UTC Project Information

Project Title	MPC-676 – Optimal Selection of Upgrade and Maintenance Interventions to Minimize Life-Cycle-Cost
University	University of Colorado Denver Colorado State University
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Total Project Cost	$112,958
Agency ID or Contract Number	69A3551747108
Start and End Dates	November 12, 2021 to July 31, 2024
Brief Description of Research Project	Operation and maintenance costs are reported to be the longest and most costly phase of buildings and infrastructure systems where it exceeds cost of design and construction. This proposal presents the development an innovation optimization model that can identify optimal selection of upgrade and maintenance interventions to minimize life-cycle-cost or equivalent annual cost of buildings and bridges. The model will be developed in three main steps (1) formulation step where decision variables, objective function and constraints are identified and formulated; (2) implementation step where an optimization algorithm is selected to execute the model computations efficiently; and (3) evaluation step where the performance of the optimization model is verified using case studies. The research team will study two applications of the proposed model, including upgrade and maintenance of buildings and bridges. Furthermore, the team will study the feasibility of expanding the model to analyze multiple assets, such as building portfolio.

Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	The developed modes were evaluated using bridges in Colorado and a State DOT building to demonstrate their new capabilities and document their benefits for decision makers. The research team will work with government agencies to implement the developed models in their maintenance and upgrade practices.
Impacts/Benefits of Implementation (actual, not anticipated)	The research has significant implications in terms of cost and performance. By integrating machine learning and binary linear programming, the models can predict the condition of concrete bridge elements and select optimal maintenance actions to maximize performance within budget constraints. For buildings, the model identifies upgrade and maintenance plans that minimize the Equivalent Annual Operation and Maintenance Costs (EAOMC) while adhering to specified budgets and performance criteria. These innovations can lead to substantial cost savings; for example, optimal maintenance and upgrade interventions for buildings can save operational cost by up to 50% over a study period of 20 years.
Web Links • Reports • Project Website	• MPC Final Report – Optimal Selection of Upgrade and Maintenance Interventions to Minimize Life-Cycle Cost