

MPC-594

February 26, 2019

Project Title

Transferring Research Innovations in Bridge Inspection Planning to Bridge Inspection Practice

University

Colorado State University

Principal Investigators

Rebecca Atadero, Ph.D.

Associate Professor

Colorado State University

Phone: (970) 491-3584

Email: rebecca.atadero@colostate.edu

ORCID: 0000-0002-7477-1620

Mehmet E. Ozbek, Ph.D.

Associate Professor and Graduate Program Coordinator

Colorado State University

Phone: (970) 491-4101

Email: mehmet.ozbek@colostate.edu

ORCID: 0000-0002-1416-364X

Research Needs

Recent bridge failures, including Minneapolis' I-35W bridge in 2007 (S.Hao, 2010), (NTSB, 2008), have called attention to weaknesses in current bridge inspection practices which rely heavily on manual inspection on a two year cycle as required by the Federal law (ASCE/SEI-AASHTO Ad Hoc Group, 2009). At the same time, a wealth of research has advanced a variety of techniques for nondestructive evaluation (NDE) of bridges and other structures (Gucunski, et.al. 2013). A new inspection paradigm is needed to overcome the limitations of current inspection practice by systematically and cost-effectively incorporating a variety of data sources including visual inspection, NDE, and deterioration modeling (Nickless and Atadero 2017) into decision-making about inspection frequency and technique. The need for a different paradigm for bridge inspection planning is well established, and several researchers have proposed new systems (Washer et al., 2016), (Lattanzi et al., 2017), (Agdas et al. 2016). Despite research advances on this topic, significant and necessary changes to bridge inspection practice are slow to occur at the departments of transportation (DOTs) (NCHRP, 2018).

Additionally, bridge inspection is not the only field where research advances are not making it into practice. Cognizant of this issue, the National Cooperative Highway Research Program (NCHRP) has recently started funding projects that are designed to promote the implementation of previously completed NCHRP studies through a program entitled "NCHRP Implementation

Support Program” (NCHRP, 2018). There is a general need to research how to engage with transportation agencies to promote the adoption (or adaptation) of research advances into routine practice.

Research Objectives

Alternatives to visual bridge inspection are gaining maturity and new approaches to bridge inspection planning have been proposed by researchers, including the PIs. However, despite the recognition of the need for changes in how bridges are inspected, new techniques for inspection have not been adopted into routine practice; and inspection planning still relies primarily on a fixed two year inspection cycle. This project will study how large-scale changes are made to engineering practice at DOTs within the specific context of bridge inspection. Specific research objectives are:

1. Determine current bridge inspection practices, costs and benefits for at least one state DOT and compare to those associated with the new method(s) for bridge inspection planning.
2. Document currently collected information about bridge condition, and identify additional information that would be needed to pursue the alternative method(s) for bridge inspection planning for at least one state DOT.
3. Document the current use of software to record inspections and provide management assistance for at least one state DOT.
4. Identify barriers to adoption of new inspection techniques and planning methods from an organizational culture and change perspective.
5. Identify incentives and other factors that would encourage the adoption of new inspection techniques and planning methods.

Research Methods

This project will use a two-pronged approach to studying how to implement a major change in bridge/infrastructure inspection practice.

One of these prongs will be to work closely with a transportation agency (potential candidates are Colorado DOT or Wyoming DOT) to collect a data set that describes current bridge inspection practice. This data set will include detailed inspection records for a set of bridges that demonstrates the range of existing information available. The data set will also include details of inspection budgets and resources, the use of in-house and outside contractors to complete inspections, agency experience with NDE, and preferred maintenance practices. Using this data set, we will study what is actually needed to transfer an agency from their existing processes over to a new system, including the anticipated costs of switching (and the costs of remaining on the older system). We will also study how the change could be implemented, or phased in, as it is necessary to have some continuity in the process. This prong aims at studying the very practical considerations associated with a major change in practice.

The second prong of our research approach is to interview and survey bridge inspection and management professionals at a variety of levels and organizations (federal, state and local agencies as well as inspection consultants and software companies) to learn what obstacles they perceive in switching to a different bridge inspection paradigm from an organizational culture

and change perspective. These interviews will be used to study the human factors associated with an organizational change.

Expected Outcomes

This project is expected to produce a thorough accounting of the factors that provide levers and limit the capacity for change within transportation agencies. The findings of this project are expected to be both specific to changes in bridge inspection practice and have some generalizability to other significant changes to engineering practice at DOTs. By studying a specific transportation agency we will be able to provide a path to change for one organization. However, the project is also expected to provide general and important information to other researchers who might want to propose large scale changes to departments of transportation and DOT professionals who want to implement changes in their own organizations.

