A winning alternative to traditional civil infrastructure design

By Jeff Lyons and Karen Weiss, PE

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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 to explore architectural forms, to communicate designs to clients and the public, and to market buildings before groundbreaking.

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 for better understanding of intent and impact, but also to inform decision-making during the design process.

Cole Engineering Group is at the forefront of this transformation. Last summer, the firm also began using software to develop pre-engineering design proposals and to support 3D project visualization throughout the design process.

COLE ENGINEERING

ABOUT COLE ENGINEERING GROUP

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 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.

When it comes to design communication, there's no question that 3D project visualizations are far superior to 2D drawings. They help clients and other project stakeholders quickly grasp the entire scope of a complex design, regardless of their engineering background.

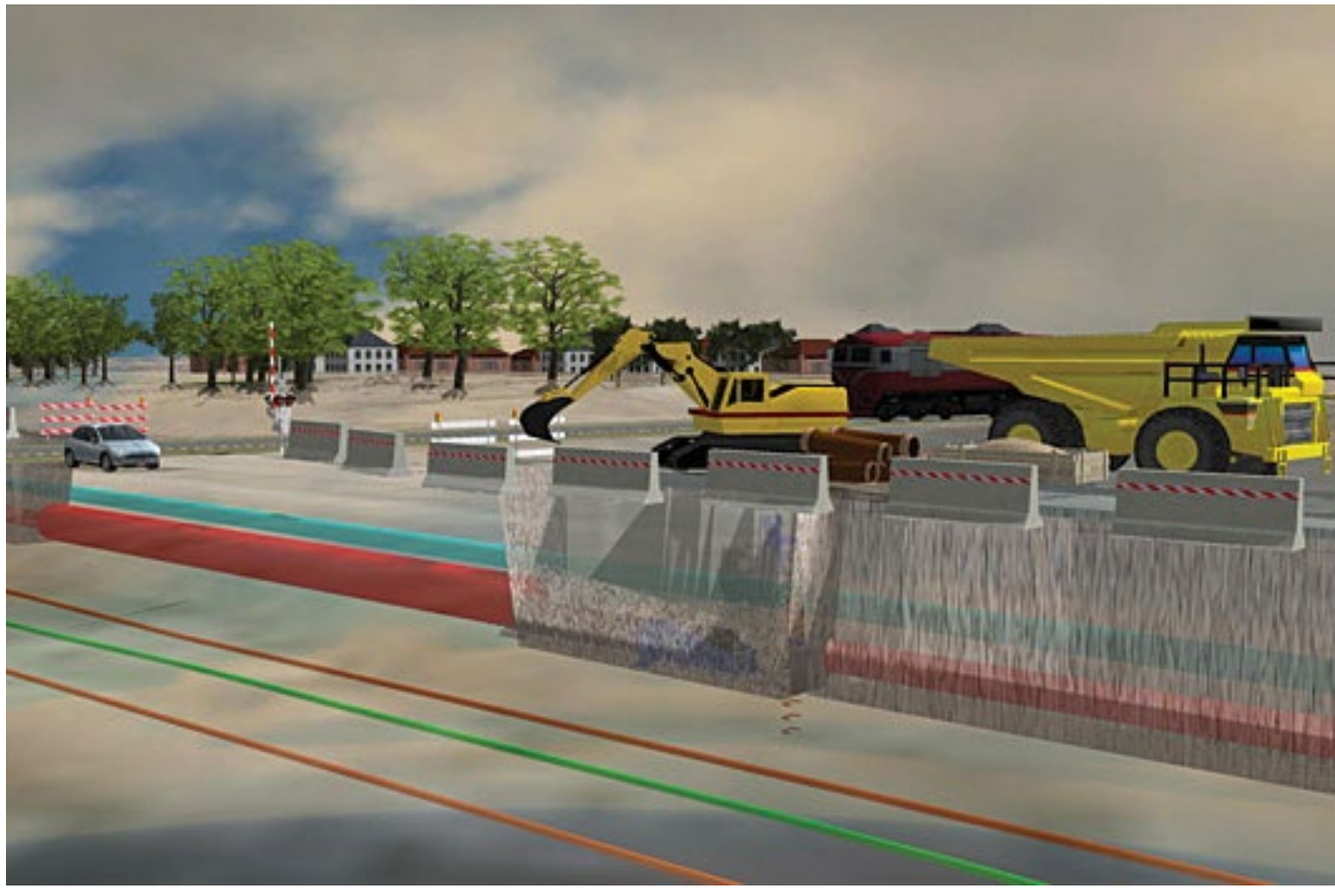
Alan Winter
General Manager
Greater Toronto Area West Office

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 quickly consolidates 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 C$150-million water distribution project for a southern Ontario regional municipality 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 pipelines 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. During the proposal stage, Cole Engineering compiled a variety of publicly 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; 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 4 surrounding environments.

