



# A Foundation for Safer Driving

A Safety Brief summarizing research preliminary to the SHRP 2 Naturalistic Driving Study

APRIL 2011

**V**olunteer drivers in six US states are pioneering new territory for all of us as they participate in the largest study of driving behavior ever conducted. We know that driving behavior is the primary cause of most crashes. Now for the first time, technologies can be combined to gather objective, scientific information about what happens when people crash, when they experience a near-crash, and when they drive without incident. What scientists and engineers learn from the volunteers and the sensors in their cars will be the basis for significant improvements in highway safety because, finally, we will have real-world data about crashes and contributing conditions. In fact, by instrumenting more than 3000 cars over two years, we will have roughly a petabyte of data (that's the capacity of a million 1-gigabyte flash drives).

Conducted through the second Strategic Highway Research Program (SHRP 2), which is administered by the Transportation Research Board of the National Academies in conjunction with the Federal Highway Administration and the American Association of State Highway and Transportation Officials, the SHRP 2 naturalistic driving study supports the program goals of advancing solutions for highway safety, renewal, and congestion.

Carrying out this driving behavior research involves layers of complexity understood by a relatively small international community of safety data experts. But the research plan is driven by a few straightforward questions. This brief report describes how the questions are being addressed in the SHRP 2 safety research projects that set the foundation for safer roads ahead. Details about each project are available on the Safety page of the SHRP 2 website and project numbers are provided here for reference to the project database. The web address is [www.TRB.org/SHRP2/Safety](http://www.TRB.org/SHRP2/Safety).

## How can we significantly improve safety?

Driver behavior has been identified as the major factor in about 90% of roadway crashes. Researchers believe that if we could understand how drivers interact with and adapt to their vehicles, the traffic environment, the roadway characteristics, the traffic control devices, and the environmental conditions that together create the driving experience, then we could identify how to reduce the risk of a crash. The transportation safety and data experts who helped to craft the SHRP 2 Safety program agree that significant improvement in road safety can only be achieved by addressing driver behavior; they also know that the driver remains the most difficult part of the system to study. The only way to obtain objective data about the driving experience is to collect it in real time with equipment that the driver can quickly accept. Such naturalistic driving studies (NDS) have been conducted before on a small scale and they provide a starting point for this much larger effort. (*TRB Special Report 260: Strategic Highway Research, Saving Lives, Reducing Congestion, Improving Quality of Life*, chapter 5, documents the early development of the research plan.)

## What questions should we investigate and which are most important?

Safety practitioners and researchers were consulted to determine which questions need to be answered so that effective safety strategies can be developed; more than 400 questions were put forward. With further input from participants at the annual SHRP 2 Safety Symposia, the questions were distilled into four broad categories, including: road-departure, intersection, driving performance, and driver interaction with advanced vehicle technology. Overall, the intent is to determine what risks are inherent in the relationship of a driver's performance to the roadway design and to traffic conditions.

The project to develop a study design for the SHRP 2 NDS also produced a process and criteria for selecting sites where data would be collected and a design for the sample of participants and vehicles that would provide the necessary range of data, including, for example, age, gender, and demographics (*Project S05*).

*The list of research questions is expected to expand as the full impact of the data collected and analyzed is understood.*

## What data do we need to answer the questions?

To answer questions about what influences the risk of being in a collision, data are needed about drivers, vehicles,

and roads. We need to see what drivers see and where they are looking. We need data on speed, distance from the car ahead, acceleration, braking, seat belt use, geographic location, and vehicle characteristics and performance. Data on road type, geometry, shoulders, safety furniture, signage, and pavement markings are needed. Additionally, environmental variables such as traffic, lighting, and weather conditions will be collected to the extent possible. Six study sites were selected to provide a range of demographics, geography, weather, state laws, road types, and road usage.

## How do we collect the data?

### *Driving and Vehicle Data*

Volunteers, of course, are central to the conduct of the study. Sampling statisticians were consulted to help plan the process of recruiting participants. A subsequent pilot test determined that a combination of recruiting methods would be needed to achieve the full complement of more than 3000 drivers. A centralized call center and centralized data base are used for consistency across the six study sites.

