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Project Title:
Highway-Rail Grade Crossing Traffic Hazard Forecasting Model

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Research Needs:
Highway-rail grade crossing safety (and the prevention of accidents) is a priority in terms of both highway and railroad safety. Highway-rail crossing accidents often cause severe impacts in terms of fatalities, personal injuries and property damage. The damage cost and disruption to both roads and railroads are often significant (*Evans, A.W., 2011; Salmon, Paul M., 2013*). In 2014, there were 1,873 crashes reported at highway-rail crossings across the U.S., and those accidents resulted 239 deaths and 703 injuries (*Federal Railroad Administration (FRA), 2015*). Concerns about crashes at highway-rail crossings have increased for different agencies because it is commonly agreed that both highway and rail traffic levels increase the occurrence and severity of accidents (*Hu, Shou-Ren, Li, Chin-Shang, and Chi-Kang Lee, 2010; Austin, Ross D, and Jodi L. Carson, 2002*). In results, increasing highway and rail traffic poses a greater risk of crashes at those crossings (*Zhang, Yunlong, Xie, Yuanchang, and Linhua Li. 2012*).

There are many studies in the academic literature focusing on highway-rail crossing accidents. Most of those studies focus on accident/ severity prediction, accident/severity influencing factors identifications, countermeasures and their effectiveness (*Konur, Dincer, Golias, Mihalis M., and Brandon Darks, 2013; Oh, Jutaek, Washington, Simon P., and Doohee Nam, 2006; Ogden, Brent D. and et al. 2007;* Eluru Naveen and et al, 2012). All of these studies shed light on understanding HRC accidents and provide foundation support for resource allocation for upgrading HRCs safety performance which is critical for the ultimate goal of "zero tolerance" for rail-related accidents/incidents established by FRA. Surprisingly little research has been conducted focusing on resource allocation for HRCs safety improvement, despite the importance of the issue (*Konur, Dincer, Golias, Mihalis M., and Brandon Darks 2013*). Moreover, the studies that focused on the issue often assumed future traffic is greater than current traffic with a certain type of growth rate. However, the detailed traffic at HRCs can fluctuate. Thus, better traffic forecasts need to be implemented in HRC safety upgrade planning.

Truck and train traffic are both increasing rapidly at many highway-railroad grade crossings in North Dakota. Much of this traffic is comprised of hazardous materials, including chemicals, fertilizers, crude oil, and other industrial products. The varying and often unpredictable pace of traffic growth poses issues for transportation planning. The number of wells in western North Dakota is predicted to increase five- to seven-fold during the next two decades. As a result, many grade crossings now experiencing modest traffic growth may experience much higher traffic levels in the future. Conversely, traffic may fluctuate and actually drop at some crossings, as drilling activities peak and shift to other parts of the region. Because of fluctuations and shifts in economic activities and traffic demands, trend analysis based on historical traffic counts at grade crossings may not yield valid results. A forecasting model is needed to identify impacted grade crossings in the future—especially those crossings where risks attributable to traffic levels may change dramatically. These forecasts are necessary to understand the scope of the problems that lie ahead.

Literature Review

It is commonly agreed that improving traffic safety at HRCs is of the utmost importance for both transportation agencies and other stakeholders (*Yan, Xuedong, Richards, Stephen, and Xiaogang Su, 2010*). Much previous research has focused on prediction methods and understanding influencing factors for HRC accidents (*Yan, Xuedong, Richards, Stephen, and Xiaogang Su, 2010; Hu, Shou-Ren, Li, Chin-Shang, and Chi-Kang Lee, 2010; Khattak, Aemal and Miao Gao, 2012*). These studies agree that highway traffic, crossing protection devices, rail traffic, and train speed have positive effects on HRCs' accident rates. Inthis study, four predominant HRC accident prediction models will be reviewed in greater detail: 1)Peabody Dimmick Formula 2) New Hampshire Index 3) National Cooperative Highway Research Program (NCHRP) Hazard Index and 4) United States Department of Transportation (USDOT) Accident Prediction Formula.

