UTC Project Information	
Project Title	MPC-504 – Improved Element-Level Bridge Inspection Criteria for Better Bridge Management and Preservation
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Brief Description of Research Project	Over 600,000 bridges in the United States are a critical component in the transportation network for economy and society need. Assessing bridge conditions and timely maintenance are critical to ensure bridge health and cost-effective decision making in preservation activities. Successful bridge-inspection programs nationwide is an important element of assessing bridge conditions, and ultimately extending service life of bridges. Bridge owners nationwide have recognized the benefits of detailed condition assessments through the use of the raw inspection information, expanded performance measures, and bridge management system deterioration forecasting and evaluation, which are covered in the 2013 new AASHTO Manual for Bridge Element Inspection. The bridge condition rating of the United States, illustrated in Fig. 1a, is based on the NBI data of national highway bridges (2013). Bridge owners and stakeholders used to assess the bridge conditions and make decision based upon these NBI data. As clearly illustrated in Fig. 1b, the vast majority of the states have already employed element-level inspection for more than a decade based on the CoRe guide. The 2013 new AASHTO Manual, however, is significantly different from the former CoRe guide. As a result, the difference in frequency of inspections, element definition, qualifications of inspection personnel, defeat description and inspection reporting from state to state may cause inconsistency of data collection and ultimately affect the quality

	of element-level data collected under different states to be reported to the National Bridge Inventory (NBI). As newer bridge types become more common, demand of new guidelines for inspection ratings is needed to increase uniformity and consistency of inspections. To improve consistency in assessment of bridge element conditions and establish accuracy levels for supporting bridge management system deterioration forecasting and evaluation, the following challenges must be addressed scientifically and systematically: a) there is a practical need for nationwide applications of high quality element-level bridge inspection. A more comprehensive, reliable and accurate levels for element conditions and defect types to accommodate this need is urgent; b) AASHTO 2013 Manual for data collection provides criteria for element condition rating and defects description, but without reliability-based calibration. The factors that affects the quality and consistence of data collection can cause high variability. Thus, reliability based indices to account for correlation between levels of element conditions and critical factors (including inspector qualification factor, structural importance factor, material vulnerability factor, defect type/location factor, age factor, and environmental factor) are necessary; and c) Existing Manuals introduce material distress for condition rating while overlook the assessment of bridge element conditions that account for performance, probability of failure and risk of failure, and thus cannot guarantee the desirable performance. New guidelines should address these concerns. Thus, to meet the requirements in the "Moving Ahead for Progress in the 21st Century Act (MAP-21)" legislation and to ensure the safety of the motoring public, a methodology for assisting bridge inspectors and bridge owners to improve the quality of element-level bridge inspection data and enhanced bridge management is needed. Significant effort is required to develop the guidelines for practicing engineers, from bridge inspectors, and inspection trainers, to local and state DOT bridge owners, to promote consistency in the collection of reliable data that support bridge asset management practices. The proposed research will address this important technical need by characterizing quality of element-level data, generating a reliability-based correlation between levels of element conditions and critical factors, and developing new data-driven based guidelines. Research Objectives: The main objective of the research is to develop guidelines to improve the quality of element-level data collection for better bridge management and bridge preservation. The specific research goals of the project are: • To identify the key factors that affect the quality and consistency of bridge element inspection and the corresponding bridge asset management; • To develop a reliability based methodology to define the data collection criteria, and

	• To establish accuracy levels for element conditions and applicable defect quantities through a reliability based correlation between levels of element conditions and critical factors (including structural importance factor, defect location factor, material vulnerability factor, and environmental factor) for supporting bridge asset management.
Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	The proposed concepts have been implemented to the practices of the new element-level inspection, from enhancement of visual inspection to improvement of data fusion of sensory data. The results confirmed that the enhanced structural condition assessment using the deep learning for better decision making in in-depth/special/damage inspection for structures with uncertainties.
Impacts/Benefits of Implementation (actual, not anticipated)	Timely information of bridge conditions obtained during visual and in-depth inspection will be used for determining needed maintenance and repairs, for prioritizing rehabilitations and replacements, for allocating resources, and for evaluating and improving design for new bridges. The enhanced methods for data fusion and information extraction will be vital in that it not only impacts bridge funding appropriations, but also dramatically improve public safety.
Web Links • Reports • Project Website	https://www.ugpti.org/resources/reports/details.php?id=986