

# Building a safer transportation system:

How the new SHRP2 safety databases can take us there



*Photo courtesy University of South Florida, Dr. Achilles Kourtellis and Dr. Pei-Sung Lin*

SEPTEMBER 2014

**SHRP2 SOLUTIONS**  
TOOLS FOR THE ROAD AHEAD

## Using new data and research to reduce crashes and improve highway safety

Traffic safety is a top priority of transportation agencies across America – safety for the traveling public using our roadways, safety for transportation agency employees and their contractors working to maintain our streets and highways, and safety for our incident responders. More than 2.36 million people were injured in motor vehicle crashes in 2012. While driver behavior is most often cited as the primary factor in more than 90 percent of these crashes, little is known about how this behavior contributes to crashes.

A project now underway and supported by the Federal Highway Administration (FHWA) and the American Association of State Highway and Transportation Officials (AASHTO) will enable state transportation agencies and their research partners to use new data developed through the second Strategic Highway Research Program (SHRP2) to develop improved methods for reducing crashes and improving highway safety.



“This information will ultimately enable states to develop specific measures that will help us reduce crashes and save lives. It’s a great opportunity for state DOTs and our partner research agencies to turn new data into valuable tools.”

—Rudy Malfabon, Chair,  
AASHTO’s Safety Task  
Force, and Director,  
Nevada Department of  
Transportation



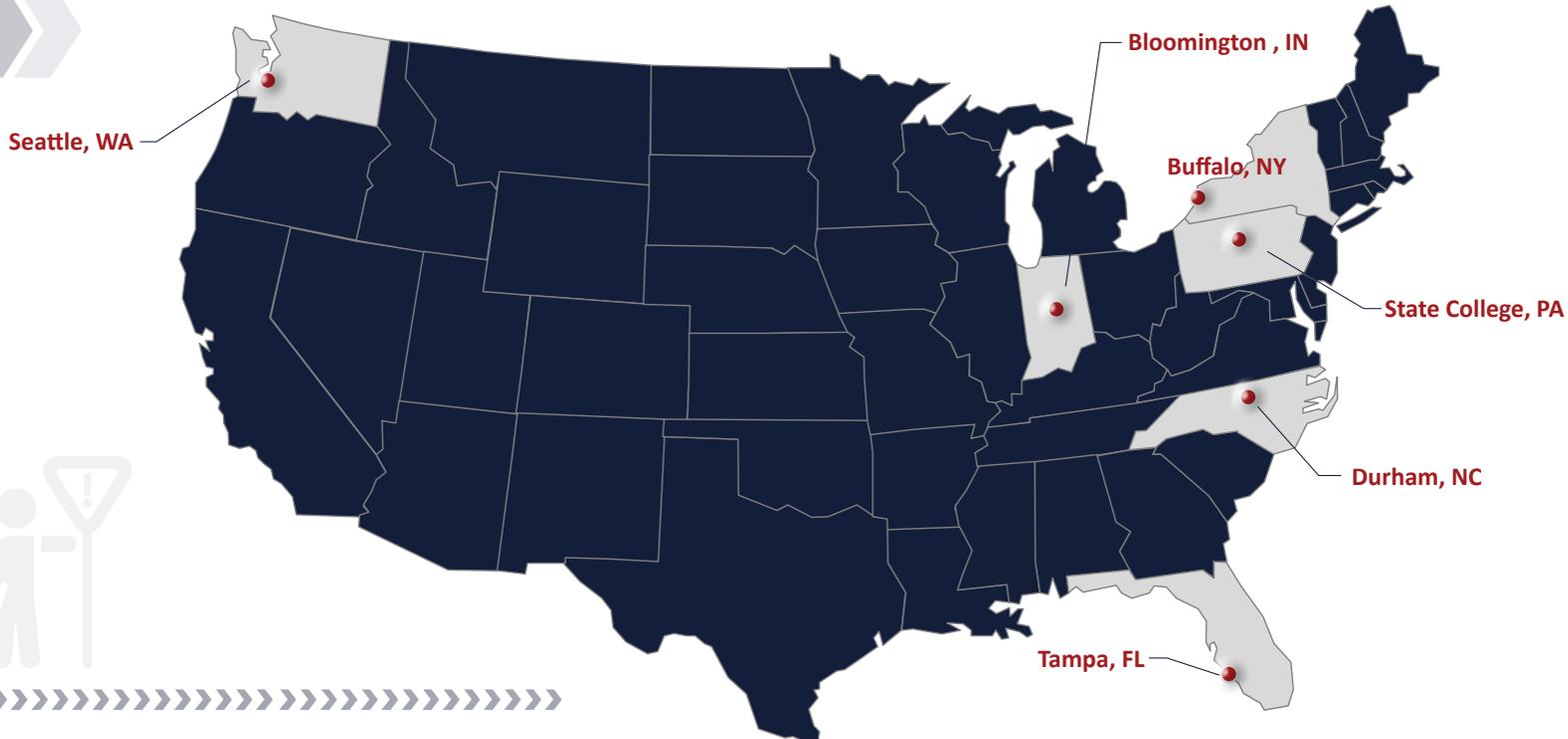
The SHRP2 safety data comprise two large databases: a **Naturalistic Driving Study (NDS)** database and a **Roadway Information Database (RID)**. The NDS data provide a wealth of information regarding driving behavior, and the RID is a companion database measuring roadway elements and conditions. These two databases can be linked to associate driver behavior with the actual roadway characteristics and driving conditions.

