U.S. Department of Transportation
Federal Highway Administration

Federal Highway Administration (FHWA) Research and Technology Agenda

Meeting the Challenge: Safety

Although tremendous progress has been made to improve highway safety, nearly 33,000 people still die in highway vehicle crashes each year. FHWA is working to prevent deaths and injuries by identifying and analyzing critical road safety issues. The Agency's comprehensive approach uses engineering, enforcement, education, and emergency services to reduce deaths and serious injuries.

FHWA's safety research program addresses the causes of roadway deaths and injuries related to roadway design, construction, and maintenance. The safety research program develops robust data analysis tools that enable transportation professionals to match crash causes with cost-effective countermeasures. With safety resources aimed at targeted safety problems, State and local agencies can deliver significant safety improvements to the public.

FHWA develops and promotes programs and technologies that have led to fewer injuries and deaths on the Nation's roads. For example, support for the implementation of roundabouts has reduced the potential for crashes at intersections and the use of longitudinal rumble strips warns drivers when their vehicles begin to stray from their lanes. Reflective traffic signs and pavement markings also make traffic control devices more visible and keep drivers aware of the road environment.

Training and technical assistance programs provided by program offices and the Resource Center extend the reach of FHWA safety research. Through these professional development activities, State and local transportation professionals gain the knowledge and tools they need to launch innovative and effective safety improvement initiatives for motorists, pedestrians, and bicyclists.

Objective: 1: Support the systematic planning, management, and evaluation of roadway safety.

Strategies

- Encourage the use of analytical, data-driven processes to improve safety decisions.
- Develop and deploy tools, processes, and guidance to support evidence-based safety decisionmaking.
- Evaluate and improve safety data collection and analysis programs, products, and countermeasures.

Showcase Activities

- Future Strategic Highway Research Program Safety Data Implementation
- Vehicle-to-Infrastructure Communications for Safety Support and Development for the Connected-Vehicle Program
- Highway Safety Information System (HSIS) VI
- Interactive Highway Safety Design Model
- Evaluation of Low Cost Safety Improvements Pooled Fund Study
- Development of Crash Modification Factors
- Crash Modification Factors Clearinghouse and Training

Future Strategic Highway Research Program Safety Data Implementation

Driver behavior is a key factor in as many as 90 percent of highway crashes, but until recently, our ability to examine behavior and its impact on safety was limited. In 2005, the U.S. Congress funded the Future Strategic Highway Research Program (SHRP2). The centerpiece of the Safety focus area in the program is the largest naturalistic driving study (NDS) ever conducted. In this

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unprecedented initiative, the vehicles of more than 3,000 volunteers were instrumented with a variety of sensors, including cameras recording the drivers' actions and the forward and rear views out of the vehicles; forward facing radars; global positioning systems to record the vehicle locations continuously; internal passive alcohol detectors; information about the drivers' uses of the vehicle controls; and a number of others. When the vehicle is switched on, all data are recorded as the driver conducts normal activities. By the time data collection ends in the fall of 2013, more than two petabytes of data will be accumulated, representing more than one million hours of driving. Analyzing these data will allow safety researchers to go beyond understanding "whether" a particular safety countermeasure works, to knowing "how" it works. Researchers will be able to observe drivers responding to all aspects of the driving environment—the vehicle, traffic characteristics, the design of the road, traffic control devices—and to assess the relative risk of drivers' actions. With this previously unavailable insight into driver behavior, the industry can develop new and improved countermeasures to save lives and reduce the frequency and severity of injuries on our highways. FHWA has the lead role for implementing the results of SHRP2. The primary objective of this effort is to provide access to and support the use of these data sets by the widest possible range of researchers. FHWA is sponsoring exploratory advanced research into the automated extraction of features of interest from massive video datasets. Also, between now and the 2015 end of SHRP2, FHWA will work with SHRP2 safety staff to create reduced datasets, richer trip file headers, and other tools, which will allow many researchers to fulfill their research objectives without having to manipulate the entire naturalistic driving study database.

