MPC- 413
January 1, 2013- December 31, 2013

Project Title:
A Pilot Case Study to Evaluate the Potential Impact and Benefit of Adopting and Implementing BIM on Bridge and Infrastructure Projects

University:
Colorado State University

Principal Investigators:

Caroline M. Clevenger
Assistant Professor
caroline.clevenger@colostate.edu
970-491-7963

Mehmet E. Ozbek
Assistant Professor
mehmet.ozbek@colostate.edu
970-491-4101

Hussam Mahmoud
Assistant Professor
hussam.mahmoud@colostate.edu
970-491-6605

Research Needs:
In recent years, Building Information Modeling (BIM) has become an important process in the vertical construction of buildings. Significant improvements in productivity, quality, and safety, as well as cost savings have been realized and are well documented. In contrast, the adoption of BIM in the horizontal world of civil engineering and construction is relatively new and unexamined. There exists significant need for research that explores and evaluates the potential impacts and benefits of implementing BIM on real-world infrastructure projects.

Across the United States, there is enormous requirement for infrastructure improvements. Transition to digitally-based collaborative processes is critical to address such need. However, various departments of transportation (DOTs) and regional transportation authorities are struggling to understand and evaluate the scope and implications of such a transition. McGraw-Hill in their 2012 report entitled, "Business Value of BIM for Infrastructure," states that 67% of current users of BIM for infrastructure projects report a positive return-on-investment. The proposed research will seek to inform Mountain Plains Consortium (MPC) DOTs about such opportunities. The study will examine a case study of bridge construction to be performed on the I-225 light rail line starting in 2013 in Denver, Colorado. Kiewit is the general contractor for the project and will be implementing BIM to facilitate construction.

Once case study data is collected, the next step of research will be to extrapolate and extend the findings of implementing BIM to a broader, regional scale. Such research is critical to Mountain Plains Consortium (MPC) DOTs as they develop policies and procedures for the imminent transition to BIM as related to the construction, operation, and maintenance of their infrastructure.

Research Objectives:
The research objectives for this project are twofold:

1. Collect cost and process data of implementing BIM for a pilot case study focused on I-225 Light Rail Line bridge construction.
2. Use case study findings regarding project impact and benefit to extrapolate and evaluate potentially broader impacts and process change implications for MPC DOTs based on adopting and implementing BIM across their infrastructure projects.

Research Methods:

Step 1: The project will begin with a literature review. To date, limited research exists specifically focusing on BIM for infrastructure. However, research does exist regarding the use of BIM for building construction, as well as applicable metrics for evaluating the impact of implementation. Notably, one of the key findings of the McGraw-Hill, "Business Value of BIM for Infrastructure," report is that exposure to the benefits of BIM on vertical building projects increases the likelihood of the use of BIM for infrastructure projects.

Step 2: Next, detailed information and data will be gathered on-site and in partnership with Regional Transit District (the Owner of the project) and Kiewit for I-225 light rail line bridge construction. BIM metrics currently used in building construction (and potentially additional metrics) will be applied to assess and quantify the impact and benefits of such implementation.

Step 3: Based on key findings and metric evaluation for the case study, I-225 light rail line bridge construction, results will be projected to estimate potential impacts and benefits for widespread adoption of BIM for MPC DOT infrastructure projects to improve the condition of their infrastructure and key facilities.

Expected Outcomes:
Expected outcomes of this research include preliminary quantification of project impact and benefits of implementing BIM on bridge construction for the I-225 light rail line in Denver Colorado; and projected quantification of such impacts and benefits on a more regional or organizational scale. This research is important because, as the use of BIM increases for infrastructure, it is critical that DOTs are not only informed and prepared for resulting changes to their organization and operating procedures, but also that they are ready to serve as experienced leaders within industry to help guide the transformative transition.

Relevance to Strategic Goals:
The proposed research aligns with US DOT's strategic goal of the **State of Good Repair** by assessing and exploring new resources that directly support asset management and advanced virtual design and construction processes to improve the condition of key infrastructure facilities.

Educational Benefits:
Recently, in 2012, Mortenson Construction provided a sizable grant to Colorado State University to fund a state-of-the-art Virtual Design and Construction Laboratory for use by students and faculty in construction management and related disciplines. The Mortenson Center for Virtual Design and Construction, currently under construction, will be used to promote facilitate academic-industry partnerships that leverage the use of BIM in construction, and to advance high-tech student learning. The proposed research presents a unique opportunity to showcase

how students can be interactively involved in BIM-related research. In turn, such research will support and expand student education and learning opportunities related to BIM by placing students at the forefront of both industry and academic innovation.

Work Plan:
Task 1: Perform a detailed literature review across relevant BIM-related research, as focused on 1) the impact of BIM implementation within building construction 2) BIM performance metrics and 3) potential value of BIM implementation for infrastructure projects. This review will inform the following tasks.

Task 2: After completing necessary research protocol (IRB etc.), observe and document project specific data related to the impact of implementing BIM on the I-225 light rail line bridge construction. This data will be collected on-site as well as in partnership with RTD and Kiewit, two key project participants.

Task 3: Use established, as well as, emerging BIM metrics to evaluate and assess the impact of implementing BIM on I-225 light rail line bridge construction. Document the impact in a written summary or PowerPoint report for distribution to the project team. Gather preliminary feedback regarding the accuracy of results.

Task 4: Using the information gathered in Task 2 and 3, extrapolate data and develop projections and recommendations of potential broader impacts on MPC DOT organizations and their projects based on wide-spread adoption and implementation of BIM.

Task 5: Prepare the draft report and then the final report detailing project specific as well as MPC DOT level research findings for distribution among MPC states. In addition, prepare and present findings in form suitable for publication in a peer reviewed journal (possible venue: Transportation Research Record Journal) and a conference (possible venue: Transportation Research Board Annual Conference) to provide for wider dissemination of results.

Time Line:

	Months				
Task	**1-2**	**3-5**	**6-7**	**8-10**	**11-12**
1					
2					
3					
4					
5					

Project Cost: (See attached budget for detailed cost breakdown.)
Total Project Costs: $60,000
MPC Funds Requested: $30,000
Matching Funds: $30,000
Source of Matching Funds: Faculty time and effort, industry support as well as hard cost match of a funded internship by Regional Transportation District for graduate research support.

TRB Keywords: Infrastructure, BIM, Performance Metrics

References:
Business Value of BIM for Infrastructure: Addressing America's Infrastructure Challenges through Technology and Collaboration, *McGrawHill Smart Market Report*, <http://analyticsstore.construction.com/index.php/the-business-value-of-bim-for-infrastructure.html> (Accessed November 29, 2012).