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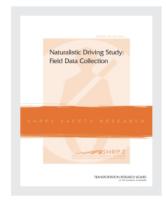
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The Second

STRATEGIC HIGHWAY RESEARCH PROGRAM



Naturalistic Driving Study: Field Data Collection

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The Second Strategic Highway Research Program

America's highway system is critical to meeting the mobility and economic needs of local communities, regions, and the nation. Developments in research and technology—such as advanced materials, communications technology, new data collection technologies, and human factors science—offer a new opportunity to improve the safety and reliability of this important national resource. Breakthrough resolution of significant transportation problems, however, requires concentrated resources over a short time frame. Reflecting this need, the second Strategic Highway Research Program (SHRP 2) has an intense, large-scale focus, integrates multiple fields of research and technology, and is fundamentally different from the broad, mission-oriented, discipline-based research programs that have been the mainstay of the highway research industry for half a century.

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FOREWORD

Andrew Horosko, SHRP 2 Special Consultant, Safety

This report describes the six SHRP 2 naturalistic driving study (NDS) data collection centers and documents their data collection activities and strategies. The study centers were located in Bloomington, Indiana; State College, Pennsylvania; Buffalo, New York; Tampa, Florida; Durham, North Carolina; and Seattle, Washington. They collected data from more than 3,000 volunteer participants and their vehicles over a 3-year period. Information is provided on the recruitment and assessment of test participants, installation of NDS data acquisition systems into participant vehicles, management of the enrolled participants and their vehicles, retrieval of data from the vehicle fleet, and lessons learned. The report will be of interest to analysts wanting background on where and how the NDS data were collected and to researchers planning future large-scale NDS projects.

The objective of the SHRP 2 NDS is to reduce traffic injuries and fatalities by preventing collisions or reducing the severity of them. The SHRP 2 NDS is the first large-scale study focused on collision prevention (as opposed to injury prevention once a collision occurs) since the Indiana Tri-Level Study (*Tri-Level Study of the Causes of Traffic Accidents: Final Report*, Report DOT HS-805 085, U.S. Department of Transportation, May 1979). Vehicle use was recorded continuously during the SHRP 2 NDS. Information on vehicle travel, or exposure, can be extracted at the same level of detail as for safety-related events, such as crashes and near crashes. Hence, the SHRP 2 NDS is the first large-scale study to support detailed estimates of collision risk. Moreover, crashes are a leading cause of nonrecurring congestion, so collision prevention has added benefits in terms of reduced delay, fuel consumption, and emissions. The NDS provides objective information on the role of driver behavior and performance in traffic collisions and on the interrelationship of the driver with vehicle, roadway, and environmental factors.

The SHRP 2 Safety research program was carried out under the guidance of the Safety Technical Coordinating Committee (TCC), which was composed of volunteer experts. The Safety TCC developed and approved all project descriptions and budgets and met semi-annually to review progress and approve any program modifications. The Oversight Committee approved all budget allocations and contract awards. Assistance was provided by expert task groups, which developed requests for proposals, evaluated proposals and recommended contractors, and provided guidance on many issues, such as data access policies and procedures. The decisions and recommendations of the governing committees were implemented by SHRP 2 staff as they carried out day-to-day management of the research projects.

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Executive Summary

This final report describes the second Strategic Highway Research Program naturalistic driving study (SHRP 2 NDS) Safety Project S07 (In-Vehicle Driving Behavior Field Study). The principal objective of the S07 project was to collect a comprehensive naturalistic driving database. This database—together with associated roadway, driver, and environmental data—provides a resource from which to study the role of driver performance and behavior in traffic safety and how driver behavior affects the risk of crashes. This involves understanding how the driver interacts with and adapts to the vehicle, the traffic environment, roadway characteristics, traffic control devices, and other environmental features.

To accomplish its objective, the S07 project enrolled 3,247 volunteer drivers as primary participants, ages 16 to 98, across six sites: two counties surrounding Tampa, Florida; 11 counties in central Indiana containing Bloomington; one county in western New York containing Buffalo; four counties in North Carolina containing Raleigh, Durham, and Chapel Hill; 10 counties in central Pennsylvania containing State College; and three counties in Washington containing Seattle. The six study centers encompass more than 21,000 square miles, contain about 7.6 million registered vehicles of all types, and have a population of approximately 6.5 million people of driving age (>15 years). The six teams selected to manage the study centers were Indiana University (Indiana), CUBRC (New York), Westat (North Carolina), Battelle (Washington), Pennsylvania State University (Pennsylvania), and CUBRC/University of South Florida (Florida).