Each volunteer in the study takes a series of assessments of driving-related skills and attributes, such as visual perception, visual-cognitive ability, psychomotor ability, physical ability, health and medication status, psychological factors, driving knowledge, and driver history. These assessments were developed with input and oversight from a panel of highly regarded experts. All protections required for the rights and safety of participants in human subject research are in place, and each step of the study design has been approved by the institutional review boards of the National Academy of Sciences and other contracting agencies.

An on-board data acquisition system (DAS) has been designed and manufactured and technicians have received training in how to install the automotive-grade equipment in the volunteer's vehicle in such a way that it can be removed at the end of the study without damage to the vehicle. The DAS will continuously record driver behavior and vehicle kinematics. It includes four video cameras, velocity and acceleration sensors, a global positioning system, forward radar, an incident button, a light sensor, and a passive alcohol sensor. Machine vision tools to track lane fidelity and an eyes-forward monitor are included. The data collected are encrypted and stored in an onboard computer for up to six months before being downloaded to a central data repository. Crash investigations will be conducted after certain crashes (for example, those in which air bags deployed) to gather more detailed data (*Projects S05, S06, and S07*).

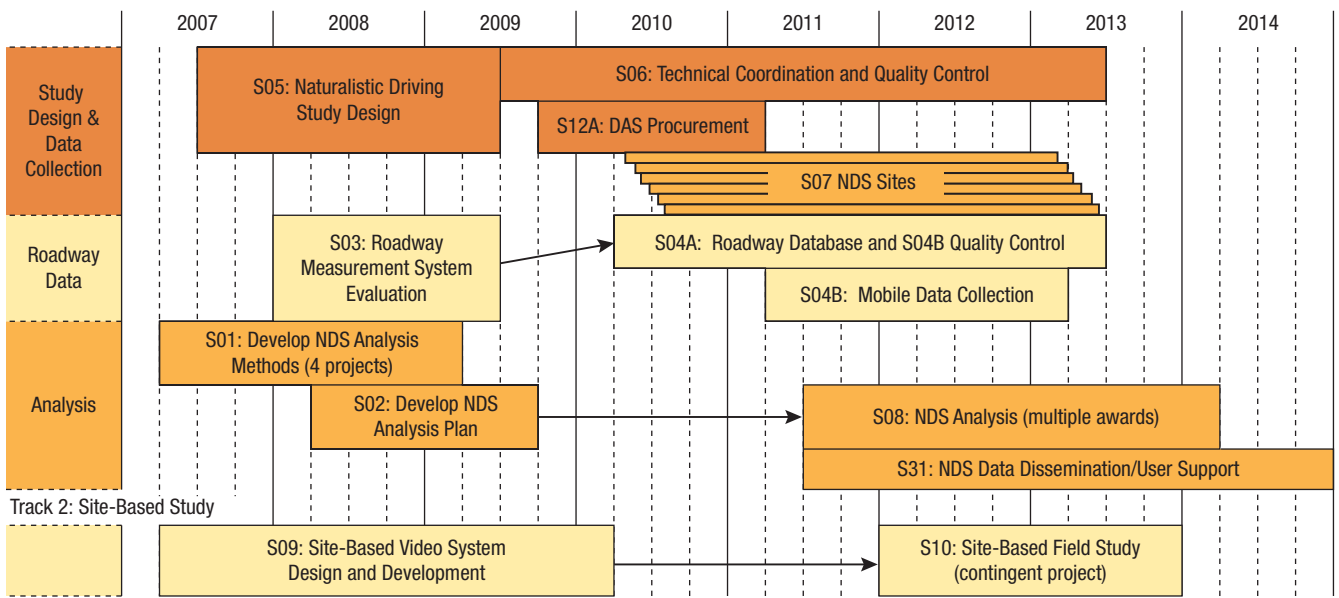
### **Research Question Categories**

Road departure • General intersection, including straight, and left- and right-turn crossing paths • Rear-end crashes, both striking and struck • Pedestrian/animal/pedalcyclist/object • Head-on • Lane-change/merge • Backing • New and near-future vehicle • General driver behavior • General multi-factor/multivariate