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Vehicle-to-Infrastructure Communications for Safety Support and Development for the Connected-Vehicle Program

Vehicle-to-infrastructure communications for safety is the wireless exchange of critical safety and operational data between vehicles and highway infrastructure. The primary intent of vehicle-to-infrastructure communications is to avoid or mitigate motor vehicle crashes, but it also can enable a wide range of other safety, mobility, and environmental benefits.
Vehicle-to-infrastructure safety applications use data exchanged between vehicles and infrastructure elements to perform calculations that recognize high-risk situations in advance, and issue driver alerts and warnings through specific countermeasures. The objectives of the vehicle-to-infrastructure communications for safety research program are to: complete the development and testing of the vehicle-to-infrastructure communications technologies, advanced applications, and standards for national interoperability; develop a rigorous estimation of safety benefits and regulatory/policy guidance in support of deployment; provide tools and information that support infrastructure deployments nationwide; and ensure that appropriate strategies are implemented for privacy, security, system certification, accessibility, scalability, governance structures, public acceptance, and a sustainable marketplace that can propel deployment effectively.

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Highway Safety Information System (HSIS) VI

Highway safety is affected by factors including the geometric design of the roadway; the selection and placement of roadside hardware; the use of traffic control measures; vehicle size and performance capabilities; and user needs and abilities. Digital data related to these critical elements of roadway design, however, are not readily available for analysis. To improve safety assessments of highway projects, FHWA developed and maintains the HSIS, a roadway-based database that provides quality data on a large number of crash, roadway, and traffic variables. The database helps transportation professionals by: processing annual data from select States into a common format and making it accessible for analysis; including data, which can be used to analyze a large number of safety issues ranging from problem identification to modeling efforts that attempt to predict future crashes from roadway characteristics and traffic factors; and sharing data with other professionals conducting research such as the National Cooperative Highway Research Program, universities, and others studying highway safety.

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Interactive Highway Safety Design Model

Transportation development processes have traditionally only addressed safety impacts on a qualitative, rather than quantitative, basis. Quantitative analysis of the expected safety impacts of geometric designs would improve project design and deployment. With the exception of the first edition of the American Association of State Highway and Transportation Officials' Highway Safety Manual (HSM), there are few quantitative tools to assess safety. To meet this need, FHWA sponsored the development of the Interactive Highway Safety Design Model (IHSDM), a suite of software analysis tools that supports project-level geometric design decisions by evaluating the safety and operational effects of design. The model includes six evaluation modules: (1) Crash Prediction, (2) Policy Review, (3) Design Consistency, (4) Intersection Review, (5) Traffic Analysis, and (6) Driver/Vehicle. The Interactive Highway Safety Design Model results help project developers make design decisions that improve a roadway's expected safety performance, and justify and support their geometric design decisions. The Crash Prediction Module also serves as an essential resource in support of the Highway Safety Manual, Part C (Predictive Method). FHWA also offers free training and technical support to assist transportation planners and engineers in incorporating this new tool into their project development process.

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Additional Resources

- FHWA: Interactive Highway Safety Design Model

Evaluation of Low Cost Safety Improvements Pooled Fund Study

In recent years, considerable effort has focused on the development and use of crash modification factors. Crash modification factors are quantitative estimates of the effectiveness of safety countermeasures. The Evaluation of Low Cost Safety Improvements Pooled Fund Study, which began in 2005, involves 28 State departments of transportation; and currently is FHWA's second-largest Transportation Pooled Fund Study. The study evaluates unproven safety improvements, which have the potential to reduce crash severity on a national level. Potential improvements are drawn from the National Cooperative Highway Research Program Report 500. The most promising improvements are submitted for inclusion in the Highway Safety Manual. The study also provides benefit/cost ratio analysis to assist State departments of transportation and transportation agencies in safety project planning.