These teams performed a variety of tasks at each study center, including establishing and maintaining appropriate Institutional Review Board (IRB) approvals, recruiting volunteer drivers to participate in the study, obtaining driver consent and performing driver assessments, installing the data acquisition system (DAS) in participant vehicles, managing the participants and fleet of equipped vehicles over the 38 months of data collection activities, and deinstalling the DAS equipment.

As described in the following sections, each of these tasks provided challenges that needed to be addressed for the data collection effort to be successful.

IRB Approval

Four of the six sites (Bloomington, Seattle, State College, and Tampa) used their local IRB for oversight. Of these four, all but Tampa were required to undergo a full IRB review. The remaining two sites (Buffalo and Durham) each had an initial full review by their local IRB before the start of the study but subsequently adopted Virginia Tech's IRB as the "IRB of Record" during the execution of the study. Over the course of the study, 18 amendments to the original IRB application were prepared, submitted, and approved by the IRB committees overseeing the project.

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Recruiting Volunteer Drivers

Recruiting participants for the NDS turned out to be the most challenging part of the study. The study design was intended to provide a balanced sample of drivers by age and gender. However, obtaining the desired number of participants in the specified age groups in a timely way proved to be more difficult than expected. Of most concern was the difficulty of attracting both younger (ages 16 to 20) and older (ages 76 and above) drivers. Recruiting activities formally began using the Center for Survey Research (CSR) at Virginia Polytechnic Institute and State University (Virginia Tech) as a single national call center for all study sites. After a few months, it became apparent that the national call center was not supplying sufficient participants. Thus, the study centers were directed to increase local recruiting to supplement the national call center efforts. The study centers employed a wide variety of recruiting methods, including flyers and posters, newspaper and magazine ads, TV/radio ads, websites, and social media. The success of the recruiting strategies varied from site to site. The most successful recruiting methods were TV and radio ads for three of the sites (Buffalo, Durham, and Seattle) and Craigslist for the other three sites (Bloomington, State College, and Tampa). In addition, the initial compensation levels for participation were raised in an effort to increase interest in participating in the program.

Obtaining Driver Consent and Performing Driver Assessments

It was necessary to obtain informed consent from potential participants before they could be enrolled in the study. In most cases, consent was obtained when the recruit showed up for assessment tests and equipment installation. The driver assessment tests, administered by a trained assessor, were an important source of information about the participants and complemented the naturalistic driving data. The objective of the assessment tests was to establish a baseline in functional abilities of the driver with regard to perception, cognition, and psychomotor and physical abilities. In addition, surveys or questionnaires included psychological testing and documentation of health, medical conditions, and medications as well as safe driving knowledge and history. Specific tests that were administered included a clock drawing test, Conners' Continuous Performance Test, Optec 6500 Vision Testing (for acuity, day and night contrast sensitivity, color perception, and peripheral vision), the Jamar Grip Strength test, and a Driving Health Inventory (DHI). Further details, including qualifications of the assessors and a list of tests in the DHI, can be found in the Chapter 3 section on participant assessment tests and surveys.

Installing the DAS in Participant Vehicles

Installation facilities were established at each of the six study centers. Study centers were required to provide one installation bay per 150 DAS units assigned to their site. Thus, the Buffalo, Seattle, and Tampa sites each established three installation bays, Durham established two installation bays, and State College and Bloomington each established one installation bay. The study centers also established the capability to perform two installations per day, per bay. As expected at the beginning of the program, installing the full set of DAS equipment in a vehicle almost always required less than 4 hours. During the course of the program, the actual number of installations completed per day ultimately depended on the success in recruiting participants in the required age groups and DAS equipment availability. Additional factors affecting the number of installations performed per day were the number of last-minute participant cancellations, participants failing to show up for their scheduled appointment (i.e., no-shows), and rejected vehicles.

Managing the Participants and Fleet of Equipped Vehicles

Participant management included answering questions about incentive payments, scheduling vehicle maintenance appointments, helping with questions from the participants' garage mechanics should they arise during routine non-NDS maintenance, and servicing activities. Fleet maintenance activities included care and upkeep of the instrumentation in the participant's vehicle, replacing a data drive that had reached its storage capacity, and repairing damaged NDS equipment. To assist in these activities, a Request Tracker (RT) tracking system was implemented by the Virginia Tech Transportation Institute (VTTI) to help monitor the fleet of installed vehicles and allow communication of any observed issues between VTTI and the study centers. This system proved to be quite effective in identifying and tracking issues of importance to the fleet.

During the course of the program, VTTI issued more than 9,576 RT tickets to the six centers. These tickets covered issues such as vehicle maintenance, solid-state drive (SSD) replacements, and other operational issues.