The NDS provides objective information on what preceded crash and near-crash events and identifies what drivers actually are doing during real-world driving conditions. In the SHRP2 study, more than 3,100 volunteer drivers in six locations had their cars outfitted with miniature cameras, radar, and other sensors to capture data as they went about their usual driving tasks. These data are the first opportunity for researchers to study U.S. driving behavior that is as close to “natural” as possible for the purpose of investigating highway safety issues.

The RID is a geo-database that contains detailed information about the roadway characteristics in and around the NDS study cities. New roadway data were collected using a mobile van on 12,500 centerline miles across the six NDS sites. Existing roadway and other relevant information were obtained from government, public, and private sources and includes crash histories, traffic, weather, work zones, and safety campaigns.

The NDS and RID data sets will be linked by December 31, 2014, to provide researchers with a uniquely powerful data source. Both data sets are geo-referenced, allowing for driver behavior to be matched with the roadway environment, as well as to temporal elements of the driving environment, such as work zones and weather.





## NDS Study Design

- ▶ Largest naturalistic driving study ever undertaken
  - 3,147 drivers, all age/gender groups
  - 3,958 data years; 5 M trip files; 49.7 M vehicle miles
  - 3 years of data collection
    - Most participants 1 to 2 years
  - Vehicle types: All light vehicles
    - Passenger Cars
    - Minivans
    - SUVs
    - Pickup Trucks
  - Six data collection sites
- ▶ Integrated with detailed roadway information in the RID



Photo Courtesy Arizona DOT



## Safety Task Force

In March 2014, AASHTO's Safety Task Force was formed to assist with designing a program to enable state departments of transportation (DOTs) and their researchers to access and begin using the safety data. The Safety Task Force includes representatives from each safety-related AASHTO committee and provides advice and counsel to the FHWA/AASHTO Implementation Assistance Program (IAP) safety effort. For the recent IAP solicitation, the Safety Task Force identified a three-phased process to ensure that the most promising strategies for capitalizing on the SHRP2 safety data analysis would be conducted by the state DOTs. The Safety Task Force has also assisted AASHTO and FHWA in reviewing the research proposals submitted for the IAP solicitation. In the future, it will assist in reviewing research findings at the conclusion of Phase 1 and make recommendations for advancing the most promising research to Phase 2.