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Additional Resources

- FHWA: Evaluation of Low Cost Safety Improvements Pooled Fund Study Web Site

Development of Crash Modification Factors

State departments of transportation and other transportation agencies are often reluctant to invest in safety improvements without reliable, scientific evidence that demonstrates their effectiveness. FHWA's Development of Crash Modification Factors project—conducted in partnership with State departments of transportation and other stakeholders in the fall of 2012—will focus on scientific evaluation and allow transportation agencies to select and implement appropriate safety improvements with confidence. The Development of Crash Modification Factors project will develop crash modification factors and benefit-cost ratios for new or unproven safety improvements, utilizing Empirical Bayes and other relevant methodologies; and provide State departments of transportation and other transportation agencies with scientifically rigorous estimates of safety improvement effectiveness.

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Crash Modification Factors Clearinghouse and Training

Transportation professionals are challenged with choosing safety strategies that deliver the greatest safety benefits, even when budgets are limited. These professionals can use crash modification factors to quantify and compare expected safety benefits of multiple safety strategies to determine the most cost-effective solutions. FHWA established the Crash

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Modification Clearinghouse in 2009 to provide transportation professionals with a regularly updated online repository of crash modification factors, a mechanism for sharing newly developed crash modification factors, and educational information on the proper application of crash modification factors. Some ways planners and engineers use crash modification factors include: evaluating the relative cost effectiveness of safety strategies for enhancing signal visibility; comparing the cost and safety consequences between paved and unpaved shoulders; comparing the long-term safety impacts of a series of roundabouts as opposed to a series of signalized and unsignalized intersections.

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Additional Resources

- FHWA: Crash Modification Factors Clearinghouse

Objective: 2: Accelerate the reduction in injury and fatal crashes at intersections.

Strategies

- Provide technical assistance and training to promote noteworthy practices in intersection safety.
- Promote innovative solutions through outreach, marketing, and technical evaluation.
- Analyze existing data to improve identification and assessment of intersection problems.
- Research, evaluate, and develop intersection safety analysis methods and tools.
- Identify and evaluate promising new intersection designs and technologies.
- Develop, evaluate, and deploy intersection safety countermeasures.

Showcase Activities

- Field Evaluation of Double Crossover Diamond Interchanges
- Field Evaluation of Detection-Control System
- Safety Evaluation of Access Management Policies and Techniques
- Field and Safety Evaluation of Mini-Roundabouts

Field Evaluation of Double Crossover Diamond Interchanges

Highway intersections pose safety conflicts between through traffic on highways and traffic turning to access or exit the highway. Transportation professionals have developed design solutions to reduce driver conflicts, such as the double crossover diamond interchange, also known as the diverging diamond interchange. The double crossover diamond design channels both through traffic and left-turning traffic to the left side of the road at ramp intersections. With this design, traffic arriving at the downstream ramp may turn left to access the freeway without conflict and can move simultaneously with through traffic. At the ramp, traffic is channelized back to the right side of the road. Double crossover diamond interchanges are used in European countries to improve safety, but have not been widely implemented in the United States. To help transportation professionals apply double crossover diamond designs to address interchange safety issues and congestion, FHWA is conducting research, which will evaluate the operational and safety impacts of double crossover diamond interchanges; document the state of practice in geometric design, signage, and signal timing coordination; and identify strategies to accommodate pedestrians and bicyclists in double crossover diamond interchanges.

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Field Evaluation of Detection-Control System

Rural and isolated high-speed intersections pose unique safety challenges, especially regarding red-light running. A detection-control system is a new dilemma zone protection technology, which is designed to reduce crashes and unnecessary delays at these intersections. It requires proper sensing to detect the speed and length of vehicles on each major road through lane, and vehicle presence detection on minor approaches. The technology must be tested thoroughly prior to implementation on a larger scale. FHWA is sponsoring research to investigate the operational and safety impacts of detection-control systems by deploying them at eight sites in four different States. Specifically, the research will identify the effectiveness of detection-control systems in reducing red-light running violations; identify environmental conditions correlated with red-light running violations; and inform future efforts to develop and deploy detection-control systems as a safety measure on rural high-speed intersections.