Another important activity was to conduct a crash investigation in the event that one of the participant vehicles was involved in a crash. There were three methods of notification when a participant of the driving study was involved in a crash. The first and most common notification occurred when participants called the study center (or sent an e-mail) to indicate that they were in a crash, as per instructions in the consent agreement. The second was incidental notifications from participants, either when they spoke with research staff during scheduling of vehicle maintenance or when SSDs were swapped. Incidental notifications were usually associated with minor crashes, when the participant assumed it was not necessary to contact the study center. The third, and least common, was notification by VTTI. Based on the severity of the crash, one of two different levels of crash investigation was performed. Over the course of the study, 110 (Level 1 and Level 2) crash investigations were performed at the six study center sites.

Deinstalling the DAS Equipment

DAS deinstallation activities during the NDS can be divided into the following two categories: deinstallations that routinely occurred during the course of the program and deinstallations of the participant fleet at the end of the program. The routine deinstallations occurred when participants either completed their time in the study or left the study before their planned completion time (e.g., if moving). The end-of-program deinstallation activities began at all study centers on September 1, 2013, and were completed in December 2013. In general, most of the deinstallations were performed at the study center installation sites. However, some deinstallations were performed in the field when necessary.

Summary

Over the course of the study, under the direction of the National Academies, and with the support of VTTI, the teams at each of the six study centers successfully

- Identified and contacted more than 16,358 people who expressed some interest in participating in the study. Of these, 3,247 became primary test participants in targeted demographic age and gender cells. This compares favorably with the goal of enrolling 3,100 to 3,300 participants which was established at the onset of the program.
- Performed 3,362 installations of DAS equipment into approximately 35 different makes of participant vehicles.
- Maintained and managed the fleet of participants and vehicles for approximately 38 months.

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• The study centers were aware of 188 crashes that were experienced by the instrumented vehicles in their fleets. None of these crashes involved a fatality or a severe injury. This is lower than the number of crashes that was expected at the beginning of the study and also lower than the number of crashes identified by VTTI. With regard to the latter point, the VTTI crash numbers are based, in part, on data obtained from the vehicles. It appears that there were crashes that were not reported by the participants to the study centers.

The S07 program activities at the six study centers have contributed to the collection of a rich set of NDS data. Most of the instrumented vehicle data include information on vehicle speed, acceleration, and braking; all vehicle controls; lane position; forward radar (indicating headway distance to objects in front of the vehicle); and video views forward, to the rear, and on the driver's face and hands. The study center instrumented vehicles traveled 49,657,037 miles during 6,650,519 trips, of which an estimated 5.4 million trips (81%) were made by consented drivers (based on driver ID) and are available to researchers. At the beginning of the program, a target of 3,900 DAS-years in the field was established. The six study centers obtained 3,958 participant-years in the field, which is 101.5% of the goal.

CHAPTER 1

Introduction and Background

The second Strategic Highway Research Program (SHRP 2) targeted specific goals in four focus areas, one of which was Safety and, in particular, the role of human behavior in traffic safety. The key objective of the Safety focus area was to identify and research the most pressing issues that currently lead to the unacceptably high number of traffic deaths and injuries on the nation's roadways. Toward that end, and under the guidance of the Transportation Research Board (TRB) and the National Academy of Sciences (NAS), SHRP 2 initiated and executed an ambitious naturalistic driving study (NDS) during which 3,362 private vehicles, all driven by volunteers from the general public, were instrumented and deployed on the nation's roadways over a period of 3 years.

The vehicles were fitted with discrete cameras, radar, and other sensors to capture data as their drivers went about their usual driving tasks (VTTI 2014). Data from 6,650,519 trips totaling 49,657,037 miles were collected; of that an estimated 5.4 million trips (81%) were driven by consented drivers (based on driver ID). Previous experience has shown that most drivers quickly forget the presence of the cameras and sensors (Dingus et al. 2006). Thus, researchers using the NDS data will be able to study driving behavior in a natural context. This context will be further enhanced by the detailed data on roadway characteristics and traffic control devices (collected under a separate SHRP 2 project), which will link to the driver trip data.

The key premise of the NDS is that a better understanding of safety issues can be acquired by conducting research focused on the driver and how the driver interacts with the vehicle, the roadway, traffic, and traffic controls under a variety of real-world weather and environmental conditions. The key goal is to identify differences in crash risk associated with the driver interactions and, ultimately, to develop data-driven countermeasures that will significantly reduce crash risk.

This report describes the activities of six organizations at six different study centers as these organizations recruited participants, conducted driver assessments, installed (and maintained) the instrumentation, and periodically downloaded the data from the 3,362 vehicles in the NDS fleet. The original study design defined by SHRP 2 stipulated the number of drivers to be recruited in each of eight age groups at each site. This was done to ensure that the total study population had the desired distribution of age and gender demographics. The actual distribution differed somewhat from the original plan but still achieves the study goals. Activities at the six study centers were initiated in a staggered fashion; this greatly benefited the program because start-up issues and problems that occurred at the first study center were resolved at that location and the lessons learned were shared with the other sites before their activation.