## Adding safety to the Implementation Assistance Program—the *Concept to Countermeasure* Project

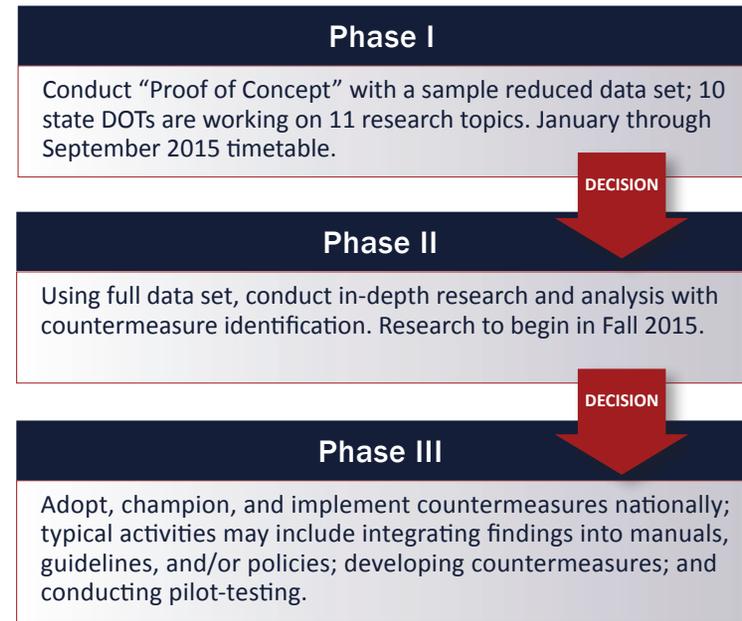
Through the FHWA/AASHTO IAP, results from the NDS and RID databases are being made available to state DOTs interested in analyzing the data to identify crash causation factors and to develop effective countermeasures, such as road designs or public safety campaigns, which will address their common safety concerns.

In August, FHWA and AASHTO announced that 10 states will participate in a “Proof of Concept” effort offered through the SHRP2 program, *Concept to Countermeasure – Research to Deployment Using the SHRP2 Safety Databases*. Approximately \$3 million in financial and technical assistance will be made available to conduct research on 11 topics. IAP recipients must agree not only to research a topic using the SHRP2 safety data but also to actively pilot and promote any promising countermeasures that are identified by their research. A primary – but not the only – goal is national adoption of new countermeasures. States, partnered with researchers, have agreed to manage research, implement findings, and deliver authorized research results.

### **A three -phased approach**

To simplify the application process and to reduce the risk and uncertainty to applicants, a three-phased process will be used. In Phase 1, participants will use a small pilot data set of NDS and RID data and demonstrate within nine months the “proof of concept” of their research proposal and that a full analysis with a larger data set can answer the research question posed by the agency and its research partners.

At the end of Phase 1, the work will be presented and reviewed by FHWA and the AASHTO Safety Task Force, which will determine whether the results are promising enough to move to Phase 2. Those DOTs selected for Phase 2 will have access to the full SHRP2 safety data set. A separate work plan, budget, and schedule will be negotiated for Phase 2.



If Phase 2 produces meaningful results that are likely to lead to an implementable countermeasure or a new behavioral strategy, then the Safety Task Force and FHWA could provide additional financial or technical support for Phase 3, which would address implementing the countermeasure. Implementation would not include additional research; instead, implementation in Phase 3 could include engineering or other support to update national manuals, policies, or strategies to incorporate the countermeasure and endorse it for national adoption. Phase 3 might also include pilot-testing a developed safety countermeasure in the field, implementing new public outreach efforts, or using other measures to improve highway safety.



## Ten states will research 11 important safety concerns

From 30 applications submitted to FHWA/AASHTO, 10 state DOTs were selected to begin research in January 2015 using the two safety databases, with each state receiving approximately \$100,000 for each proposal. They will initially use a sample data set and will report on their findings by September 2015.

