Predicting railroad crossing crashes

Every year in the United States, more than 200 people lose their lives at railroad crossings. Although the number of crashes has been steadily declining in recent decades, the result of a vehicle–train collision is often catastrophic. To ensure the number of rail crossing crashes continues to decline, it’s important for highway departments to invest in safety improvements at the locations where those improvements will have the greatest impact. However, the models currently used to predict where rail crashes will occur are often imprecise.

“Today, most highway departments rely on the USDOT model to predict rail crashes, which was developed using data from the 1974 database, and most of the coefficients remain unchanged since 1980,” says Rahim Benekohal, a professor in the Department of Civil and Environmental Engineering at the University of Illinois at Urbana-Champaign and researcher with the Roadway Safety Institute.

At an October 2 Roadway Safety Institute seminar, Benekohal described a project that aimed to improve on the USDOT model by developing a more accurate crash-prediction model for rail crossings. Benekohal and his research team created the new model by applying a macroscopic approach, which traditionally identifies general trends in national or regional data, to data from Illinois. The researchers also incorporated variables identified in a detailed micro analysis—which examined individual crashes at high-crash locations to identify contributing factors—into the macro approach.

To complete the micro analysis, the researchers looked at several high-crash crossings, first completing a detailed crash diagram of each crossing to visualize key information such as where the crashes happened and what types of crashes occurred. Next, they created a dynamic tree structure for each location to identify crash trends. In one instance, this process revealed that the intersection angle
was contributing to a number of crashes. At a second location, they found all crashes involved elderly drivers—likely due to the high number of assisted-living communities in the area.

“By performing this type of analysis at the micro level, we can identify contributing factors that will enable highway departments to select the proper countermeasures at individual high-crash crossing locations,” says Benekohal. In addition, the researchers can take those factors and determine whether they should be included in a macro-level model. “For example, we found that angle was a significant contributing factor to rail crossing crashes. So in our new model, we use crossing angle as one of the variables to predict the number of crashes at a crossing.”

The early results of the project are promising, Benekohal says. The new crash model is already more accurate at predicting the number of crashes at rail crossings and ranking high-crash locations than the USDOT model, and researchers hope additional improvements will provide an even greater level of precision.

Currently, Benekohal’s research team is continuing to refine the new model with funding from the Roadway Safety Institute. The researchers will also study train delays to estimate train arrival times at rail crossings, develop tools to support emergency response planning and investment, and develop models to optimize the coordination of emergency response to railroad crashes across jurisdictions.

Research looks for new ways to prevent wrong-way driving crashes
Wrong-way driving on highways is a serious and persistent safety problem that results in more than 300 deaths each year nationwide. While the total number of highway traffic fatalities in the United States has been declining since 2004, the number of wrong-way driving fatalities has held steady. This troubling trend has led to an increased interest in safety countermeasures to reduce wrong-way driving and sparked new research on the subject.

Working with Roadway Safety Institute researcher Albert Luo at Southern Illinois University Edwardsville, Hugo Zhou, an associate professor in the civil engineering department at Auburn University, has been at the forefront of that effort as one of the country’s leading experts on wrong-way driving. As part of the Roadway Safety Institute seminar series, Zhou presented findings from a project that collected six years of crash data from the Illinois Department of Transportation to identify and analyze wrong-way crashes.

“When we began our first wrong-way driving study, there was no national effort to reduce wrong-way driving crashes and the data was challenging to work with,” says Zhou. “In addition, it is difficult to identify wrong-way driving entry points: only one percent of wrong-way driving incidents end up in a crash because most drivers self-correct quickly. Those that do end in a crash are often fatal, so it is difficult to determine where the driver entered.”

Two of Zhou’s recently published reports (for the Illinois Center for Transportation and the American Traffic Safety Services Association) and the creation of a National Wrong-Way Driving Summit have helped address those previous gaps. The result is a wealth of new wrong-way driving data, along with more comprehensive resources for highway departments interested in implementing safety countermeasures to prevent wrong-way driving.