This report is organized as follows: Chapter 2 describes the six study center areas in terms of geographic location (and extent) and provides an overview of the study design. Chapter 3 summarizes the major project tasks and the performance achieved in each. Topics covered include Institutional Review Board (IRB) activities, recruiting, the consent and assessment process, installations, participant management and fleet maintenance (including crash investigations), and deinstallations. Chapter 4 summarizes issues encountered and lessons learned, and Chapter 5 provides concluding remarks.

CHAPTER 2

Study Centers and Study Design

Study Center Designations

The six NDS data collection study centers were selected by a SHRP 2 Expert Task Group (ETG) formed for this purpose. The ETG used a two-stage process: first a request for qualifications (RFQ) was released, then a request for proposal (RFP) was sent to contractors that passed the qualification stage. The RFQ was released a second time after the first release resulted in no qualified contractors in southern states. After the second release, the RFQ stage produced 11 qualified sites, three located in southern states. The RFP stage considered cost as well as site characteristics. Not all qualified contractors responded to the RFP. The RFP stage resulted in the selection of the final six sites (Antin et al. 2011).

For the purposes of this report, the study centers are labeled using the name of the major city in the study area. Table 2.1 lists these cities along with the lead organization and the number of data acquisition system (DAS) units originally allocated for installation in vehicles at that site.

Note that the total number of DAS units corresponds nominally to the maximum number of instrumented vehicles that could be on the road at any one time across all study centers. Some DAS units were installed in a single vehicle throughout the study while other DAS units were installed in multiple vehicles, each for shorter periods of time.

Figure 2.1 provides a map in which gold stars depict the location of each study center and illustrate the geographic distribution of the study centers across the country.

A brief description of each city follows:

- *Bloomington* is a city in the southern part of Indiana. The primary study area encompasses all or parts of 11 counties in the south central part of the state with substantial portions of the area dedicated to agriculture and forestry. It is home to Indiana University Bloomington.
- *Buffalo* is the second largest city in New York State. It is located in Erie County which is at the western end of the

- state, bordered on the west by Lake Erie and Canada. The study area encompasses all of Erie County.
- *Durham* is the fifth largest city (by population) in North Carolina. The study area incorporates portions of Research Triangle Park.
- Seattle is located along Puget Sound in Washington state.
 Lake Washington divides the Seattle metropolitan area into an east side and a west side. To the east lies the Cascade mountain range. Both Seattle and Tacoma are included in this study area.
- State College, home to Pennsylvania State University (Penn State), is located in central Pennsylvania in a largely rural area. The study area is situated in both the Ridge and Valley and the Appalachian Plateau provinces of the Appalachian Mountains.
- *Tampa* is located on the west coast of Florida on Tampa Bay near the Gulf of Mexico. Tampa is home to the main campus of the University of South Florida.

Study Design and Overview

Before proceeding with detailed descriptions of the study center areas and population demographics, it is helpful to compare the targeted number of participants in each age group required in the SHRP 2 study sample design with the actual number of participants enrolled in the study. Table 2.2 shows the initial study design with target values in each age/gender cell along with the total number of actual participants from all six study centers. Note that there were 3,102 participants planned in the original design. The study actually enrolled 3,247 primary participants. Targeted numbers in each age group and gender were sought to provide a balanced distribution by age and gender. The rationale for the participant sample design is described in the Project S05 final report (Antin et al. 2011). An additional SHRP 2 report is currently being prepared which further examines how representative

Table 2.1. SHRP 2 NDS Centers

Study Center Area Name	State	Lead Organization (S07 Contractor) ^a	Number of DAS Units in the Field (Planned) ^b
Bloomington	Indiana	Indiana University	150
Buffalo	New York	CUBRC	450
Durham	North Carolina	Westat	300
Seattle	Washington	Battelle	450
State College	Pennsylvania	Pennsylvania State University	150
Tampa	Florida	CUBRC/University of South Florida (USF)	450
		Total	1,950

^aThe lead organizations were called S07 contractors, with S07 referring to the SHRP 2 designation for the NDS data collection.

the NDS participant population is relative to the total population by age and gender (Antin 2014).