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Safety Evaluation of Access Management Policies and Techniques

Access management policies are regulations restricting intersection and signal spacing along a road, which are common for arterial roads. States and municipalities incorporate access management policies with other roadway design strategies to reduce collisions from turnoffs from arterials onto smaller streets. However, there have been few quantitative assessments of the effectiveness of these policies, both in design and compliance. To ensure that State and local agencies are employing proven strategies to meet the safety needs of communities, FHWA is conducting a research study to develop methods to evaluate the safety impacts of access management policies and design techniques; develop an access management evaluation method to assess driver compliance of these policies; and develop corridor-level crash prediction models that will assist in the effective selection and application of these techniques.

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Field and Safety Evaluation of Mini-Roundabouts

Mini-roundabouts are gaining popularity in the United States as a new type of intersection. They can be part of a traffic-calming scheme, and may be an optimal solution for a safety or operational issue at an existing stop-controlled or signalized intersection where there is insufficient right-of-way for a standard roundabout installation. Although mini-roundabouts could address numerous safety and congestion issues, they may not be appropriate in all contexts, including areas with high truck volume or light volumes of street traffic. FHWA is investigating the operational and safety impacts of converting existing sign- and signal-controlled intersections into mini-roundabouts, and is producing a design guide for mini-roundabout implementation in the United States. The study will enhance the understanding of the safety benefits of mini-roundabouts; impacts of mini-roundabouts on reducing congestion; and implementation of mini-roundabouts in a variety of contexts.

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Objective: 3: Increase pedestrian and bicycle safety and mobility.

Strategies

- Develop tools to improve identification and assessment of pedestrian and bicycle safety problems through data analysis.
- Develop and evaluate countermeasures that address safety issues for pedestrians and bicyclists.
- Deliver, market, and evaluate products and technologies to improve pedestrian and bicyclist safety.

Showcase Activities

- Evaluation of the Effectiveness of Existing Pedestrian Safety Measures
- Human Factors Assessment of Pedestrian Midblock Behavior
- Evaluation of Pedestrian Safety Engineering Countermeasures at Urban and Suburban Midblock Crossing Locations

Evaluation of the Effectiveness of Existing Pedestrian Safety Measures

Pedestrians tend to choose the shortest possible path from a point of origin to a destination, even when the shortest path may result in increased safety risks. Safety engineers need to be able to identify, evaluate, and apply safety measures for drivers and pedestrians at locations that are potentially hazardous, so that the most convenient path is also a safe path. State and local agencies have used various treatments to encourage safe pedestrian crossing, including pedestrian hybrid beacons and rectangular rapid flashing beacons. An evaluation of the effectiveness of these practices is needed. FHWA is conducting research to help improve the understanding of pedestrian and driver responses to existing pedestrian treatments. This research will evaluate the performance of selected pedestrian crossing treatments in reducing pedestrian injuries and fatalities; help guide the development of higher-performing and more cost-effective devices and installations; enhance the ability of designers to incorporate pedestrian hybrid beacons,

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rectangular rapid flashing beacons, and other devices into pedestrian crossings, which will ultimately allow pedestrians to choose routes designed for their safety.