To identify specific locations where wrong-way crashes occur, Zhou and his research team developed a new method of ranking high-crash locations by assigning higher weights to the known entry points for
wrong-way driving crashes and lesser weights to possible entry points for wrong-way driving crashes in which the entry point was unknown. They applied the new method to Illinois data and ranked the top 10 entry locations for wrong-way driving crashes in the state, then conducted field reviews and identified safety countermeasures for those locations.

Zhou’s research findings have shed additional light on the contributing factors leading to wrong-way driving crashes. An analysis of where wrong-way drivers enter the highway revealed that interchange type is a significant contributing factor, with many wrong-way drivers entering from interchanges where the on and off ramps are close together, such as compressed diamond interchanges.

“We found also a high percentage of wrong-way crashes occur after midnight and in the early morning because of the greater number of impaired drivers at this time and low traffic volumes that make it easier to enter the road going the wrong way,” says Zhou. “Wrong-way drivers are most often senior drivers, male drivers, and [drivers] impaired by drugs, alcohol, or fatigue.”

The new wrong-way driving publications present a variety of countermeasures that can be used to help prevent wrong-way driving crashes and fatalities. Low-cost countermeasures that have been effectively deployed in the United States are presented as case studies; these measures include low-mounted wrong-way signage, high-visibility signage, raised pavement markings, access management for exit ramps, channelizing devices, ITS detection and warning systems, and countermeasure packages for partial-cloverleaf interchanges.

In addition to these low-cost countermeasures, Zhou’s team also looked at geometric design improvements. “We discovered that using geometric design features such as median barriers, control radiuses, and channelizing islands can reduce the risk of wrong-way crashes by making it extremely difficult for drivers to enter the highway going the wrong direction.”

Zhou and Luo are currently working on research funded by the Roadway Safety Institute on the potential of directional rumble strips to reduce wrong-way driving at freeway entries.

**Researcher spotlight: Ray Benekohal**

Rahim (Ray) Benekohal is a civil and environmental engineering professor at the University of Illinois at Urbana-Champaign and a researcher for the Roadway Safety Institute.

Benekohal conducts research in the areas of adaptive traffic signal operation and design, congested traffic networks, and work-zone traffic and safety.

He is currently working on a research project with the Institute to improve safety at and analyze railroad grade crossings using predictive technologies.

“The severity rates of railroad crossing accidents are much worse than highway accidents,” he says. “We are looking at what can be done before the accidents happen so we can predict potential accident locations and try to find some cause-effect relationship.”

The study focuses on utilizing new technologies to analyze patterns and past data to pinpoint an accident “hot spot” and take corrective action. The researchers also use the technology to make real-time predictions about where a crossing may be blocked and determine where to allocate resources.

The new technology allows the researchers to predict crash trends and collect data immediately, which will lead to improved efficiency and safety of transportation systems—a goal driving his work. “My motivation is really trying to get this number of fatalities and injuries and accidents down,” he says.
In addition to his research and teaching, Benekohal is the director of the Traffic Operations Lab at the University of Illinois and is director of the Illinois Traffic Engineering and Safety Conference.

Before arriving at the University of Illinois in 1987, Benekohal worked as a traffic consultant for RKA Inc. He holds a B.S., M.S., and Ph.D. in civil engineering from Ohio State University and has authored more than 120 journal articles and technical reports.

**Researcher spotlight: Kathy Quick**

Kathy Quick is an assistant professor at the University of Minnesota’s Humphrey School of Public Affairs and a researcher for the Roadway Safety Institute. Quick’s research and teaching areas include public and nonprofit leadership, urban planning, and public policy.

Quick’s research focuses primarily on involving diverse stakeholders in policymaking to address complex public problems. She often conducts her research in transportation and urban planning settings.

