which there are often many, regardless of the scope and scale of the modifications. On a lengthy project, that process can be repeated multiple times. These iterations are expensive and time-consuming, with little room for error.

Building Information Modeling (BIM) is helping resolve these challenges by facilitating a collaborative environment for end-to-end project design and management of large-scale infrastructure projects.

THE BENEFITS OF BIM

While BIM is known for its precise 3D modeling capability, it has other benefits beyond being an enhanced drawing and design tool.

First, BIM offers a **common data environment, or CDE.** This enables all engineers to work from the same model, always using the most recent, up-to-date version of the design. Projects with a long lifecycle generate a great deal of documentation that must be managed. This rigorous and expensive task can be automated with a CDE. By ensuring that all team members and outside contractors are sharing

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a single source of truth, the model, reports, and schedules generated by BIM are always current, accurate, and consistent for all team members, no matter their role.

Secondly, BIM offers **easy data exchange.** An OpenBIM program such as Allplan Engineering works from an open API that easily allows the import of files or seamless import of data generated by other software programs. Since elements in different file formats can be read and integrated into a cohesive package, the need for stakeholders to use the same software to effectively collaborate is eliminated. Each stakeholder can use their preferred program for creating design and build elements, confident their work will be accurately integrated into the complete package.

Finally, **clash detection and change management** are challenging for projects with multiple teams. If a change is made in one part of the project, will it interfere with elements in another part of the design? Clashes are common with traditional modeling methods. In addition, it is difficult to know if the design at hand is current. Such situations make version control and change management costly, time-consuming, and fraught with potential for significant error. With BIM, however, structural integrity is constantly monitored by the software, and the most updated design

The Gotthard Base Tunnel is comprised of two double-walled concrete tubes, which are connected every two-tenths of a mile along its entire legnth. The use of Allplan Engineering helped optimize two sections of the tunnel, resulting in a concrete savings of 3 million cubic ft and a cost savings of $19 million.

and reports are automatically made available to everyone on the team, no matter their role.

But while the concept of applying BIM would seem to bear few challenges, how does it hold up in the field? The following discussion of how Allplan Engineering functions on site seeks to answer that question.

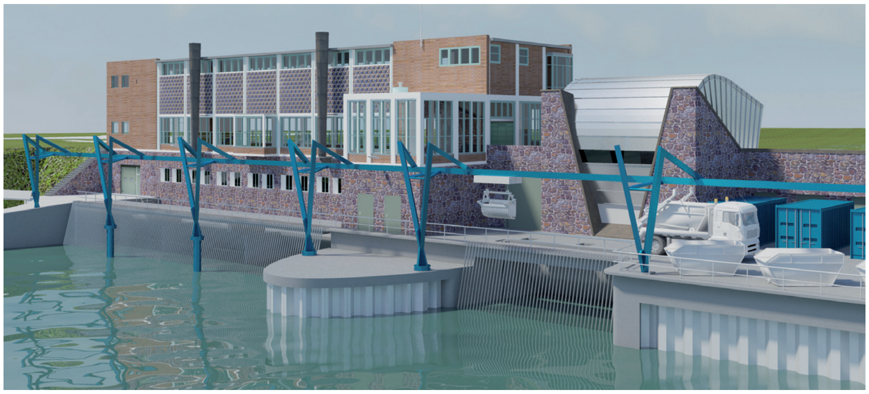
PROJECT OF THE CENTURY

The Gotthard Base Tunnel, running deep under the Swiss Alps, is a marvel of infrastructure technology. It is the longest railway tunnel in the world, at just over 35 miles in length. About 2,600 people dedicated 500 total man-years of work to complete the tunnel project during a span of 17 years. In order to reach completion in that timeframe, about 14 miles of tunneling was laid for each of its two tubes every 10 months.

The tubes are connected every two-tenths of a mile along its entire length. The entire tunnel and cross-passages are double-walled, which required an enormous volume of concrete. However, thanks to the optimization afforded by Allplan Engineering in two of the five sections of the tunnel, Erstfeld and Amsteg, more than 3 million cubic ft of concrete was saved. This translated into more than $19 million cost savings at today's exchange rate.

Because of the project's complexity and scope, construction teams often worked simultaneously on different sections of the tunnel. This necessitated a high level of precision and coordination in the data delivered to the various stakeholders. And, to make matters more complicated, the engineering teams didn't use BIM software for the entire project. Indeed, Allplan Engineering wasn't implemented until they were nearing the end of the work in Amsteg and beginning the execution planning in Erstfeld. The volume of documentation that then needed to be imported into the BIM tool was quite immense, but even so, the project managers were pleased with their ability to deliver accurate layouts that could then be further edited without any problems.

