

Feasibility of Visualization and Simulation Applications

tech transfer summary

Few transportation projects have utilized advanced simulation techniques; and static image composites remain the most common visualization technique in spite of recent advancements in design software.

RESEARCH PROJECT TITLE

Feasibility of Visualization and Simulation Applications to Improve Work Zone Safety and Mobility

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SPONSORS

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The mission of the Center for Transportation Research and Education (CTRE) at Iowa State University is to develop and implement innovative methods, materials, and technologies for improving transportation efficiency, safety, and reliability while improving the learning environment of students, faculty, and staff in transportation-related fields.

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Objective

The goal of this feasibility study was to examine the use of visualization and simulation applications for use in improving highway planning, design, construction, and safety and mobility.

Problem Statement

Use of visualization improves understanding of design intent and project concepts and facilitates effective decision making. However, visualization tools are typically used for presentation only in large-scale urban projects. Visualization is not widely accepted due to a lack of demonstrated engineering benefits for typical agency projects, such as small- and medium-sized projects, rural projects, and projects where external stakeholder communication is not a major issue. Furthermore, there is a perceived high cost of investment of both financial and human capital in adopting visualization tools. The most advanced visualization technique of virtual reality has only been used in academic research settings, and 4D computer-aided design (CAD) has been used on a very limited basis for highly complicated specialty projects. However, there are a number of less intensive visualization methods available which may provide some benefit to many agency projects.



The location of the new 24th Street Bridge

Methodology

For this feasibility study, the research team investigated current technologies, collected suggestions from academic and industry focus groups, conducted an industry survey, and developed a simulation prototype. The 24th Street Bridge Renovation Project in Council Bluffs, Iowa was selected to be the sample study project.

The research team studied the wide range of current visualization techniques emphasizing 4D CAD. To simulate a 4D-like system, working with a 3D environment application along with short programming codes is a viable alternative. This approach is able to create visualization and simulation without coding from scratch.

After a review of all possible programs to use, the research team selected a combination of Google SketchUp and Google Earth. End users can use free, downloadable software to view simulations created with these programs. In addition, end users can rotate, zoom, and pan to the specific work zone areas of interest. The development software cost is free compared to other software.

Prior to developing the simulations, the research team convened a nine-person focus group of knowledgeable industry leaders from academia, the Iowa DOT (Department of Transportation), the Federal Highway Administration (FHWA), and traffic control contractors. Using the issues identified in the focus group, a 40-item survey was created to gather opinions from a broad range of transportation organizations.

From the software feasibility review, the focus group input, and survey responses from the industry, the research team developed a traffic highway visualization and simulation by using a combination of Google SketchUp and Google Earth software.

Key Findings

Survey results indicated that responders' opinions are neutral toward the work zone simulation initiative. The simulation's potential benefits are not noticeable over the current work zone system. However, analyzed t-test survey results showed that people from government agencies favor simulation benefits more than non-government people. At the same time, people with less than 20 years experience in highway construction favor simulation benefits more than those who have more experience in construction. In general, those respondents who had less experience and more knowledge of CAD and geographic information systems (GIS) held different perceptions of the benefits of visualization than those with more experience and less familiarity with CAD and GIS technologies. In short, there may be a generational effect in perception of the value of visualizations.

The simulation also shows that it is feasible to use relatively simple programs as tools for public communication and 4D visualization of traffic work zones at different construction phases. From the meetings with focus groups and Council Bluffs engineers and contractors, the researchers found people prefer 3D simulation over the typical 2D drawings for communication purposes. For the planning phase it can be useful to communicate between stakeholders showing how the current and future traffic work zone looks without causing other interference and construction conflicts. The ease of use and the availability to everyone are major keys to developing the system further.



Rendered image of proposed 24th Street Bridge

Implementation Recommendations

Future research should examine how the simulation can be improved in the level of detail. The approach can be altered depending on the visualization and simulation purposes. Some recommendations are as follows:

- 3D model details—The visualization can be improved by increasing the accuracy or dimensional scale of the models themselves. However, development cost will likely be increased accordingly. In the future, if the highway construction design process moves from 2D to 3D design, the 3D models can be available without recreating them.
- Time details—The visualization can be improved by increasing the level of detail of the schedule from a day to an hour or a minute. To do this can be as simple as modifying code to a specific time period. An example of application for higher time details is to simulate task traffic control or quality control such as installation of the traffic devices in a specific time period.
- Traffic Management—If traffic counts are available in time intervals for the construction site, the simulation could be modified to incorporate a realistic traffic mix and flow. This could allow for examination of queue lengths, wait times, turning movements, blind spots, and many other types of analysis prior to the start of construction.