Proof of Concept	
Pedestrian Safety	Florida DOT Nevada DOT New York State DOT
Roadway Departure	Iowa DOT
Speeding	Michigan DOT Washington DOT
Work Zones	Minnesota DOT
Horizontal and Vertical Curves	North Carolina DOT
Interchange Ramps	Utah DOT
Adverse Conditions	Wyoming DOT
Roadway Lighting	Washington DOT

The DOTs included Florida, Iowa, Michigan, Minnesota, Nevada, New York, North Carolina, Utah, Washington, and Wyoming. Washington State DOT received two awards for separate research topics. The topics include pedestrian-vehicle interaction; roadway departures; speeding; work zones; horizontal and vertical roadway curves; interchange ramps; adverse weather conditions; and roadway lighting.



Photo courtesy University of South Florida, Dr. Achilles Kourtellis and Dr. Pei-Sung Lin



## Florida DOT

### Understanding the interactions between pedestrians and drivers at signalized intersections

The Florida DOT is seeking to better understand the interactions between drivers and certain pedestrian features—such as pedestrian signs, pedestrian signals, and crosswalks—and drivers and pedestrians at signalized intersections in order to develop more effective engineering, education, and enforcement countermeasures to improve pedestrian safety. Gender and age group information will be included in this research, which will cover four broad topics: vulnerable road users, roadway features and driver performance, intersections, and driver speeds.

The findings of the research can help the Florida DOT assess the following: 1) driver interactions with pedestrian features, such as pedestrian traffic signals, yield-to-pedestrian signs, and crosswalks at signalized intersections when pedestrians are or are not present; 2) the effectiveness of pedestrian features; 3) the impact of gender and age group on driver interactions; 4) specific interactions between drivers and pedestrians; and 5) the impact and types of driver attention and/or distraction on driver interactions with pedestrian features and pedestrians. This analysis can assist in developing effective engineering, education, and enforcement strategies and countermeasures to reduce pedestrian fatalities and enhance pedestrian safety in Florida.



Understanding the interactions between pedestrians and drivers at signalized intersections | Photo courtesy University of South Florida, Dr. Achilles Kourtellis and Dr. Pei-Sung Lin

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## Iowa DOT

### **Investigating the roles of the driver and roadway characteristics in crashes**

Road departures account for approximately 58% of all roadway fatalities and can occur on any type of roadway. The Iowa DOT's research will focus on driver speed and distraction, roadway geometry, and how roadway design countermeasures may affect road departures. Early estimates suggest that 500 to 600 actual road departure events will be available for analysis during Phase 1.

The objective of this research is to draw a relationship between crash characteristics and roadway, driver, and environmental factors. Although Phase 1 is a proof-of-concept study, the Iowa DOT hopes to have early results that can provide transportation agencies with information about which characteristics either contribute to roadway departures or are associated with fewer roadway departures. The results will allow agencies to better understand which roadway safety countermeasures and roadway characteristics are associated with fewer and less severe road departure crashes.

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Researching distracted driving. | Photo courtesy iStockphoto



## Michigan DOT

### **Assessing how speed limits on certain types of roadways affect driver behavior**

The Michigan DOT will focus on addressing how a driver's behavior changes in response to posted speed limits, while controlling for the effects of other important factors, such as roadway geometry, particularly horizontal and vertical alignment. This research will emphasize limited access facilities (e.g., freeways), where the design

standards are higher, and as a result, a higher range in operating speeds occurs. The research questions to be addressed as part of the Phase 1 proof-of-concept study include differences in speed selection for different drivers and differences in speed due to traffic crashes or near-crash events.

This research hopes to provide critical insights regarding the setting of maximum speed limits, the use of advisory sign location and designs, and important differences among drivers. Given the level of detail provided by data from the NDS and RID databases, speed selection behavior can be related back to individual driver characteristics, as well as to issues that influence driver distraction (e.g., use of cell phones).

