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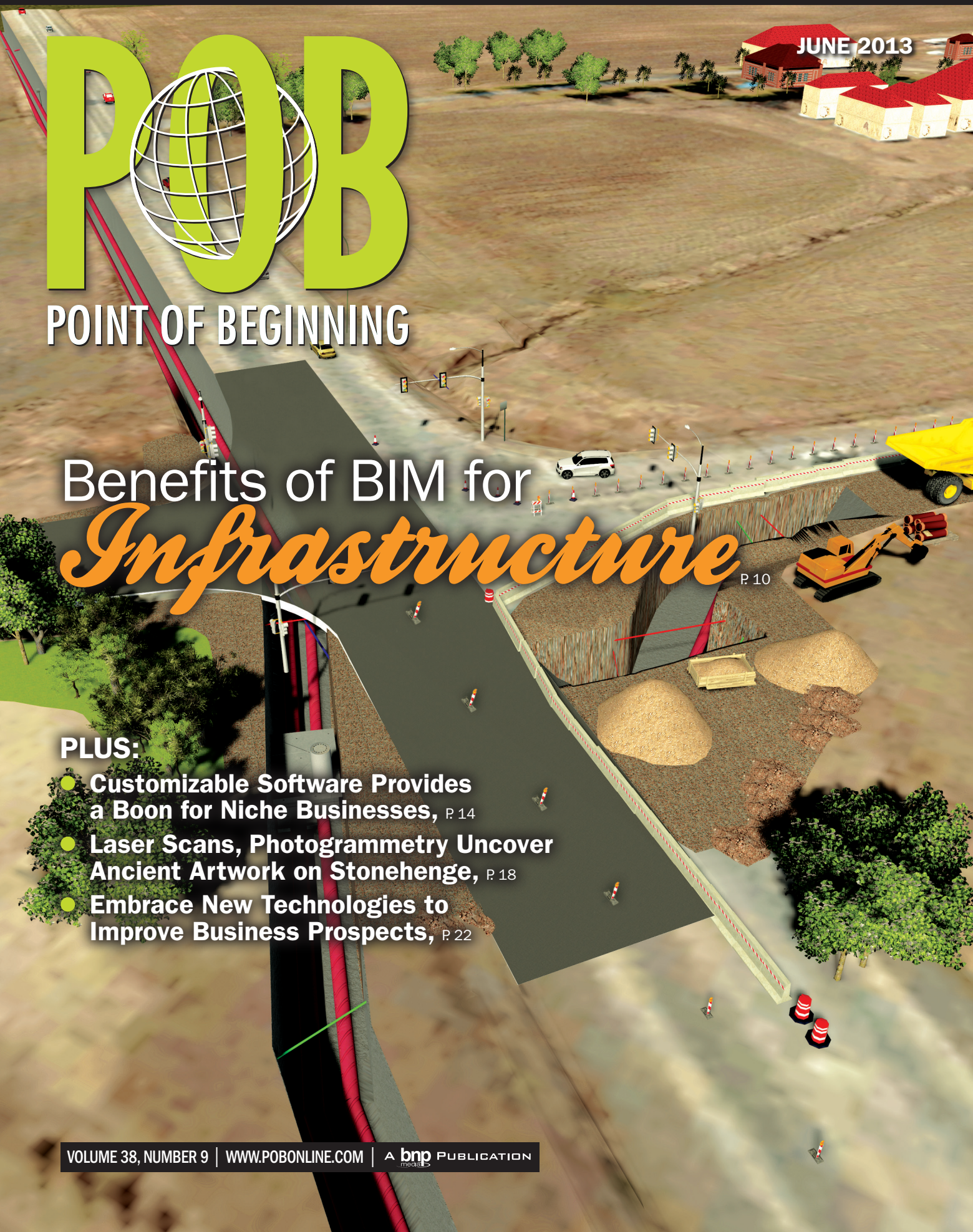

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A Winning Alternative

TO TRADITIONAL CIVIL INFRASTRUCTURE DESIGN

An increasing demand for 3D modeling and building information modeling (BIM) workflows is fueling interest in design-time visualization that improves infrastructure project outcomes.

By Jeff Lyons and Karen Weiss, PE

Glossy, colorful design visualizations are almost compulsory in the building industry these days. For many years, building professionals have used 3D project models and visualizations (usually in the form of photo-realistic renderings and animations) to explore architectural forms, to communicate designs to clients and the public, and to market buildings before groundbreaking. Pick any sizeable building under construction, search for online images of that project, and you will undoubtedly find computer-generated renderings of the building. If it's a high-profile project, your screen will be overwhelmed by search results.