With more than 1,000 layouts required for both sections of the tunnel base, there was a huge volume of data to be synthesized. In addition, many different software programs



Engineers working to expand a uniquely shaped pumping station in the Netherlands used existing 2D plans to develop a 3D model. This new model served as a basis for reinforcement planning, which is a difficult task to complete in 2D.

(PHOTO COURTESY OF PUMPING STATION KATWIJK, NETHERLANDS, CONSULTING ENGINEERS TAUW, NETHERLANDS)

of varying versions were used by different contributors, so the ability to assimilate them all was essential to effective data exchange. One of the team members emphasized the importance of this seamless data exchange, citing Allplan Engineering as the reason they experienced no problems with data integrity during collaboration.

The tunnel opened in late 2016 and has since served to decrease travel time for rail passengers; shift roadway truck traffic to freight train transport, thereby benefitting the environment; and reduce traffic accidents.

SLIM AND STRONG

In central Germany, there runs the streamlined and surprisingly delicate-looking Grubental Railway Bridge. With its semi-integral design, this nearly-seamless structure was the first rail bridge of its kind in the area. More than 700 ft long and soaring 115 ft into the sky, the bridge is supported by piers that, upon first glance, do not look capable of bearing the weight of trains traveling upwards of 180 miles per hour—and yet they do.

The monolithic construction method that enabled this streamlined appearance required engineering vision and creativity, but a significant challenge lay in the terrain surrounding the bridge's location. The narrow valley it spans is bordered by steep slopes that drop at an angle of 50 degrees. Allplan Engineering was able to create a digital terrain model of the area, which was then incorporated into the larger plan model to ensure there were no design collisions with the bridge foundations, which had also been modeled as 3D elements in the program.

In addition, information sharing was facilitated by the software's data exchange format capabilities, importing files in various formats from suppliers, storing drawings by type, and seamlessly transferring plans among the various contributors.

While the resulting structure appears effortlessly slim, creating minimal obstruction to the area's picturesque views, the software was working hard behind the scenes to make it possible. A design engineer at the firm that designed the bridge commented that the CAD features didn't take center stage, but rather the ability to manage routine work in an efficient and safe manner. Fortunately, Allplan Engineering successfully handled both tasks, with a result that is both elegant and structurally sound.

UNUSUAL GEOMETRY

Built in 1954, a Netherlands pumping station on the coast of the North Sea in Katwijk needed an upgrade. The local water and soil association contracted with Consulting Engineers Tauw to ensure that the plant was capable of meeting future anticipated needs. The planned expansion would nearly double the output of the facility by upgrading the three existing pumps and adding a fourth.

Perhaps the most significant challenge of this expansion, one that would be near-impossible to manage with standard 2D drawing methods, was that the facility was designed using several complex shapes. There were trapezoidal exterior walls, a cylinder-shaped pump trough, and elliptical platforms. With no 3D data available due

The unique shape of the pumping station in Katwijk, the Netherlands, made expansion a challenge. By converting 2D drawings to 3D, engineers minimized the potential for design conflicts due to the building's unusual form.

(PHOTO COURTESY OF PUMPING STATION KATWIJK, NETHERLANDS, CONSULTING ENGINEERS TAUW, NETHERLANDS)

to the facility's age, there was great potential for clashes given these unusual forms. The answer? Convert the 2D drawings to 3D.

First, existing data was imported from 2D plans and used to generate solid 3D shapes. Once the 3D model was created, it served as a basis for general arrangement and reinforcement planning. Multiple Tauw engineers then generated new ground plans, views, and sections using the model, all done simultaneously without the worry of introducing design conflicts. The software immediately detected and reported any clashes, and modifications were made to the working design and instantly synced up and made available to everyone working on the project.

A crucial benefit of using 3D is that it enables reinforcement planning. While this is typically a difficult task in 2D, Allplan Engineering worked so well for reinforcing the simple structural shapes that it was quickly extended for use on the more complicated ones, such as circular forms.

Of course, a major consideration was cost, which had already been determined and set in the tender. Throughout the process, required quantities of concrete were automatically recalculated and compared to the initial budget to ensure there were no cost overruns.

According to one Tauw employee, Allplan was responsible for the high quality deliverables on this project, achieved with significantly fewer errors.

INTELLIGENT INFRASTRUCTURE

Since megaprojects are often essential to meeting critical needs for transportation and utilities, their design and execution must ensure long-term viability and safety. With intelligent design capabilities that allow constantly up-to-date information sharing among engineers, contractors, and the clients they serve, regardless of the original software used, the benefits of using BIM are many: better construction, greater efficiency, reduced waste, lower cost, improved and enhanced record-keeping and reporting, and less environmental impact.

These benefits would not be possible without sophisticated BIM solutions like Allplan Engineering. As the AEC industry continues to move forward and technology innovates beyond the current landscape, 3D will become the go-to method, particularly in complex building projects. Ask an Allplan customer, and they'll tell you, "Allplan is the best tool for 3D planning."

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