Evaluation of Grade Crossing Hazard Ranking Models

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Research Results Presentation
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Team Introductions and Acknowledgements

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• Acknowledgements:
  – ORDC/PUCO Staff
  – Jim Dahlem, FHWA
  – Interview Participants
Research Results Presentation Outline

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Research Problem
Ohio Highway-Railroad Grade Crossings Background

• Ohio has more than 5,760 highway-railroad grade crossings.
  – Fourth-highest in the U.S.
• Approximately one-third of crossings have “passive” warning devices.
  – Crossbuck sign with Stop or Yield sign in some locations.
• FHWA “Section 130” program provides funding for grade crossing
  warning device improvement projects.
  – Provides funding for installation of flashing lights and highway gate arms.
  – Section 130 program has been effective at improving grade crossing safety.
• Two Ohio agencies are responsible for grade crossing safety programs.
  – Ohio Rail Development Commission (ORDC) – Administers Section 130 program funds
    on behalf of ODOT and coordinates other safety initiatives.
  – Public Utilities Commission of Ohio (PUCO) – Maintains highway-railroad grade
    crossing inventory database, regulatory oversight, and annual crossing inspection.
Research Problem

Ohio Highway-Railroad Grade Crossing Safety Issues

• Grade crossing safety has improved due to ORDC and PUCO investments.
  – 2005 – 2010: average of 110 crashes per year
  – 2010 – 2015: average of 67 crashes per year

• Trends in grade crossing crashes, 2010 – 2015:
  – Approximately one-third of crashes are at passive grade crossing locations.
  – Crossings that have experienced a crash in the past five years have higher train volumes, train speeds, and more tracks as well as higher AADT than statewide average for all crossings.

• Continued focus on passive crossings is justified:
  – On an average day, there are an estimated 13.9 million highway vehicle interactions and 77,300 train interactions at Ohio’s grade crossings.
  – A majority of the highway and train traffic occurs at crossings with active warning devices yet one-third of crashes are at passive locations.
Research Problem

Annual Warning Device Project Development Process

1. Develop List of Candidate Grade Crossing Locations
   - PUCO generates list of the most hazardous crossings based on the hazard ranking model (discussed on next slide).
   - Initial list is reviewed to identify approximately 40 candidate locations, taking into account existing projects and other factors.
   - Initial list is forwarded to the ORDC for further review.

2. Diagnostic Review
   - Per FHWA guidelines, a multi-disciplinary diagnostic review team visits each candidate location.
   - Team includes ORDC, railroad, and local highway agency representatives.
   - Determination made by the diagnostic review team on if a project can be implemented.

3. Project Implementation
   - ORDC staff manages programming and implementation.
   - Typical project is approximately $250,000 with 20 – 30 projects per funding cycle.
   - Inventory database is updated once project is complete.

• Two cycles per fiscal year if funding allows.
Research Problem

Current Hazard Ranking Model Used in Ohio

• Currently, the ORDC and PUCO use the U.S. DOT Accident Prediction Model to develop a hazard ranking of grade crossings in the state as part of the warning device project development process.

• The U.S. DOT Accident Prediction Model is a multi-stage model that predicts the number of crashes per year at a grade crossing. The model consists of the following components:
  1. A mathematical formula which generates an initial estimate of the annual frequency of crashes at a grade crossing based on the characteristics of the roadway, highway traffic, and railroad traffic at the crossing.
  2. Adjustment to the initial crash estimate to reflect crash history at the crossing.
  3. Adjustment to update the crash estimate based on national trends.
  4. Prediction of the probability of a fatality or injury crash given that a crash has occurred (currently not used in Ohio).