Despite the importance of resource allocation for HRCs safety improvement in the academic literature, only a few research efforts have focused on the issue. In this study, literature examining resource allocation for grade crossing safety improvement will be conducted to understand current applications of HRCs safety improvements. Specifically, how forecasted long-term traffic information can be integrated with HRC safety improvement planning will be reviewed in detail. The findings and limitations from earlier studies will also be summarized.

Research Methods:

Data:

Federal Railroad Administration Office of Safety (FRA) administrates National Highway-Rail Crossing Inventory Program (NHRCIP). The purpose of the U.S. DOT NHRCIP is to provide a uniform national inventory database regarding highway-rail crossings which can be applied to improvement of highway-rail crossing safety.

The most current highway-rail crossing inventory data for North Dakota state has been downloaded from FRA's Safety website at *http://safetydata.fra.dot.gov/officeofsafety/*. The inventory contains railway and highway data – related physical characteristics and traffic exposure at highway-rail locations reported by railroads for both at-grade and grade-separated crossings. To name a few items, the information includes environment, topography, geometry, and highway and railway traffic. Between railroad on-track equipment and any user of crossing sited is required to be reported to the inventory data. A total of 7,335 ND crossings obtained from the data will be transferred as GIS point file. Highway-rail accident data from year 1996 to 2014 can also be downloaded from the same FRA website. Whenever a highway-rail grade crossing accident/incident results in damages greater than the reporting threshold, the accident must be recorded in the accident database. The reportable threshold for CYs 1996 was $6,300 and for CYs 2010 was $9,200. Total of 384 accidents were reported for ND crossings during time period from 1996 to 2014. The accident data consists of detailed historical highway-rail crossing accident information.

In this project, both data along with railroad and highway network shape files will be integrated for analysis. Railroad and highway network shape files have been downloaded from Oak Ridge National Laboratory and ND Hub, respectively; then, edited and cleaned by Upper Great Plains Transportation Institute research staffs

Research Objectives:

The primary objective of this project is to construct a forecasting model which can identify impacted grade crossings in terms of safety upgrades in the future—especially those crossings where risks attributable to traffic levels may change dramatically.

Research Tasks:

The following major tasks have been included in the scope of the study:

(1) Literature review: A national literature review will be conducted including journal articles and government reports.
(2) GIS data model: The grade crossing inventory will be integrated with the road and rail networks to form a comprehensive GIS model. Each crossing will be located on a specific road segment and rail line, generating milepoint or other reference points.
(3) Traffic model: Baseline truck traffic forecasts and traffic counts will be used to update and fill in the highway traffic counts in the grade crossing inventory.
(4) Integrate traffic model and GIS data model: Forecasted changes in truck traffic over the next 20 years will be developed for each grade crossing.
(5) Updating hazard ratings: Possible changes in grade crossing hazard ratings will be developed based on these traffic forecasts.
(6) Summary and suggestions: The implications for grade crossing planning and the programming of safety improvements will be described.

Expected Outcomes:

Reducing accidents at highway-rail crossings is a goal everyone shares. Better understanding of how traffic fluctuation affects highway-rail crossing safety performance can help agencies provide better support for resource allocation for safety upgrades which, in turn, may improve safety performance.

Relevance to Strategic Goals:
This research project and its potential outcomes relate directly to the Safety Goal. The project directly focuses on improving highway-rail crossing safety by implement a better traffic forecasting model to HRC accident prediction model which, in turn, will improve an effective resource allocation for HRCs upgrading to approaching “zero tolerance” rail accident goal.

Educational Benefits:
Students who are interested in learning highway-rail accident characteristics, traffic forecasting, and crossing planning can be involved in the project at different levels.

Work Plan:

All the project tasks will be completed from April 15, 2015 to September 1, 2016. The last one and half months of the project will be dedicated to reviewing and finalizing the final report.

Project Cost:
Total Project Costs: $150,000
MPC Funds Requested: $75,000
Matching Funds: $75,000 Source of Matching Funds: NDSU

TRB Keywords:
Transportation Safety, Railroad Grade Crossings

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