Relevance to Strategic Goals

This project primarily addresses the USDOT strategic goal: State of Good Repair. Inspection is a critical part of managing bridges and other transportation assets. Current inspection practices are well established and seem resistant to large scale changes. The aim of this project is to understand how researchers can better facilitate change in federal and state inspection practices. The results of this project are expected to help DOTs take advantage of advances in inspection techniques and new methods of inspection planning. The intent is to conduct inspections in ways that preserve safety, save money and provide more useful information for decision making which will be adopted by transportation agencies.

Educational Benefits

A Ph.D. student will be hired to assist the PIs in conducting this research project; and it is anticipated that this research will form a foundation for their dissertation. Furthermore, Dr. Atadero has recently developed a graduate level course titled: Inspection, Management and Repair of Structures; and the findings of this research project may be introduced in that course.

Technology Transfer

This study, by its very nature, is aimed at significantly enhancing the technology transfer process in transportation-related research. As stated earlier, we will study how large-scale changes are made to engineering practice at DOTs and how to engage with transportation agencies to promote the adoption (or adaptation) of research advances into routine practice. While we will study these within the specific context of bridge inspection, we will also seek to provide insights about how major changes may occur in DOT practices that might be more generally applied to other aspects of transportation. As such, the proposed study's impact will be broad and supportive of the technology transfer efforts of other MPC projects performed by our colleagues across the MPC schools.

As we have successfully done in our past projects, we will also disseminate project findings to other researchers and practitioners through technical publications (journals, conferences, reports) and presentations (at conferences and to DOT audiences).

Work Plan

Task 1 is conducting a literature review on the concepts of organizational culture and organizational change. Task 1 is expected to be completed in six months from the starting date.

Task 2 is working closely with a state DOT to collect comprehensive data with respect to bridge inspection (cost and benefits, existing practices and experience). Task 2 is expected to be completed in nine months from the starting date.

Task 3 is analyzing the collected data to identify what would be needed to switch to alternative bridge inspection planning methods. Task 3 is expected to be completed in fifteen months from the starting date.

Task 4 is conducting interviews and surveys with transportation professionals in various agencies to identify barriers to change and incentives for change. Task 4 is expected to be completed in twenty months from the starting date.

Task 5 is analyzing the data collected from interviews and the study of practical implementation needs to develop a proposed plan for change. Task 5 is expected to be completed twenty-two months from the starting date.

Task 6 is drafting the final report and content for other avenues of dissemination and is expected to be completed in twenty-four months from the starting date.

Project Cost

Total Project Costs:	\$116,000
MPC Funds Requested:	\$58,000
Matching Funds:	\$58,000
Source of Matching Funds:	Colorado State University

References

Hao, S. (2009). I-35W bridge collapse. *Journal of Bridge Engineering*, 15(5), 608-614.

National Transportation Safety Board. (2008). Collapse of I-35W Highway Bridge, Minneapolis, Minnesota, August 1, 2007. Highway Accident Report NTSB/HAR-08/03. Washington, DC.

ASCE/SEI-AASHTO Ad-Hoc Group On Bridge Inspection, Rating, Rehabilitation, and Replacement. (2009) White Paper on Bridge Inspection and Rating, *Journal of Bridge Engineering*, 14(1), pp.1-5. [http://dx.doi.org/10.1061/\(ASCE\)1084-0702\(2009\)14:1\(1\)#sthash.O1zlyBPF.dpuf](http://dx.doi.org/10.1061/(ASCE)1084-0702(2009)14:1(1)#sthash.O1zlyBPF.dpuf)

NCHRP. (2018). NCHRP Implementation Support Program. Available at: <http://www.trb.org/NCHRP/NCHRPImplementationSupportProgram.aspx>

Gucunski, N., Imani, A., Romero, F., Nazarian, S., Yuan, D., Wiggernhauser, H., Shokouhi, P., Taffe, A., and Kutrubes, D. (2013). Nondestructive Testing to Identify Concrete Bridge

Deck Deterioration. SHRP 2 Report S2-R06A-RR-1. Transportation Research Board, Washington, D.C.

Nickless, K. and Atadero, R. (2017) Investigation of Mechanistic Deterioration Modeling for Bridge Design and Management. CDOT Report # : 2017-05.
<https://www.codot.gov/programs/research/pdfs/2017-research-reports/2017-05>

Washer, G., Connor, R., Nasrollahi, M., & Provines, J. (2016). New framework for risk-based inspection of highway bridges. *Journal of Bridge Engineering*, 21(4), 04015077.

Lattanzi, D., & Miller, G. (2017). Review of robotic infrastructure inspection systems. *Journal of Infrastructure Systems*, 23(3), 04017004.

Agdas, D., Rice, J. A., Martinez, J. R., & Lasa, I. R. (2015). Comparison of visual inspection and structural-health monitoring as bridge condition assessment methods. *Journal of Performance of Constructed Facilities*, 30(3), 04015049.