• Statistical coefficients in U.S. DOT model are based on national averages.
• Hazard ranking is established based on estimated crash frequency.
Research Problem

Current Hazard Ranking Model Used in Ohio

- Candidate grade crossing locations are ranked based on the annual crash frequency as predicted by the U.S. DOT Accident Prediction Model as the measure of hazard risk.
- Mathematical models provide an objective ranking of grade crossings but the practical difference in the crash risk at a set of crossings being considered for improvement may be negligible.
- Moving forward, grade crossing improvement projects will be selected from a list of crossings for which the model shows little difference in the crash risk.
- The ORDC and the PUCO are tasked with distributing limited funding resources on the projects which are most effective at improving grade crossing safety (i.e., at the most hazardous locations).
- A better understanding of other grade crossing hazard ranking models currently in use would enhance the project selection process used by the ORDC and PUCO.
Research Goal and Objectives

• Research Goal: Provide ODOT, the ORDC, the PUCO, and other interested stakeholders with a better understanding of the grade crossing hazard ranking formulas and other methods used by State DOTs to evaluate grade crossing hazards and select locations for hazard elimination projects.

• Research Objectives:
  1. Conduct a preliminary review of grade crossing hazard ranking formulas currently in use.
  2. Investigate the current practices for grade crossing hazard ranking in Ohio.
  3. Interview practitioners of selected grade crossing hazard ranking formulas to determine strengths, weaknesses, and functional effectiveness of the formulas.
  4. Conduct a detailed evaluation of selected grade crossing hazard ranking formulas.
  5. Develop recommendations for ODOT, the ORDC, and the PUCO on potential improvements that could be made to current hazard ranking practices in Ohio.
Research Approach

• Comprehensive Literature Review
  – Identify methods used by State DOTs and other organizations for modeling grade crossing hazard ranking and warning device project prioritization.
  – Section 130 program annual reports from each state reviewed.

• Practitioner Interviews
  – Telephone interviews of DOT or other agency staff in other states to obtain details about the performance of certain grade crossing hazard ranking models with respect to ease of use, reliability, data needs, and other relevant factors.

• Detailed Evaluation of Selected Grade Crossing Hazard Ranking Models
  – “Analytical” Evaluation: Comparison of model output using data from Ohio’s highway-railroad grade crossing inventory database.
  – “Functional” Evaluation: Assessment of how models could be accommodated within existing practices and available data in Ohio.
## Research Approach

### Comprehensive Review of Current Grade Crossing Hazard Ranking Practices

<table>
<thead>
<tr>
<th>Formula/Method</th>
<th>Number of States</th>
<th>Percent of States</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. DOT Accident Prediction Model</td>
<td>19</td>
<td>38%</td>
</tr>
<tr>
<td>State-Specific Formula or Method</td>
<td>11</td>
<td>22%</td>
</tr>
<tr>
<td>None/No Formula Mentioned</td>
<td>11</td>
<td>22%</td>
</tr>
<tr>
<td>New Hampshire Hazard Index</td>
<td>5</td>
<td>10%</td>
</tr>
<tr>
<td>Multiple Formulas</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>NCHRP 50 Accident Prediction Model</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Peabody-Dimmick Formula</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td><strong>Total All States</strong></td>
<td><strong>50</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Source: Ohio University research team review of state 2014 Railway-Highway Crossing Program annual progress reports and follow-up research.
Research Approach

Comprehensive Review of Current Grade Crossing Hazard Ranking Practices

• Typical Factors Considered in Models:
  – Train-Related Variables: Train Volume, Train Speed, # of Tracks
  – Crossing-Related Variables: Existing Warning Device, AADT, Crash History, # of Lanes

• Specific Factors not Considered in Ohio:
  – Stopping Sight Distance (9 States; 3 Formulas)
  – School Bus/Special Vehicle Volume (4 States; 2 Formulas)
  – Highway Traffic Speed (5 States; 3 Formulas)
  – Proximity of Rail Crossing to Nearby Intersection (3 States; 1 Formula)
  – “Close Call” Data

• Other Interesting Findings:
  – Several states have conducted research projects to improve hazard ranking process, including development of new hazard ranking models – application of findings varies.
  – Post Facto evaluation of warning device projects relatively limited.
  – Economic analysis of warning device improvements desired but limited application in practice.
Research Approach

Practitioner Interviews Overview

• Telephone interview included questions about state grade crossing safety programs, warning device project development, and implementation of hazard ranking formula in that agency.