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Driving Simulator, Automotive Safety Group | Photo courtesy IA Wayne State University College of Engineering



## Minnesota DOT

### **Determining the role played by speed and distractions around work zone crashes**

More than 1,000 fatalities and 40,000 injuries occur annually in work zones in the United States. The most common way to evaluate these type of safety issues is through analyzing crash data, which only includes reported crashes and reports that are often open to interpretation by present parties. Using the SHRP2 safety data, however, the Minnesota DOT will have available a first-hand view of driver activities in work zones. Actual driver behavior can be observed, helping to determine how drivers negotiate work zones and the factors present when critical situations arise.



Speeding in work zones will be studied. | Photo courtesy WSDOT

The products that will be created out of this research can help stakeholders, including safety researchers, AASHTO, FHWA, state DOTs, counties, and cities, answer what role speed and distraction play in work zone crashes and near crashes. The Minnesota DOT expect to provide reports outlining safety impacts for drivers, work zones, and road characteristics, recommendations for application, and evaluations for changes to work zone standards

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## Nevada DOT

### **Assessing the influence of different factors on pedestrian crashes at intersections**

The FHWA reported that each year approximately 4,000 people die in pedestrian-vehicle crashes, and another 59,000 are injured. The largest proportion of these crashes occur at intersections. Many factors, including drivers, vehicles, roadways, and environment, may have an influence over vehicle drivers being able to see and react to pedestrians. The Nevada DOT will study how driver, vehicle, roadway, and environmental factors affect turning and drivers seeing and yielding to pedestrians at intersections. Research findings will be used to guide the development and implementation of effective countermeasures to improve the safety of pedestrians at intersections. The Nevada DOT will acquire data from SHRP2 NDS data, state crash data, and geographic information system (GIS) road networks to help investigate the effects and influences of the various factors so that they



Research focuses on high visibility crosswalks. | Photo courtesy FHWA

can be prioritized or modeled to estimate pedestrian-turning-traffic crash risk at intersections and to develop effective countermeasures.

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## New York State DOT

### **Analyzing pedestrian safety and high-visibility markings**

In New York state, 297 pedestrians were killed by vehicular crashes in 2012, approximately 25 percent of all vehicle-crash-related fatalities in the state. Numerous countermeasures and programs have been undertaken to reduce pedestrian crashes. Past pedestrian safety studies relied upon observations of motorist speed and vehicle-pedestrian conflicts to evaluate crosswalk treatment effectiveness. The New York State DOT will evaluate the use of high-visibility markings of crosswalks (HVC) and how they might improve pedestrian safety at uncontrolled intersections. The DOT also will research preferred design and implementation methods as well as HVC-related improvements.

The SHRP2 safety data provide the opportunity to study the behavior over time as the same driver (s) traverse treated and untreated crosswalks under a variety of different driving and environmental conditions. In addition, the SHRP2 in-vehicle instrumentation offers the opportunity to use additional conflict-related observations such as steering wheel motion, brake application, and throttle position. This analysis is expected to provide new insight into the effectiveness of HVC markings in reducing risks of pedestrian vehicle crashes and conflicts at uncontrolled intersections. This analysis also will enable the development of improved HVC design, countermeasure practice, and usage policies.

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Research focuses on high visibility crosswalks. | Photo courtesy CUBRC



## North Carolina DOT

### Evaluating the interaction of traffic on rural, two-lane roads

Many studies have shown that horizontal and vertical curves and grades on rural roads are associated with more crashes when compared with tangent-level sections. For many states, including North Carolina, preventing lane departure crashes is a very high priority. Using SHRP2 safety data, the North Carolina DOT will investigate the effects of different road alignments on road departure crashes and research how speed, driver-controlled variables, time of day, curves, and grades may also affect near-crashes. This research is expected to lead to more effective countermeasures or, at a minimum, a better understanding of where additional countermeasures may be necessary. Examples of countermeasures may include different types of advance warnings, in-lane rumble strips, and improved roadway delineation.



