Florida Department of Transportation Research

Improving Safety at Highway-Rail Grade Crossings in Florida while Maintaining Continuity of Passenger and Freight Flows: A Multi-Objective Approach

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Current Situation

In 1960, Florida was home to 5 million people. In the 50 years since, that number has quadrupled to over 20 million, and this growth is expected to continue so that by 2050, there will be 30 million Florida residents. Add to this the more than 100 million visitors to Florida each year. The goods required to supply all these people represent 700 million tons of freight moved by trucks and trains.

A line of vehicles waits while a train passes.

Overall, growth has led to more roads and more highway-rail grade (HRG) crossings – currently over 4,500 in Florida – with more vehicles using these crossings, resulting in more crashes. Reducing these crashes poses a challenge to balance efficiency and safety because increasing safety at crossings can also increase traffic delays on roads surrounding the crossing. For example, systems that preempt traffic signals on roadways near a crossing can reduce crashes but at the cost of imposing delays on many vehicles not intending to cross the tracks. Finding the right balance for any individual crossing requires sophisticated planning tools that can take into account many factors and present choices that are feasible within available budgets.

Research Objectives

Florida State University researchers developed a decision support system to assist in the design of highway-rail grade crossings which aims to minimize both hazard severity and traffic delay.

Project Activities

In their literature review, the researchers found that methods to estimate delays due to safety treatments at HRG crossings did not address the full range of issues required. They began to build a decision support system (DSS). Their first step was to develop a mathematical model, the Multi-Objective Resource Allocation Problem (MORAP), to balance crash severity reduction against delay for safety treatments. To estimate crash severity, the researchers used an existing model, the Florida Priority Index Formula. To estimate vehicle delay due to safety treatments implemented at or near crossings, they developed a novel approach based on several factors, including the number of blockages (i.e., number of trains passing), the overall delay experienced by queued vehicles during each blockage, average train length, etc.

The second step was to find the right mathematical method to implement MORAP. Three methods were investigated, and one called the Multi-Objective Profitable Severity and Delay Reduction (MPSDR) heuristic was selected because it performed better in terms of both solution quality and computational time.

In step three, the researchers developed an application, HRX Safety Improvement, to facilitate use of MORAP and MPSDR in analyzing HRG crossings: estimating overall hazard severity, estimating overall traffic delay, and ranking countermeasures in terms of available budget. Computational experiments showed that this methodology can serve as an effective DSS.

Project Benefits

This project has provided new tools for safety improvements at highway-rail grade crossings that will improve both their safety performance and efficiency.

For more information, please see www.fdot.gov/research/.