• Agencies Interviewed:
  – California Public Utilities Commission
  – Illinois Department of Transportation
  – Kansas Department of Transportation
  – Michigan Department of Transportation
  – Missouri Department of Transportation
  – New Mexico Department of Transportation
  – North Carolina Department of Transportation
  – Texas Department of Transportation
Research Approach

Practitioner Interviews Key Takeaways

• Formula Usage:
  – States generally satisfied with formulas and recognize limitations of existing models and data.
  – Increased accessibility of the U.S. DOT model via web-based tools has increased its usage.

• Project Development:
  – Hazard ranking model used as “first cut” but professional judgement always used in final program determination.
  – Always money available for warning device projects at “sensitive” locations that are not high ranked.
  – Locations of recent crashes or local highway agency application process also used to identify candidate locations.
  – “Near Miss” data, if available, are also used to identify candidate locations.

• Database Issues:
  – Some concerns expressed regarding the accuracy of the data used to implement hazard ranking models.
  – Train counts and AADT typically lag in updates.
  – However, inventory database represents best available data on grade crossings.
  – Crossing inspectors and local data sources are used to confirm database values.
Research Approach

Detailed Evaluation of Selected Grade Crossing Hazard Ranking Models

- Detailed evaluation of selected grade crossing hazard ranking models included analytical evaluation and functional evaluation.

- Specific Formulas Evaluated:
  - U.S. DOT Accident Prediction Model (model currently used in Ohio plus 2 variations)
  - Exposure Model
  - New Hampshire Hazard Index
  - NCHRP 50 Accident Prediction Model
  - Florida DOT Safety Hazard Index
  - Missouri DOT Exposure Index
  - North Carolina DOT Investigative Index
  - Texas DOT Priority Index

- Ohio highway-railroad grade crossing database obtained from PUCO was used to calculate the hazard ranking using each method.
Research Findings

Analytical Evaluation of Selected Grade Crossing Hazard Ranking Models

- Analyzed relationship between the hazard rankings obtained from each specific model and the current model used in Ohio, the U.S. DOT Model.
  - Does any other model currently available produce similar rankings as the existing model?
- Added “Expert Panel” analysis and ranking to comparison.
  - Hazard ranking of 20 randomly-selected crossings based on the characteristics of each crossing without reference to the accident prediction value or the current hazard ranking.
  - ORDC staff analyzed crossing data and determined the hazard ranking of the sample.
  - Provides approximate measure of the “true” hazard ranking for a group of crossings.
  - Does any hazard ranking model replicate the “true” hazard ranking as defined by the Expert Panel?
- The evaluation results showed that the current model used in Ohio, the U.S. DOT Accident Prediction Model, was superior to other models.
  - North Carolina DOT Investigative Index also had strong performance on the Expert Panel analysis.
Research Findings

Functional Evaluation of Variables Not Currently Considered in Ohio

• Factor 1: Stopping Sight Distance
  – Primary Concerns: Ability of drivers to judge presence of on-coming train and proceed through crossing.
  – Currently considered by 9 states and included on 3 formulas analyzed.
  – Currently no sight distance information in Ohio highway-railroad grade crossing inventory database.
  – Desirable sight distance requires highway traffic speed to calculate (discussed on next slide).
  – Difficult to measure consistently and concerns about seasonal sight distance restrictions (foliage or crops).
  – Sight distance not noted as a factor in Ohio grade crossing crashes over last 10 years.

• Factor 2: School Bus/Special Vehicle Volume
  – Primary Concerns: Longer vehicles, required stop at crossings, protection of children.
  – Currently considered by 4 states and included on 2 formulas analyzed.
  – Currently only 34.4 percent of inventory database records have data for school bus volume.
  – Accuracy of existing data is questionable; schools not required to report to PUCO.
  – Only 1 out of 884 crashes in Ohio in the last 10 years involved a school bus.
Research Findings

Functional Evaluation of Variables Not Currently Considered in Ohio

• Factor 3: Highway Traffic Speed
  – Primary Concerns: Higher speed traffic reduces time available to make a decision at crossing approach.
  – Currently considered by 5 states and included on 3 formulas analyzed.
  – Currently only 21.0 percent of inventory database records have data for highway traffic speed.
  – State statutory speed limit could be used in place of actual speed limit if needed.
  – Some measure of highway traffic speed would be needed for sight distance calculations.
  – Crash analysis indicates that higher-speed locations are not any more hazardous than lower-speed locations.