As indicated previously, a total of 1,950 DAS units were available to all study centers. Some DAS units were installed in more than one vehicle. The initial plan was that 60% of participants would have DAS units installed in their vehicle for 1 year and 40% would have DAS units installed for 2 years (Campbell

2010). This approach was intended to allow a larger number of drivers to participate while also enabling longer-term monitoring of a smaller group of drivers. Participant preference was to be used as the basis for enrollment in the 1- or 2-year group. For a variety of reasons (e.g., recruiting issues, equipment availability) this requirement was subsequently relaxed. The 3,247 participants who enrolled in the study remained for varying lengths of time ranging from a minimum of 1 day to a maximum of 38 months. Only a small number (fewer than 5%) were in the study less than 4 months.

Table 2.2 also shows that 350 DAS units were initially targeted for vehicles containing advanced vehicle technology (AVT). These were vehicles with advanced features such as collision avoidance radar, advanced cruise control, and electronic stability control. Participants with these type vehicles could be of any age. As will be discussed in later sections, as the recruiting process progressed, difficulties in recruiting AVT participants as well as difficulties in recruiting the youngest (16–17) and oldest (76+) group of drivers necessitated some modification in recruiting priorities and strategies.

There were three classes of drivers defined.

- A *primary driver* was the usual driver of the car and typically owned the vehicle in which instrumentation was installed.
- Additional primary drivers included those who frequently
 drove the same vehicle as the primary driver, were consented, and completed the same assessment tests and surveys. They could be other adults, but often were minors in
 the 16–17 age group, or young adults 18–25 years of age



Figure 2.1. Locations of six study centers in Bloomington, Buffalo, Durham, Seattle, State College, and Tampa.

^bThe total number of data acquisition system (DAS) units at each site fluctuated during the program. Some sites installed slightly more than those indicated and some slightly less. There was also a small number of additional DAS units available as spares.

Table 2.2. Design of Study Sample with Target and Actual Cell Values

Gender	Age Range (years)	Age-Range Description	Planned Primary Participants ^a	Actual Participants ^b	Delta (Actual – Planned)
М	16–17	Minor teen	172	119	-53
М	18–20	Adult teen	172	237	65
М	21–25	Young adult	172	245	73
М	26–35	Adult	172	158	-14
М	36–50	Middle adult	172	156	-16
М	51–65	Mature adult	172	157	-15
М	66–75	Younger older driver	172	166	-6
М	76+	Older older driver	172	249	77
F	16–17	Minor teen	172	143	-29
F	18–20	Adult teen	172	289	117
F	21–25	Young adult	172	348	176
F	26–35	Adult	172	150	-22
F	36–50	Middle adult	172	165	-7
F	51–65	Mature adult	172	182	10
F	66–75	Younger older driver	172	148	-24
F	76+	Older older driver	172	199	27
		Not specified	0	1	1
Any Adv	anced Ver	nicle Technology (AVT)	350	135	-215
		Total	3,102	3,247	145

^aCampbell (2010)

driving a parent-owned vehicle. Additional primary drivers were counted toward the target number of participants in a given age/gender cell.

• Secondary drivers were other family members or friends who drove the vehicle at least once a week and were consented. However, secondary drivers did not count toward the target number of drivers in an age/gender group and did not take the assessment tests (although they were asked to complete a survey on driving history and a demographics questionnaire).

Once recruiting and installations started it became clear that the original recruitment goals in some age groups would be very difficult to attain. In particular, recruiting for the 16–17 and 18–19 age groups, as well as the AVT category, lagged well behind planned goals early in the program. There were also deficits in the 76+ age category. The reasons for these shortfalls varied. Recruiters from the national call center had no name recognition in the local study areas. They also did not reach younger drivers who only used cell phones (not landlines). Younger drivers typically did not own the newer prime vehicles

of most interest to the study and so initially did not qualify. The types of media and outreach that worked with younger drivers were quite different from those that worked with older drivers, and recruiting approaches that were successful in urban areas were often not as successful in rural areas. In recruiting, one size did not fit all.

Based on the recruiting difficulties experienced early in the study, changes were made in the recruiting strategy to place increased focus on engaging younger and older drivers. The type of vehicles allowed in the study was further expanded to accommodate the older vehicles typically owned by younger (and some older) drivers. The difficulty in recruiting drivers with AVT-equipped vehicles also led to a change in strategy. The AVT group was subsequently capped, and the DAS kits were diverted for use in vehicles driven by the 18–25 and 76+ age groups.

Vehicles were classified by type as follows:

Prime vehicles were those with a large sample of data available from the onboard diagnostics (OBD) bus. Generally, year 2010 and newer vehicles fell into this category.

^b Includes 3,200 primary and 47 additional primary drivers in study at least 1 day. Data provided by VTTI (2014).