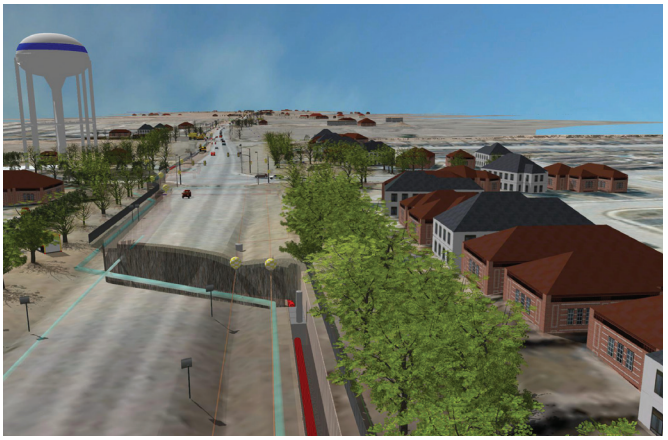
Unfortunately, this widespread use of visualization does not extend to civil infrastructure projects. In some cases, firms working on very large, expensive or contentious infrastructure projects produce still images or cinematic-quality animations of a project, primarily to support public outreach efforts. However, most engineering firms continue to rely on 2D plan and profile drawings to communicate design alternatives and concepts.

But that's changing. As more civil engineers embrace 3D modeling techniques and adopt building information modeling (BIM) workflows, the use of design-time visualization to improve infrastructure project outcomes is growing. Increasingly, engineering firms are using visual communication tools to not only convey their infrastructure designs—helping clients, municipal agencies, and public stakeholders better understand the design and the impact of that design on the surrounding environment—but also to inform decision-making during the design process.

Cole Engineering Group is at the forefront of this transformation. Based in Ontario, Canada, Cole is a multidisciplinary consulting engineering firm serving clients in the public and private sectors. Since 2009, the firm has been using Autodesk AutoCAD Civil 3D—civil engineering software that supports building information modeling (BIM) workflows—to generate proposals and detailed designs for its land development, transportation, water resources and municipal infrastructure projects. Last summer, the firm also began using Autodesk InfraWorks software (formerly Autodesk Infrastructure Modeler) to develop pre-engineering design proposals and to support 3D project visualization throughout the design process.

"When it comes to design communication, there's no question that 3D project visualizations are far superior to 2D drawings," says Alan Winter, general manager for the firm's Greater Toronto Area West (GTA West) office. "They help clients and other project stakeholders quickly grasp the entire scope of a complex design, regardless of their engineering background."

A high-accuracy mobile LiDAR point cloud of a project intersection. Mobile LiDAR data collection and mapping were performed by Tulloch Mapping Solutions based in Ottawa, Ontario.



Above: A visualization of an open cut trench for the proposed feeder main (red pipe) crossing a four-lane urban roadway and an existing water main (blue pipe). Right: A visualization of the feeder main in a steel casing (red) jack-and-bore auger technique used at railway crossing.

It's only logical that 3D models and visualizations are better at conveying designs that are, after all, 3D in nature. But in the past, producing visualizations of infrastructure projects—particularly those that portrayed the design in the context of the surrounding environment—were very expensive and time consuming to create. Nowadays, Cole Engineering uses InfraWorks software to quickly consolidate different data files representing existing conditions, such as 2D CAD, GIS, raster and 3D models, into a single model. With the existing conditions model in place, designers then sketch early-stage designs directly in that modeling environment or import detailed design information from Civil 3D to easily create project visualizations and simulations.

The firm's first InfraWorks project is a CA$150-million water distribution project for a southern Ontario regional municipality. The project involves the design and construction of approximately 25 miles of pipeline that spans two towns: a large urban municipality and an adjacent rural town. The new water mains (ranging in size from large 4-foot-diameter subtransmission mains and 3-foot-diameter feeder mains to smaller 0.5-, 1- and 1.5-inch distribution mains) are being installed to meet water demands for future development in the area by connecting several water storage facilities.

Most of the water mains will be constructed in open trenches alongside existing roads. In some cases, the pipes will run underneath highways, intersections, railway beds and creeks, which will require jack and bore tunnel construction techniques. Cole Engineering was awarded the contract for design and contract administration of the project in October.

During the proposal stage, Cole Engineering used a combination of InfraWorks and Civil 3D to win the contract. Using InfraWorks, the firm compiled a variety of publically available datasets to create a model of the existing project area. These datasets included a digital elevation model (DEM) of the existing terrain from airborne LiDAR; aerial orthophoto images; GIS information that contained property, right-of-way and utility data; and digitized features such as trees, poles, lights, building pads, railway lines and roads. The firm also added other existing features that would influence the design (such as water towers and bridges) to complete the model of the surrounding environment.

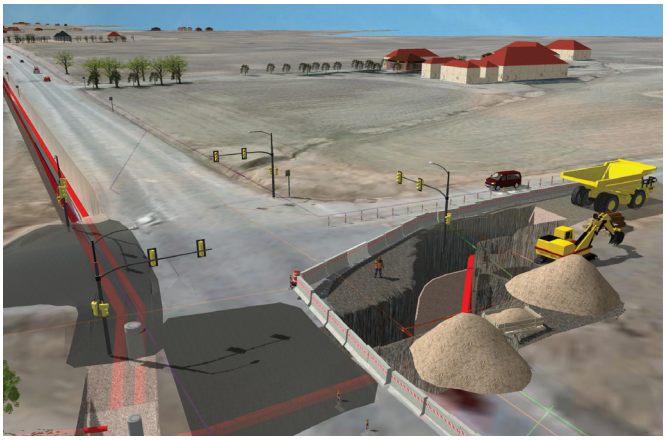
Next, the team imported its Civil 3D concept-level design proposal for the water mains, trenches, shafts and tunnels. The IMX file format was used to transfer data between Civil 3D and InfraWorks. The InfraWorks software maintained a link to the IMX file, which contained all relevant Civil 3D design information and could be easily refreshed to reflect any significant changes in the Civil 3D model.