Human Factors Assessment of Pedestrian Midblock Behavior

Crash data indicate that the majority of pedestrian fatalities occur in nonintersection locations. It is likely that a substantial proportion of these fatalities occur when the pedestrian is crossing the roadway outside of appropriate intersection crossings. Despite greater safety risks, many people will cross a road where it is most convenient to access their destinations. While it is not feasible to place crosswalks at all locations where pedestrians might choose to cross the roadway, it is possible to identify the environmental characteristics and cues that influence pedestrians to cross at risky locations. If a better understanding of midblock crossing affordances is attained, modifications can be made to increase pedestrian safety through marked crossings or midblock crossing inhibitors. To reduce pedestrian fatalities and injuries resulting from midblock crossings, this research project will apply human factors techniques and methodologies to identify pedestrian motivations to cross at midblock locations in urban and suburban areas; identify the environmental characteristics associated with different crossing behaviors; and develop effective and low-cost countermeasures, including roadway treatments or other safety strategies to improve pedestrian safety relevant to midblock crossing.

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Evaluation of Pedestrian Safety Engineering Countermeasures at Urban and Suburban Midblock Crossing Locations

Midblock or nonintersection locations account for about half of the pedestrians injured in crashes. For fatal crashes, the situation is much worse. Approximately 75 percent of pedestrian fatalities occur at nonintersection locations. When pedestrian travel involves crossing a street or highway with long distances between intersection crossings, many pedestrians choose to cross at a midblock location, despite the lack of a formal crosswalk. The goal of this research is to improve pedestrian safety at urban and suburban midblock crossing locations through the identification of appropriate low- to mid-cost countermeasures. Specifically, the project will evaluate the effectiveness of pedestrian crossing signs with embedded light-emitting diodes and pedestrian crossing signs with beacon designs on the yielding behavior of drivers; and identify driver preferences and responses to pedestrian crossing sign brightness levels.

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Objective: 4: Provide policy and technical assistance to State and local agencies in reducing speeding-related fatalities, injuries, and crashes.

Strategies

- Identify and promote effective methods and technologies for creating a safer road environment with appropriate travel speeds, consistent speed limits, and condition-responsive warnings.
- Conduct research and evaluation to better define the relationship between speed and safety.
- Improve the level of knowledge, understanding, and awareness of the dangers of speeding among safety professionals and the driving public.

Showcase Activities

- Informational Report on Methods to Achieve Safe Speeds on Rural and Suburban Roadways
- Evaluation of Speed-Activated Displays on Curves

Informational Report on Methods to Achieve Safe Speeds on Rural and Suburban Roadways

In rural and suburban areas, excessive speed on curves is a contributing factor in many roadway crash fatalities and injuries. State and local agencies have used a variety of roadway treatments to encourage drivers to identify safe speeds for upcoming curves and to self-adjust. Such treatments include rumble strips and other surface modifications. Without a holistic understanding of roadway treatments to encourage safe speed, however, State and local agencies may not have the