- *Subprime vehicles* had a smaller set of data available from the OBD bus. Generally, vehicle year 2009 and later were in this category.
- *Legacy vehicles* had minimal amounts of data available from the bus and included pre-2009-year vehicles. (Authorization to include these vehicles came in June 2011.)
- *Basic vehicles* were manufactured pre-1996 and had no data available from the bus. For these vehicles, the only data acquired came from the DAS sensors.
- *AVT vehicles* were prime vehicles (year 2010 and newer) with advanced technology.

The Virginia Tech Transportation Institute (VTTI) served as the technical coordination and study design contractor for the NDS. VTTI developed the DAS which continuously recorded data while the participant vehicle was operating (Antin et al. 2011; Dingus et al. 2014). Some of the instrumentation installed in each of the vehicles is illustrated in Figure 2.2. The figure shows (a) the head unit containing four cameras, a passive alcohol sensor, infrared illuminator, accelerometers, and Global Positioning System (GPS) sensor; (b) the NextGen computer with a 128-gigabyte (GB) solid-state drive (SSD); and (c) the forward-looking radar mounted on the front license plate holder. The full suite of sensors is listed in Table 2.3. For additional details on the instrumentation and its placement, the reader is referred to the installations section of Chapter 3 in this report and to VTTI reports describing the design and development of instrumentation (Antin et al. 2011; Dingus et al. 2014).







Figure 2.2. Instrumentation installed in vehicles: (a) head unit mounted behind rearview mirror containing four cameras, passive alcohol sensor, infrared illuminator, accelerometers, and GPS; (b) NextGen main unit with 128 GB SSD, power controller, and sensors mounted in trunk; and (c) forward radar mounted on front license plate holder.

Table 2.3. Summary of Instrumentation in Data Acquisition System (DAS)

Instrumentation	Notes
Four video cameras	2 outward (1 color, 2 wide-angle view) and 2 inward-viewing black and white video
Still image camera	Periodic image to detect number of people in vehicle
Accelerometers (3 axis)	Lateral, longitudinal, and vertical vehicle accelerations
Rate sensors (3 axis)	Lateral (turning), longitudinal, and lateral (roll) rate
GPS (with antenna)	Latitude, longitude, elevation, time, velocity
Forward radar (on front bumper) and radar interface box (RIB)	X, Y positions and X, Y velocities of objects in front of vehicle
Cell phone (with antenna)	Automatic crash notification; vehicle location notification, health checks, remote upgrades
Illuminance sensor	Level of luminance outside vehicle (day/night indicator)
Infrared illuminator	To enable viewing of driver's face at night by camera
Passive alcohol sensor	Intended to detect nominal amounts of alcohol in cabin air; NOT driver specific; may also detect alcohol from topical sources (hand sanitizer, etc.)
Incident push button	Audio recorded only if button pushed
Turn signals (other lights?)	State of turn signal (on/off) recorded
Vehicle network data (cabling to connect DAS with OBD)	Accelerator, brake pedal activation, automatic braking system (ABS), gear position, steering wheel angle, speed, horn, seat belt information, airbag deployment, and other data

Timeline of Start-Up Activities at Each Study Center

Before initiating the installation of DAS equipment into participant vehicles, each study center needed to complete a number of critical start-up activities. These activities included submitting IRB applications and obtaining approvals, preparing installation facilities, training installation technicians, obtaining recruit information, and scheduling recruits for installations. Initiation of DAS installation activities at each study center began in a time-phased fashion. As noted in the timeline shown in Figure 2.3, Buffalo was the first study center to begin installations in October 2010. Over the next 5 months the remaining study centers began installing DAS equipment into participant vehicles. The strategy to stagger the start of installations was driven in large part by the availability of DAS equipment. However, the strategy also served the useful purpose of enabling some of the early start-up difficulties to be identified and resolved, thus reducing problems that needed to be addressed by the later starting study centers.

Study Center Areas

A study center area for a driving study can be defined as the area targeted for recruiting participants (i.e., areas where they lived) or as the area in which most participants drove during their time in the study. The approach taken here was to use the first of these definitions (i.e., recruit participants based on where they lived). Recruitment areas also had some practical geographic restrictions. First, candidates had to be close enough to the S07 study center facility to enable proper servicing of their vehicle by the S07 contractor. Second, the preference was to recruit participants who were likely to drive on roads for which detailed roadway characteristics were being collected by another SHRP 2 program.

The six study center (recruitment) areas were specifically defined by either zip codes of residence (as occurred in

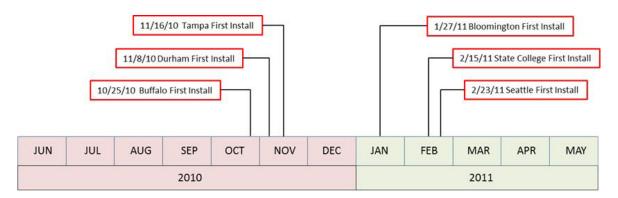


Figure 2.3. Timeline for initial DAS installations at each study center.