Next, the team imported its concept-level design proposal using the IMX file format for the water mains, trenches, shafts and tunnels. All relevant design information and could be easily refreshed to reflect any significant changes.

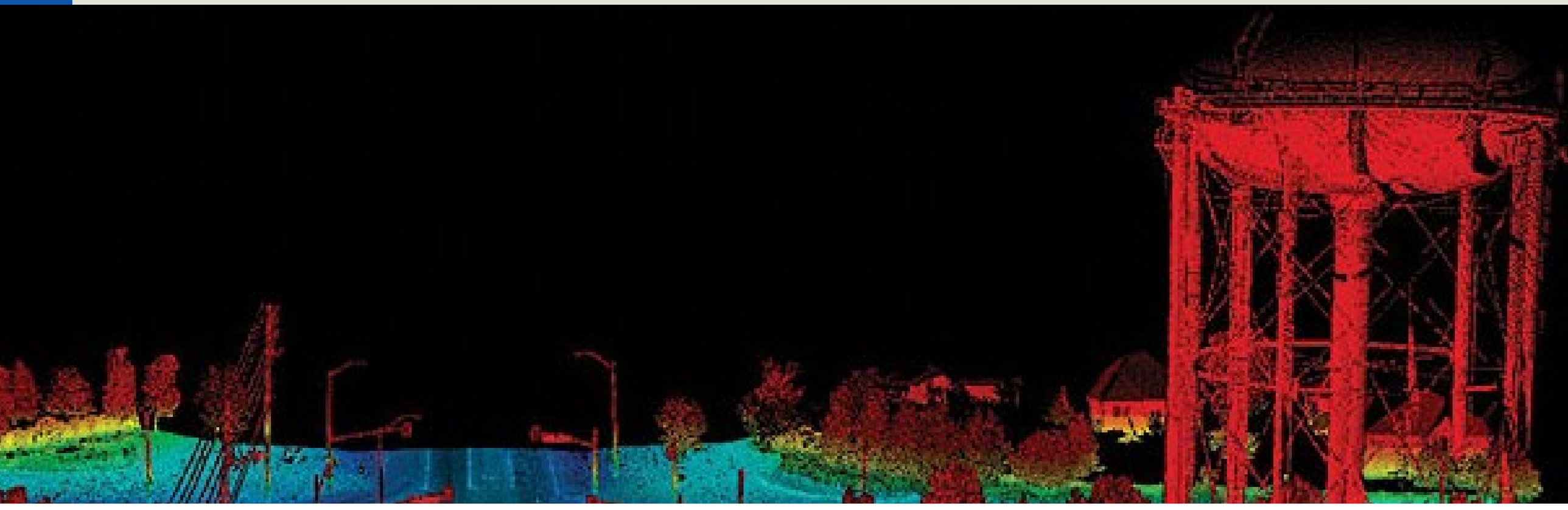


When the concept-level design was complete, Cole Engineering created a series of high-level concept images and animation sequences of its virtual design model that were included in its proposal to the client. “Our model was developed over just a two-week period, using publicly available GIS data and the conceptual engineering design datasets,” says Winter.

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. “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. Cole Engineering commissioned Tulloch Mapping Solutions of Ottawa, Ontario, to conduct a high-definition mobile LiDAR survey. The survey data even included documented survey codes that, when imported, enabled Cole Engineering to automatically generate the appropriate 3D model objects (tree, telephone pole, hydrant, etc.)



Cole Engineering used 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 had a better understanding of 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 more accurately in the context of the surrounding environment, Cole Engineering created new still images and animated videos of the detailed design. Software also allowed Cole Engineering to visualize and simulate construction staging areas to better understand space requirements and to help determine the impact on road and pedestrian traffic and hazardous intersection and railway crossings.

“Seeing our design against the municipal backdrop helped simplify, and therefore expedite, our design investigations, helping us shorten the delivery of our design,” says Winter. “We were able to more quickly identify and resolve design issues in this virtual environment—more effectively 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 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 help 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."

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.

By visualizing the design as it progresses, civil engineering firms are finding they can more quickly and easily identify and resolve problems, and present proposed solutions to the client. They can more clearly show clients what the problem is and how to solve it—helping to expedite the entire decision-making process

About the authors

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 at 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 the transportation, land and water segments.