North Carolina's research focuses on rural road crashes. | Photo courtesy ND DOT

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## Utah DOT

### Assessing driver behavior near closely spaced interchange ramps

Transportation agency concerns regarding new or modified freeway access include ramp spacing on the mainline and its impact to freeway operations and safety. The Utah DOT's research will cover the scenario of an entrance ramp followed by a downstream exit ramp (EN-EX), with or

without an auxiliary lane between entrance and exit ramps. By exploring driver behavior and performance near closely spaced interchange ramps (less than 2,000 feet) and looking at sequences of events that lead to crashes and near crashes in areas with closely spaced interchange ramps, the Utah DOT will seek to identify possible changes in design criteria, signing, and marking practices, as well as uncover other promising countermeasures to reduce crash frequencies and severities in these areas.



Assessing driver behavior near closely spaced interchange ramps. | Photo courtesy University of Utah

SHRP2 safety data will be used to examine driver behavior and performance at a very microscopic level, allowing UDOT to more fully understand and explain previously reported statistical associations that generally show lower levels of operational and safety performance as ramp spacing decreases. The data will allow the team to capture the complexity of gap searching, gap acceptance, merging, diverging, and other lane-changing and lane-keeping activities that occur on freeway segments with an entrance ramp followed by a downstream exit ramp.

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## Washington State DOT

### Examining episodic speeding

Speeding-related crashes continue to be a serious problem, and studies have found that a range of factors are associated with speeding. The Washington State DOT will conduct analyses using SHRP2 safety data to examine the effects of specific roadway locations and infrastructure features on episodic speeding (e.g., 10 miles per hour or more over the posted speed). Examining speed behaviors allow the Washington DOT to determine whether specific aspects such as infrastructure, bicycle and pedestrian access, roadside parking, number of lanes, visual cues to motion, and shoulder width result in excessive speeding.

The effects of roadway design features will be the focus of the analysis, and the results could help to identify features that may be associated with excessive speeding and potential countermeasures. Pedestrians and bicyclists are at particular risk at some locations associated with excessive speeding, and countermeasures aimed at protecting these road users may emerge from this research as well.



Examining “episodic speeding” project for SR 99 in Washington State. | Photo courtesy Ida van Schalkwyk at WSDOT

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## Washington State DOT

### Identifying the role roadway lighting conditions play in crashes

Half of the fatal crashes in the United States occur in dark lighting conditions, although nighttime traffic represents only 25 percent of the total traffic volume on the system. The Washington State DOT will research how roadway lighting characteristics affect safety performance and driver behavior for different types of roadways and intersections as well as investigate the type of lighting needed to improve safety on different roadways.



Black Lake Adaptive LED Lighting System on State Highways project | Photo courtesy WSDOT

Current estimates indicate that there are more than 13 million streetlights nationwide. Roadway lighting impacts energy consumption and light pollution. To address these concerns,

several transportation agencies are considering or are instituting adaptive lighting as an energy-saving tool, decreasing, for example, lighting levels during periods where traffic volumes are very low. The Washington DOT will evaluate road lighting as a safety countermeasure and support improvements in lighting selection. The DOT will also investigate cost-sensitive lighting design standards and policies that can improve safety and lower energy consumption.

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## Wyoming DOT

### Investigating how weather conditions affect speed behavior and drivers

The Wyoming DOT will research how drivers respond to adverse weather and road conditions. The study will gain insights into driver dynamics with regard to choosing speeds and headways for different conditions and what cues are the most effective in providing drivers with a more realistic variable speed limit system. The study will also provide valuable information about how drivers interact with roadway and weather and the impact on the effectiveness of countermeasures.



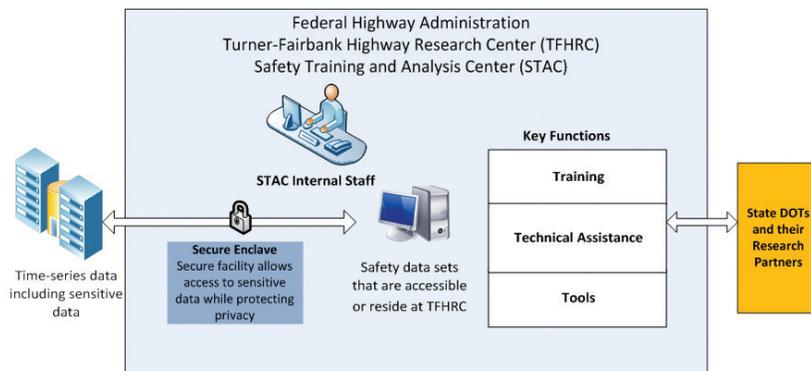
Roadway conditions captured in the SHRP2 data will be used to understand driver reactions. | Photo courtesy University of Wyoming, WYT2/LTAP Center