Bloomington and Durham) or by county of residence (as occurred in Buffalo, Seattle, State College, and Tampa). Occasionally, to help meet the desired participant age distribution (e.g., recruiting very young or very senior drivers) some of these residential requirements were relaxed to include participants who lived just outside the originally defined area as long as they typically drove in the study area.

Table 2.4 provides a geographic description of how the recruitment areas were defined for each study center and lists some of the unique features of each area. Table 2.5 provides the geographic size of water and land areas within each study center area. Note that these areas are calculated for the entire county *or* for selected zip codes within a county, as appropriate for the study area.

Table 2.4. Recruitment Areas and Unique Features of Six Study Centers

Study Center Area Name (State)	Recruiting Area Defined by	Counties Within Study Center Recruiting Area (Major and Minor Contributors)	Unique Features Within Area	Nominal Number of DAS Units Assigned
Bloomington (Indiana)	39 zip codes in primary area; 25 zip codes in secondary area ^a (64 total)	Major/Primary (11): Brown, Dubois, Greene, Johnson, Lawrence, Martin, Monroe, Morgan, Orange, Owen, Putnam Minor/Secondary (6): Marion, Bartholomew, Clay, Davies, Jackson, Shelby (8% of participants from secondary)	Large parts of the Hoosier National Forest and the Deam Wilderness area Naval Surface Warfare Center Crane located in Martin County Camp Atterbury located in Bartholomew County Primary area mostly rural, agricultural; secondary area more urban	150
Buffalo (New York)	1 county	Major/Primary: Erie Minor/Secondary: Niagara (4% of participants) and Cattaraugus (0.2% of participants)	One international border crossing within primary study center area Peace Bridge, Buffalo, NY Additional features just outside primary area Three additional U.S./Canada bridge crossings (Niagara County) Niagara Falls Air Force Base (Niagara County)	450
Durham (North Carolina)	39 zip codes	Major/Primary: Chatham, Wake, Orange, and Durham Minor/Secondary: Granville, Johnston, and Hartnett (less than 5% of county areas)	Durham is in North Carolina's central piedmont, a geographic region lying nearly equal distance between the mountains and coastal plains.	300
Seattle (Washington)	3 counties	Major/Primary: Snohomish, King, and Pierce	Two military bases within primary study center area: Joint Base Lewis-McChord (south of Tacoma in Pierce County) Puget Sound Naval Complex in Everett, Snohomish County Additional features just outside primary area: Whidbey Island Naval Air Station, northwest of Snohomish County Several U.S./Canada border crossings (e.g., Vancouver, B.C.) within a few hours' drive north of primary driving area	420 ^b
State College (Pennsylvania)	10 counties	Major/Primary: Blair, Cambria, Centre, Clearfield, Clinton, Huntingdon, Juniata, Mifflin, Snyder, Union	Although mostly rural, area features include rugged mountainous environ- ments as well as sweeping, rolling valleys.	150
Tampa (Florida)	2 counties	Major/Primary: Hillsborough and Pasco Minor/Secondary: Pinellas	MacDill is an active U.S. Air Force base located in Tampa, Florida.	450

^aIn Bloomington, 39 of the zip codes were in the primary rural recruiting area, and the remaining 25 were in a secondary recruiting area that was more urban and generated about 8% of the total participants.

^bThe number of DAS units was reduced from the originally planned 450 to 420.

