

RESEARCH SPOTLIGHT

Project Information

REPORT NAME: 3-D Highway Design Model Cost-Benefit Analysis

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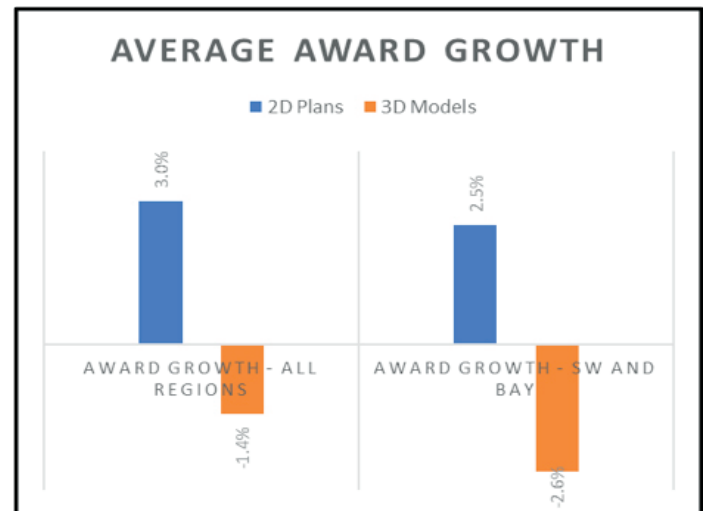
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3-D models in MDOT highway projects save time and money, improve process

MDOT recognizes the value of using 3-D models in construction projects, and since 2012 has enabled their use as Reference Information Documents (RID) in collaboration with contractors. However, the traditional paper plans remain the official contract documents. In this project, MDOT sought to learn the extent of contractors' use of 3-D models, obtain a cost-benefit analysis and assess other aspects relevant to making 3-D models contractual for the agency.

PROBLEM

The use of digital 3-D models for construction has become the preferred method for communicating design intent across the transportation industry. A product of computer-aided design (CAD) technology, 3-D models offer precise and easily modified design products using global positioning systems (GPS), photogrammetry, LiDAR and other digital technologies. MDOT has been a leader in the deployment of 3-D models through its participation in the Federal Highway Administration's Every Day Counts initiative, which [promotes the use of 3-D models](#). Despite this successful



An analysis of 261 MDOT construction projects between 2012 and 2016 showed that the final contract cost for projects using 3-D models averaged up to 2.6 percent below the project award. Projects using 2-D plans averaged as high as 3 percent above the project award. Use of 3-D models was estimated to have saved MDOT \$32.5 million.

use of 3-D models as RID, however, MDOT's contracts still specify 2-D paper plans as the official contractual documents.

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“The initial benefits of providing 3-D models are more accurate bids and fewer change orders. Leveraging 3-D models also enhances designer confidence, conveys design intent, and enables multi-disciplinary collaboration, public outreach and risk management throughout the entire program.”

John Wilkerson, P.E.
Project Manager

To make the transition to 3-D models as the agency’s contractual “communication of intent” of a design, MDOT needed to assess what the change would require and what the benefits would be. MDOT sought to learn how and to what extent contractors have been using 3-D models in highway construction. MDOT also wanted a statistical analysis of historical data to show the quantifiable benefits of 3-D models as RID on contractor bids and change orders. Further, researchers were asked to assess contractor and agency risks, identify ways to improve processes, and develop a return-on-investment framework.

RESEARCH

Researchers consulted contractors, designers and MDOT construction staff through surveys and interviews. Questions addressed the use of 3-D RID models, 3-D model data and file formats, general suggestions and considerations for making 3-D models contractual, and perceived financial impacts.

Benefits of using 3-D models, such as increased productivity and quality and fewer change orders, are recognized, but MDOT needed to know if there were

quantifiable cost savings. Researchers conducted a statistical analysis of cost data from 261 highway projects delivered with and without 3-D models between 2012 and 2016. Researchers examined data considering the following questions:

- Does use of 3-D models as RID result in lower bid prices compared with 2-D models?
- How do accuracy of 2-D and 3-D project estimates compare?
- Does the use of 3-D models result in a significant financial benefit for MDOT?

Researchers investigated the steps MDOT would take to make 3-D models contractual documents, including education, outreach and training, and multidisciplinary collaboration. This included development of a framework for internal collaboration and contractual 3-D models.

RESULTS

Researchers learned from the surveys and interviews that many contractors use 3-D models to prepare their bids, verify the quality of plans and enable the use of automated systems for construction operations. Contractors have been satisfied with the quality of MDOT’s 3-D models as RID.

Researchers analyzed 261 construction projects from 2012 to 2016 with and without 3-D models. Results showed that projects valued from \$5 million to \$20 million benefited most from using 3-D models. Projects employing 3-D models in all categories regardless of size generated contractor bids that were lower than MDOT’s engineer’s estimates and resulted in fewer change orders. Researchers noted that this saved MDOT more than \$32.2 million during the five-year period.

Researchers found that making 3-D models contractual generated several concerns, such as the need for meticulous tracking of changes made to the document. The level of development (LOD) specified for the 3-D model would also drive which elements could become contractual. Researchers addressed these concerns and

developed a framework for contractual 3-D model requirements that includes consideration of LOD, data management guidelines, and a sample special provision for MDOT to use in projects requiring 3-D models. Researchers also plan to develop a workshop for MDOT addressing training and an action plan for implementation of recommendations.

VALUE

Research results provide quantitative evidence that 3-D models generate more accurate contract bids and save money in construction projects of every size. By taking the steps described – training, outreach, multidisciplinary collaboration and careful contract development – MDOT could make 3-D models the official “communication of intent” for construction contracts.

Research Administration

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