The unique SHRP2 safety data will enable Wyoming DOT researchers to understand the role of driver performance and behavior in various highway conditions. The data also will allow for a better understanding of how drivers adjust their behaviors to compensate for increased risk due to reductions in visibility. The safety data will help in obtaining objective insights into what drivers are actually doing during adverse weather and road conditions.

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## FHWA's new Safety Training and Analysis Center will support continued research

The Safety Training and Analysis Center (STAC) is a new resource at the Turner-Fairbank Highway Research Center that FHWA is establishing to help facilitate implementation of the SHRP2 safety data. The STAC will expand FHWA's services to state DOTs by providing technical assistance and training opportunities that increase their knowledge of the data and its potential to address a variety of transportation problems, especially those related to driver behavior.



The STAC will serve as an incubator of new ideas throughout the research community, by providing sponsored opportunities for graduate and postdoctoral students, fellows, and other researchers to gain experience working with the data. The STAC will also continue to support the needs of the U.S. Department of Transportation by using the SHRP2 safety data to conduct research on DOT priority topics and by developing tools that enhance data extraction and analytical capabilities.

Some of those tools and projects include:

- ▶ Automated video decoding/data extraction
- ▶ Automated extraction of facial features from video
- ▶ Automated masking of the identity of participants

Through a separate effort, FHWA's STAC will offer more opportunities for lead researchers who are partnered with state DOTs to conduct additional research using the SHRP2 safety data. The process will be similar to the Implementation Assistance Program, except FHWA will award contracts to research institutions that are in partnership with state DOTs. FHWA has allocated \$2.8 million toward this research.

FHWA has also allocated \$25 million through a five-year assistance agreement with the National Academy of Sciences and Transportation Research Board for continued work with the SHRP2 safety data to facilitate and improve future implementation efforts. This work will be guided by a Safety Oversight Committee established by TRB. The committee will develop policy requirements and set the standards on how to share the data so they can be widely used.



# More information

## **For information on the FHWA IAP or on the safety program:**

Pam Hutton, AASHTO's SHRP2 Implementation Manager at [phton@aaashto.org](mailto:phton@aaashto.org); Kelly Hardy, AASHTO's Program Manager for Safety at [khardy@aaashto.org](mailto:khardy@aaashto.org); or Aladdin Barkawi, FHWA Safety Implementation Lead at [aladdin.barkawi@dot.gov](mailto:aladdin.barkawi@dot.gov).

## **A wealth of information is available at:**

- ▶ AASHTO Safety website: <http://shrp2.transportation.org/Pages/Safety.aspx>
- ▶ FHWA GoSHRP2 Safety website: [http://www.fhwa.dot.gov/goshrp2/Solutions/Safety/NDS/Concept\\_to\\_Countermeasure\\_Research\\_to\\_Deployment\\_Using\\_the\\_SHRP2\\_Safety\\_Data](http://www.fhwa.dot.gov/goshrp2/Solutions/Safety/NDS/Concept_to_Countermeasure_Research_to_Deployment_Using_the_SHRP2_Safety_Data)

## **Resources include:**

- ▶ [SHRP2 Naturalistic Driving Study Fact Sheet](#)
- ▶ [NDS available data](#)



*Photo courtesy FHWA (left), WSDOT (right)*

For more information go to:  
<http://www.fhwa.dot.gov/goshrp2/>  
and <http://SHRP2.transportation.org>.

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