Quick and her colleague Guillermo Narvaez, a research associate at the Humphrey School, recently began an Institute-funded research project focused on collaborating with tribal governments to identify issues and solutions related to motor vehicle crashes among American Indians.

The rate of death and injury from motor vehicle crashes is significantly higher for American Indians than for any other ethnic group in the United States, Quick says, and the aim of her research project is to understand the nature of the problem and the sources of risk.

“To date, there has not been enough research done on why this is happening,” she says. “Much of what has been done is at the level of the American Indian population in the country as a whole. That does not give us a very good picture of what is happening in particular locations.”

To fill this gap, Quick is working with a broad variety of stakeholders to develop a more nuanced picture of the issue in terms of place-specificity. Although the project is just getting started, Quick says she has already begun to develop relationships with tribal transportation leaders, which she believes will lead to more future collaboration.

“Through the project itself we want to explore and build capacity for the kinds of policy measures and governance relationships that can effectively enhance safety,” she says.

Quick holds a Ph.D. in planning, policy, and design from the University of California, Irvine; an M.S. in city and regional planning from the University of California, Berkeley; and a B.S. in biology from Swarthmore College. Quick previously worked as an environmental advocate and policy analyst in Indonesia and as a community development manager in California.

**Institute researchers highlight safety work**

On August 18, several RSI researchers participated in Congressional Staff Day at the University of Minnesota. The event informed national and Minnesota congressional staff of the broad range of transportation research, education, and outreach initiatives important to Minnesota. RSI director Max Donath along with researchers Janet Creaser, Tom Horan, Chen-Fu Liao, Greg Lindsey, Lee Munnich, and Andrew Owen shared their safety-related work with attendees.

Creaser also presented at the National Conference of State Legislatures (NCSL)’s “Street Smart: Innovations in Traffic Safety Pre-Conference” in Minneapolis in August. The presentation highlighted the Teen Driver Support System (TDSS), which uses a teen driver’s smartphone to provide real-time, in-vehicle feedback to the teen about risky driving behavior and immediately communicate (via text
messages) with parents if the behavior continues.

The presentation was subsequently featured on the NCSL’s blog as a “particularly compelling session” that examined the driving behaviors of younger drivers, “who are increasingly connected to their cell phones, and how a cell phone application [the TDSS] could actually help teens develop safe driving habits.” The article goes on to note that legislators in attendance were interested in how the application worked, the data it collected, and how they could get the application to their states.

Additionally, Creaser presented her TDSS work in a presentation titled, “Teenage Driver Cellular Phone Use During the First Months of Driving” at the Fourth International Symposium on Naturalistic Driving Research in Blacksburg, Virginia, in August.

In September, the Institute was invited to showcase its research at a bicycle and pedestrian safety workshop held at the headquarters of the United States Department of Transportation in Washington, D.C.

Institute director Max Donath and Humphrey School professor Greg Lindsey discussed how work by researchers at the Institute is reducing the high risks faced by pedestrians and bicyclists through approaches that target all aspects of the journey—from better planning for routes and facilities to developing technologies and countermeasures for preventing crashes. Workshop attendees included representatives from the Federal Highway Administration, National Highway Traffic Safety Administration, and the Office of the Assistant Secretary for Research and Technology.

**Upcoming seminar: improving traffic safety with V2V communications**

Don’t miss the Institute’s last seminar this year, “Improving Traffic Safety and Mobility Using DSRC-Based V2V Communication” with Professor M. Imran Hayee of University of Minnesota–Duluth on December 4.

The seminar will highlight the development phases of a traffic information system for work zones using vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication that relies on dedicated short-range communication technology.

This Roadway Safety Institute seminar series provides updates on research related to the Institute’s focus areas of high-risk road users and traffic safety systems. As always, there’s no cost to attend, and each seminar qualifies for one Professional Development Hour. Attend in person, watch online, or watch any previous seminars you may have missed. Visit the Roadway Safety Institute website for more details.