When the concept-level design was complete, Cole Engineering created a series of high-level concept images and animation sequences of its virtual design model that were included in its proposal to the client. "Our InfraWorks model was developed over just a two-week period, using publicly available GIS data and the conceptual engineering design datasets," says Winter. "After we got the contract, the only concern the client had was that our use of the InfraWorks project visualizations set the bar too high for other firms bidding on future projects."

Once the contract was awarded, Cole Engineering was immediately thrown a curveball. The firm knew that there would be four different construction contracts and four matching detailed design phases. "But during our first post-award meeting, the client handed us a massive schedule change," says Winter. "They chopped a year off the schedule for the first design segment, leaving us just seven months to complete the first construction contract." The regional municipality had an urgent need to supplement its existing water supply: The "future" developments were well underway, with some homes already built, sold and anxiously awaiting water hookups.

In addition to the time crunch, the accelerated project schedule produced another design challenge. The regional municipality had no time to acquire extra property beyond its own right-of-way. As a result, all the new mains had to fit into existing municipal properties and compete for space against existing buried utilities.

The team got right to work, using Civil 3D and InfraWorks. Cole Engineering commissioned Tulloch Mapping Solutions of Ottawa, Ontario, to conduct a high-definition mobile LiDAR survey, replacing the airborne DEM used during the proposal phase with a very precise DEM. The survey data even included documented survey codes that, when imported into Civil 3D and InfraWorks, enabled the software to automatically generate the appropriate 3D model objects (tree, telephone pole, hydrant, etc.). "The new



Left: A visualization of construction staging and traffic control for an open cut road crossing at an intersection. Right: A visualization of the impact of trenching and pipe construction on local residents.

schedule didn't allow us time to perform a conventional ground survey," says Winter. "This mobile LiDAR gave us the same information with the same quality and same accuracy, but much faster."

Cole Engineering used Civil 3D software to model the detailed design, including alignments, profiles and sections for the pipes and trenches. "We were able to layer in all the different databases, so we knew exactly where the utilities were, where the property lines were, and therefore, where we should dig our trenches," says Winter. "We could even identify which trees on private property might be impacted by the digging."

To visualize the detailed design in the context of the surrounding environment, Cole Engineering imported its Civil 3D model to InfraWorks and created new still images and animated videos of the detailed design. InfraWorks was also used to visualize construction and simulate construction staging areas to understand space requirements and determine the impact on road and pedestrian traffic and hazardous intersection and railway crossings.

"Seeing our design against the municipal backdrop simplified, and therefore expedited, our design investigations and helped us shorten the delivery of our design," says Winter. "We were able to quickly identify and resolve design issues in this virtual environment–identifying potential utility conflicts, right-of-way concerns and constructability issues." In addition, Cole Engineering's images and animations helped the client better understand the design and assess its impact on neighboring businesses and homes.

Some of the videos merge InfraWorks animations with real aerial and ground footage, and include narration that explains the project, the construction techniques in use, and the mitigation and restoration measures in place. As the project progresses, these videos will be used to communicate the design to the public to help inform affected property owners about the work that will be happening outside their door and allay concerns about the project.

Mobile LiDAR technology provided fast, accurate mapping.

The design of the first phase of the project is complete, and the bidding process for construction is underway. Cole Engineering successfully met the project schedule of this first phase and is working on the remaining three phases of its design. The firm continues to use both Civil 3D and InfraWorks to develop and visualize the project, helping the team better understand how their designs will perform in the existing environment and more effectively communicate those designs to the client.

"We pride ourselves on being proactive versus reactive when it comes to design issues," says Winter. "By using InfraWorks to visualize our design as it progresses, we can quickly and easily identify and resolve problems, and present proposed solutions to the client. We can show them exactly what the problem is and how to solve it–expediting the entire decision-making process. When time is of the essence, InfraWorks provides invaluable tools."

Jeff Lyons is the business unit leader of the AEC Solutions Group at Cole Engineering (www.coleengineering.ca) and has more than 17 years of experience in the land development industry. He specializes in design process and computer-aided modeling for municipal infrastructure and land development projects. Karen Weiss, PE, is the senior industry marketing manager for infrastructure for Autodesk. She worked 19 years in the transportation industry, holding engineering positions in the public and private sectors. For the last four years, she has focused on developing marketing programs for infrastructure infrastructure, land and water. For more information about Autodesk InfraWorks, visit www.autodesk.com/infraworks.

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