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necessary information to make the best decisions for their roadways. To address this lack of knowledge, FHWA is sponsoring research to document and analyze the wide variety of roadway treatments designed to reduce speed, focusing on treatments that are implemented during road rehabilitation. The research report will describe the available roadway treatments that result in appropriate driver speed adjustments on rural and suburban roadway curves and tangent sections; document the cost-effectiveness and aesthetics of the treatments; describe the impact of the treatments on bicyclists and pedestrians; provide guidance to transportation agencies on how to implement appropriate treatments as part of rehabilitation, resurfacing, and reconstruction projects.	richard.knoblauch@dot.gov
Evaluation of Speed-Activated Displays on Curves Curves on two-lane rural roads are a significant safety concern. An estimated 56 percent of run-off-road fatal crashes on curves are speed related. Dynamic speed feedback sign systems are new methods designed to encourage drivers to reduce speeds on curves, decreasing the risk of roadway departure. These systems show promise, yet they have not been evaluated fully. This project will evaluate the effectiveness of dynamic speed feedback sign systems in reducing speed and crashes on rural, two-lane roadway curves; and enhance transportation professionals' knowledge of the potential of this new technology to reduce speed-related fatalities and serious injuries due to lane departure.	**Activity Contact** **Richard Knoblauch** FHWA Office of Safety Research and Development Tel: 202-493-3369 Email: richard.knoblauch@dot.gov
Objective: 5: Reduce crashes and fatalities due to roadway departure.	
Strategies • Research and analyze roadway crashes to improve understanding of crash causes. • Develop methods and tools for the design and evaluation of roadway departure programs and treatments. • Develop and evaluate innovative countermeasures for roadway departure crashes. • Deploy products, guidance, and training and provide technical support to help States keep vehicles on the roadway and minimize the consequences of leaving the roadway.	**Showcase Activities** • Reduction of Horizontal Curve Crashes on Two-Lane Rural Highways • Analysis of Influences of Highway Features on Rollover Crashes • Analysis of Crash Testing of Infrastructure Security Barriers • Vehicle and Hardware Finite Element Models
Reduction of Horizontal Curve Crashes on Two-Lane Rural Highways Curved roads, especially those in rural locations, are common sites for crashes due to increased speed and reduced visibility. FHWA is working with partner agencies to research innovative techniques and strategies to reduce crashes at horizontal curves. Through this program, FHWA seeks to identify and promote proven and effective implementation practices; and the best technologies for speed-activated traffic control devices.	**Activity Contact** **Joseph Cheung** FHWA Office of Safety Tel: 202-366-6994 Email: joseph.cheung@dot.gov
Analysis of Influences of Highway Features on Rollover Crashes Roadway departure crashes account for the majority of highway fatalities. In 2009, there were 16,265 fatal roadway departure crashes (53 percent of all fatal crashes in the United States), which resulted in 18,087 fatalities. Roadway departure crashes include those that occur when a vehicle crosses an edge line or centerline. To reduce roadway departure fatalities and serious injuries, FHWA is conducting research to understand the causes of road departures and vehicle rollovers better, and to develop strategies and safety standards. The objectives of this research are to undertake detailed analyses of rollover crashes to better understand underlying vehicle kinematics associated with rollover crash causes; evaluate the potential effectiveness of new treatments or countermeasures; and investigate whether current design practices can be improved	**Activity Contact** **Ana Maria Eigen** FHWA Office of Safety Research and Development Tel: 202-493-3198 Email: ana.eigen@dot.gov

to reduce rollovers. Reviews of crashworthiness datasets have been undertaken to improve understanding of the evolving, yet limited, forensic data. Sources of the data range from a fatality census based on police crash reports, to onscene crash investigations with detailed crash environment, vehicle, and occupant data. This literature review and data analysis will feed into a modeling effort to understand vehicle dynamics and occupant outcomes when a vehicle leaves the roadway. Vehicle interactions with barriers and various terrains types are under consideration for the modeling effort.

Analysis of Crash Testing of Infrastructure Security Barriers

Perimeter security devices are used to prevent the unwanted intrusion of speeding motor vehicles into Government buildings and other critical facilities, and thus serve a critical national role in enhancing infrastructure security in the United States. To support the development of perimeter security devices, FHWA works in conjunction with the Department of State to develop state-of-the-art computer models and crash simulations to study the effectiveness of infrastructure security barriers. Simulations are validated through full-scale crash tests at FHWA's Federal Outdoor Impact Laboratory. The results of the simulations and testing are used to improve the design, applicability, constructability, and deployment of infrastructure barriers.

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Vehicle and Hardware Finite Element Models

To support crash research, FHWA develops and maintains an array of finite element models for typical vehicles. Developing such models involves reverse engineering to create new vehicle models, understanding the technical requirements for modeling vehicle features (e.g., suspension systems, frame structures, interiors), and verifying and validating the models. It also consists of assessing changing vehicle characteristics to reflect next generation vehicles, and assuring that modeling of these vehicles is compatible with finite element modeling protocols and crash simulation software tools. FHWA also provides documentation and support to users of the models. Current projects include developing and validating detailed finite element models for a mid-sized car and a tractor-trailer vehicle.

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Objective: 6: Improve the visibility on and along the roadway and of traffic control devices.