### **Subcategories**

Questions related to: Traffic, roadway, and environment • Vehicles • Driver or driver error • Multifactor or multivariates • Passengers • Infotainment systems and Nomad devices • Aggressive driving • Vision, attention, and distraction • Speed and speeding • Crash countermeasures • Passing maneuvers

## SHRP 2 Safety Research Program



As of spring 2011, the nationwide driving study is operational at all six sites, including (from west to east) Seattle, Washington; Central Indiana; Erie County, New York; Central Pennsylvania; Tampa, Florida; and Durham, North Carolina. Contractors selected to establish and operate the field data collection sites are responsible for equipment installation and driver assessments, collecting and transmitting data, addressing problems, investigating crashes, and for periodic reports documenting the field study activities. Another team provides technical oversight, coordination and quality control, including training, communications, logistics, and data management. The combined goal is to collect about 3,900 vehicle-years of data in a 28-month period (*Projects S06 and S07A-F*).

### Roadway Data

Determining the relationship of roadway characteristics to crash risk and driver behavior requires detailed data about road grade, curvature, cross slope, posted speed limits, and other characteristics. These types of data are being collected, with an emphasis on the roadways likely to be traveled by drivers participating in the study. Roadway inventory data may also be supplied by state, county, and municipal transportation organizations. A database will be developed and linked to the driving behavior database by a research contractor who will identify the data and analysis requirements of those who will eventually be using the data to improve safety (*Projects S04A and B*).

## What's the best way to analyze the data?

To begin to answer this question, four research teams independently identified and developed different ways to analyze this type of data and applied their analysis methods to data collected during smaller field studies of crashes involving cars running off the road (road departures) and intersection safety issues (*Project S01*). A different research team in a later project reviewed the results and integrated various components of the plans. They developed a list of essential elements and sample work plans to illustrate the type of information that is relevant to analyzing data

### Site-Based Data

A second track of data collection focuses not on individual drivers but on all traffic that passes through specific road segments. A video system is being deployed to record the movements of all vehicles at a site, such as an intersection. Cameras placed above the selected site will record details about the motion and relative positions of the traffic, while the steering, braking, and throttle control reflect the driving behavior through the segment. Eventual application of this technology will support more direct and systematic comparison of roadway design and driving behavior (*Project S09*).

related to a research question and the methodological issues specific to that question. These plans illustrate some of the fundamental challenges that researchers must address in using naturalistic driving study data to answer driving safety research questions (*Project S02*).

***Every 1 percent reduction in crashes will prevent 330 deaths and about \$2 billion annually in medical expenses and other losses from these crashes. Crashes are also a leading cause of traffic congestion, which increases delay, fuel consumption, and emissions.***

As data become available from the six sites, researchers will begin to use the data and analytical methods to address some of the high-priority questions identified earlier in the program. The first analysis projects will begin in mid-2011. Early results from these activities will help refine data ac-

cess and analysis methods in addition to providing the way toward improved safety countermeasures (*Project S08*).

## What Happens Next?

As volunteer recruitment and data collection continue, questions of how to house and maintain the enormous NDS database will continue to be addressed. Allowing qualified researchers to access and use the data is crucial to developing the knowledge from which a new generation of safety improvements can develop. Yet the access must be balanced with rigorous restrictions necessary to protect the confidentiality and safeguards promised to participating drivers. Establishing protocols and crafting the kinds of living documents needed for the coming years will be a focus of efforts as the study gains momentum.

A website for the Naturalistic Driving Study hosted by the research team is at <http://www.shrp2nds.us/>

Details on the entire SHRP 2 Safety research program are on the SHRP 2 website at [www.TRB.org/SHRP2/safety](http://www.TRB.org/SHRP2/safety)

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