• Factor 4: Proximity of Rail Crossing to Nearby Highway Intersection
  – Primary Concerns: Complexity of nearby intersection, queues across tracks, longer vehicles, traffic signal preemption.
  – Currently considered by 3 states and included on 1 formulas analyzed.
  – Currently 91.0 percent of inventory database records have data for the proximity of a nearby highway intersection.
Recommendations

Grade Crossing Hazard Ranking Models

• Recommendation #1: The ORDC and the PUCO should continue use of U.S. DOT Accident Prediction Model for grade crossing hazard ranking to assist with warning device project prioritization in the state.
  – U.S. DOT Model represents state of the practice for grade crossing hazard ranking.
  – Performed strongest on all analytical evaluations performed for this project.
  – No other models currently available would provide a more superior hazard ranking.

• Recommendation #2: Hazard index models such as the Missouri DOT Exposure Index or the North Carolina DOT Investigative Index should be considered to provide a secondary ranking for passive crossing locations after the initial ranking and diagnostic review process has been completed for the annual program.
  – Models require data on stopping sight distance and highway traffic speed, which could be obtained as part of the diagnostic review process (see Recommendation #3).
  – Could provide a supplemental ranking to assist with prioritization in the event that the annual program could only fund a portion of the crossings that were included in the diagnostic review process.
Recommendations

Warning Device Project Selection Process

• Recommendation #3: The existing field diagnostic review process should be updated to obtain better information about the available sight distance at a grade crossing.
  – At the diagnostic review level, record highway speed limit and sight distance information on all four quadrants of the crossing approaches. Sight distance along the highway should be measured and the nature of any obstructions (permanent or seasonal) should be noted. This information should be entered into the inventory database.

• Recommendation #4: The ORDC should consider revising its warning device project development process to include a larger number of crossings on the preliminary list of project locations.
  – Casting a “wider net” in the development of the preliminary list of project locations may help overcome issues related to outdated inventory data. For example, outreach to County Engineers could help identify grade crossings in fast-growing areas where existing AADT data have not been updated to reflect growth.
  – Outreach to railroad labor to identify “near miss” locations or school districts to identify crossings that are thought to be particularly hazardous based on feedback from bus drivers.
Recommendations

Highway-Railroad Grade Crossing Inventory Database Issues

- Recommendation #5: The ORDC and the PUCO should consider developing a formal written protocol or framework to ensure that key variables in the Ohio highway-railroad grade crossing inventory database are updated and maintained.
  - Coordinate with ODOT Office of Technical Services to ensure that traffic counts are consistent for similar locations.
  - Coordination on routine traffic counting locations to provide more details for railroad crossings.
  - Routine review of number of tracks and number of highway lanes at all grade crossings.

- Improvements to the highway-railroad grade crossing inventory database to address accuracy as well as the potential addition of sight distance information for each crossing will allow for a more comprehensive analysis of the factors that influence grade crossing crashes in Ohio.
  - Development of a state-specific crash prediction model is not appropriate at this time given the on-going efforts of ORDC and PUCO to update inventory database and address many of these issues.
Implementation Strategy

• Short-Term Implementation:
  – Develop spreadsheet-based tool to calculate secondary hazard index values and corresponding ranking for annual warning device improvement program.
  – Pilot test of sight distance measurement during upcoming field diagnostic reviews.
  – Coordinate with ODOT Office of Technical Services for traffic count issues.

• Long-Term Implementation:
  – Revise annual project development process to obtain feedback from different organizations on candidate grade crossing locations for warning device improvement projects.
  – Develop written protocol for maintaining grade crossing inventory database.
  – Potential development of state-specific crash prediction model or hazard index based on updated database.
Questions & Discussion

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Final report will be available online in a few weeks at: www.state.oh.us/Research