Strategies

- Research and analyze the impacts of roadway lighting and visibility on safety.
- Develop cost-effective new practices and technologies to improve visibility.
- Provide technical support on visibility issues.

Showcase Activities

- Strategic Initiative for the Evaluation of Reduced Lighting on Roadways
- Impact of Spectral Power Distribution on Driver Performance

Strategic Initiative for the Evaluation of Reduced Lighting on Roadways

Adaptive lighting is a growing trend in the roadway industry, driven by the development of new lighting technology and a nationwide push to reduce energy use and environmental impacts. Adaptive lighting is a design methodology where the lighting system adjusts to the roadway environment, providing an optimum level of light as ambient conditions change. While transportation agencies have begun to introduce adaptive lighting into their roadway projects, techniques for implementing adaptive roadway lighting have not yet been standardized. The Strategic Initiative for the Evaluation of Reduced Lighting on Roadways will evaluate the issues associated with the application of adaptive lighting to the roadway environment and develop recommended practices for implementing adaptive lighting systems. The study will develop recommended approaches to implement adaptive lighting; provide a legal review of the issues associated with adaptive lighting; and conduct a review of the crash and safety benefits

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associated with implementing adaptive lighting technologies.

Impact of Spectral Power Distribution on Driver Performance

Vehicle headlamps and glare can impair a driver's ability to navigate and identify safety hazards, especially at night. A better understanding of the factors contributing to visual disturbance is needed in order to develop standards and policies that will make roadways and vehicles safer for everyone. FHWA is sponsoring research to evaluate driver performance in high-speed road and low-speed street environments, as well as the safety impacts of vehicle headlamp options and prototype adaptive illumination concepts (such as camera-based detection systems involving a momentary peripheral illumination feature). Through this project, researchers will identify any measurable differences in driver performance among varying lighting types and levels; develop methods to evaluate the safety impacts of lighting types; and identify the correlations between driver performance and vehicle and roadway lighting to inform safety policies and standards.

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Objective: 7: Reduce motorcycle crashes and fatalities.

Strategies

- Conduct research to help identify the causes of motorcycle crashes.
- Develop and evaluate countermeasures to address motorcycle safety issues.
- Promote the deployment of effective countermeasures that address motorcycle safety issues.
- Deploy products, guidance, and training to help States reduce motorcycle crashes and fatalities.

Showcase Activities

- Motorcycle Crash Causation Study

Motorcycle Crash Causation Study

Over the past decade, motorcycle fatalities have risen to 14 percent of all traffic fatalities in the United States. In response to this growing issue, FHWA initiated the Motorcycle Crash Causation Study, the most comprehensive investigation about motorcycle crashes in the United States in more than 30 years. The study currently is collecting data on real-world motorcycle crashes in Orange County, California. Trained crash investigators are collecting information on the crashed motorcycle, the riders involved in the crashes, the crash scene, and resulting injuries. The results of this study will include a unique dataset on motorcycle crashes, riders, and roadway conditions; a better understanding of motorcycle crash causation factors; analysis leading to countermeasures and safety standards; and ultimately, a reduction in motorcycle crashes and fatalities.

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Additional Resources

- FHWA: Motorcycle Crash Causation Study

Objective: 8: Reduce fatalities and serious injuries on local and rural roads.

Strategies

- Conduct outreach to elevate awareness of roadway safety issues and notable practices among local elected officials and provide technical assistance navigating the Federal-aid funding process.
- Develop and deploy tools and technologies to help road owners develop and design local solutions to their roadway safety issues.
- Promote the use of Intelligent Transportation Systems (ITS) technologies to improve safety on local and rural roads.

Showcase Activities

- Low-Cost Intelligent Transportation Systems (ITS) Safety Countermeasures

Low-Cost Intelligent Transportation Systems (ITS) Safety Countermeasures	Activity Contact
Rural areas can benefit from low-cost intelligent transportation systems as a means to reduce vehicle crashes. Intelligent transportation systems can improve safety by efficiently alerting drivers to changing travel and road conditions, traffic incidents, or other important information. FHWA is supporting research in this area to identify the most promising intelligent transportation systems solutions for rural roads; understand application of intelligent transportation systems in rural areas; and provide tools and training for local and rural implementation.	**Rosemarie Anderson** FHWA Office of Safety Tel: 202-366-5007 Email: rosemarie.anderson@dot.gov

Objective: 9: Improve the understanding of how road users perceive, process, and respond to the roadway environment to inform better roadway design, construction, repair, and improvement processes.

Strategies	Showcase Activities
• Research highway user needs and capabilities to advance the understanding of safety impacts and design implications. • Provide technical support on human factors issues.	• Pilot for Study of Driver Behavior on Horizontal Curves • Understanding Driver Expectations When Navigating Complex Interchanges • Improving Signing and Markings at Complex Interchanges • Information as a Source of Driver Distraction

Pilot for Study of Driver Behavior on Horizontal Curves	Activity Contact
Approximately 4,700 annual roadway fatalities are run-off-road crashes on rural two-lane roadways with horizontal curves. Post-crash investigations show that in most cases, the driver was familiar with the roadway, but could have been distracted or in a hurry. The purpose of this project is to evaluate methods of establishing and eliciting precrash conditions using a driving simulator. Expected outcomes of the project include a better understanding of precrash driver behavior on two-lane rural roadways with horizontal curves for use in driving simulation research; and development of strategies to reduce run-off-road crashes on such roadways.	**Jim Shurbutt** FHWA Office of Safety Research and Development Tel: 202-493-3420 Email: jim.shurbutt@dot.gov

Understanding Driver Expectations When Navigating Complex Interchanges	Activity Contact
Driver confusion, especially when related to lane choice, can lead to dangerous driving errors. The purpose of this project is to develop a method to predict driver expectations at interchanges and determine how these expectations affect driver behavior. Researchers will study driver behavior and expectations at a range of interchanges of varied complexity. Expected results of this study include recommendations for more intuitive directional signage at interchanges and for interchange designs that will improve driver navigation, safety, and comfort.	**Jim Shurbutt** FHWA Office of Safety Research and Development Tel: 202-493-3420 Email: jim.shurbutt@dot.gov

Improving Signing and Markings at Complex Interchanges	Activity Contact
Designing navigation signage for complex interchanges is a challenging undertaking. At the same time, complex interchanges are precisely where clear navigation signage and markings are most needed. This project seeks to identify potential improvements to current practices of displaying navigational signs and highway markings for complex interchanges. This project will develop noteworthy practices for interchange signage to improve driver comfort and safety while	**Jim Shurbutt** FHWA Office of Safety Research and Development Tel: 202-493-3420

enhancing transportation professionals' understanding of different signage effects on driver decisionmaking.	Email: jim.shurbutt@dot.gov
Information as a Source of Driver Distraction With advances in technology, changeable message signs now can be built to resemble existing static signs, and can display exact replicas of signs from the Manual of Uniform Traffic Control Devices (MUTCD). New changeable message signs also have custom color, animation, video, and brightness options, which could distract drivers and result in heightened safety risks. The project will examine the distraction potential of information sources in the right-of-way, with a focus on the full graphic capabilities of changeable message signs. The project will determine the distraction potential of various types of information when displayed on changeable message signs, including advertisements within the right-of-way. The study will determine how motorists respond to these types of information when displayed on a changeable message sign in both simulated and onroad driving environments; develop a scientific basis for making decisions about the types of information that can be displayed safely within the right-of-way without adversely distracting drivers (with a focus on graphically enabled changeable message signs); and determine appropriate guidelines for using changeable message signs based on the study outcomes.	**Activity Contact** **Brian Philips** FHWA Office of Safety Research and Development Tel: 202-493-3468 Email: brian.philips@dot.gov

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