Table 2.5. Geographic Size of Study Center Areas

Study Center	County	Percentage of County in Study	Water Area (sq. mi.)	Land Area (sq. mi.)	Total Area (sq. mi.)	Notes
Bloomington	Brown Dubois Greene Johnson Lawrence Martin Monroe Morgan Orange Owen Putnam Primary total (sq. mi.) Total of all primary and secondary (towns, cities,	81.3% 2.6% 55.1% 19.0% 94.8% 52.6% 97.8% 67.5% 85.6% 64.6% 0.7%	3.8434 0.0454 1.5957 0.5141 2.7608 2.5698 16.8120 4.2562 6.9348 0.9396 0.0000	253.688 11.466 299.085 60.684 425.851 176.483 385.588 272.241 342.327 249.718 3.350 2,480.481	257.531 11.512 300.681 61.198 428.611 179.052 402.399 276.497 349.262 250.658 3.350 2,520.751 3,800.000	Values provided are for the 39 zip codes for the primary recruiting area. Secondary recruiting area included additional parts of these counties and significant areas of Marion and Bartholomew Counties. ^a
Buffalo	unincorporated areas) Erie Total (sq. mi.)	100%	183 183	1,043 1,043	1,227 1,227	
Durham	Chatham Wake Orange Durham Granville Johnston Hartnett Total (sq. mi.)	49.5% 51.3% 14.0% 89.1% 3.3% 0.3% 1.6%	23.36 12.21 0.20 7.92 0.58 0.06 0.02 44	330.81 427.41 55.90 257.73 17.01 2.10 9.72 1,101.00	354.1 439.62 56.10 265.65 17.59 2.16 9.74 1,145.00	Values provided are for targeted zip codes in each county.
Seattle ^b	King Pierce Snohomish Total (sq. mi.)	100% 100% 100%	191.3 136.93 109.03 437.00	2,115.57 1,669.51 2,087.27 5,872.00	2,306.87 1,806.44 2,196.30 6,310.00	
State College	Blair Cambria Centre Clearfield Clinton Huntingdon Juniata Mifflin Snyder Union Total (sq. mi.)	100% 100% 100% 100% 100% 100% 100% 100%	1 5 4 7 7 15 2 3 1 0 45	526 688 1,108 1,147 891 874 392 412 332 317 6,687	527 693 1,112 1,154 898 889 394 415 333 317 6,732	
Tampa	Hillsborough Pasco Total (sq. mi.)	100% 100%	215 123 338	1,051 745 1,796	1,266 868 2,134	

^aBloomington detailed data for 39 primary zip codes plus total area for all primary and secondary regions. The Census Bureau has developed approaches for giving zip codes approximate areas, which allows a size estimate to be provided based on zip code tabulation areas (ZCTA); see http://www.census.gov/geo/reference/zctas.html. Accessed April 22, 2014.

Figure 2.4 shows state maps with the study center areas outlined in red. Note that actual county or zip code boundaries of the study areas are traced in these illustrations. The actual area in square miles is provided in the table inset in the figure. The total study area for all six sites encompassed over 21,000 square miles (sq. mi.).

The remainder of this section provides population demographics and other data to characterize each of the six SHRP 2 NDS study areas. Note that the NDS data collection took place over a period of more than 3 years. During that time, populations and other study area attributes changed. However, to maintain consistent descriptions of the study areas,

^b State of Washington Office of Financial Management. 2011. Census 2010 Redistricting Data [P.L. 94-171] for Washington, County Summary, Table 1: Population and Housing. http://www.ofm.wa.gov/pop/census2010/data.asp. Accessed Nov. 7, 2013.

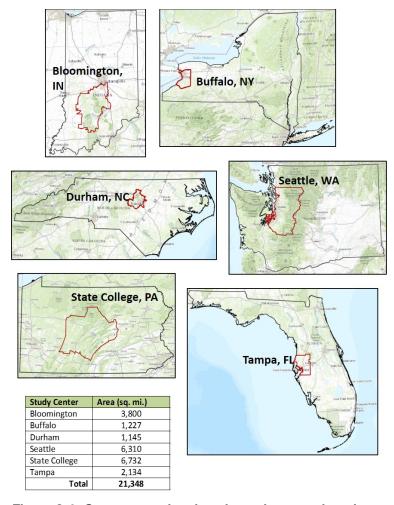


Figure 2.4. State maps showing six study center locations and areas.

this document provides data and statistics from the year 2010 across all sites.

Towns and Cities Contained in Study Center Areas

This section describes the county and/or zip code areas that make up each of the study center areas. Figures 2.5 through 2.10 contain maps illustrating each study area in a state context with an expanded view of the local area and a list of the counties included. Figure 2.11 shows summary plots indicating the rural versus urban character of the various study center areas, viewed from the perspective of both population and geographic area. In terms of population, Buffalo, Durham, and Seattle are predominantly urban in character; and Bloomington, State College, and Tampa are predominantly rural. From a geographic perspective, all the study center areas are largely rural.

The names of the towns and cities contained in the study areas are found in Appendix A, which lists the political subdivisions contained in each study center area (i.e., city or town name). Also provided are the geographic size, population, and population density. For some sites, only portions of a city may be contained in the study area. Classification as urban or rural is then indicated along with the county that the town or city is in. Unincorporated areas are also included. Appendix Tables A.1 through A.6 present these data.

Populations, Licensed Drivers, and Registered Vehicles in Study Center Areas

It is expected that the SHRP 2 naturalistic driving data will be used to examine a wide variety of research questions for many years to come. Not all the research questions can be anticipated at this time, however. It is therefore important to document the characteristics of the study areas while relevant data are reasonably accessible. For example, a researcher might want to study the driving behavior of older drivers in rural areas and their response to different types of signage. (continued on page 16)

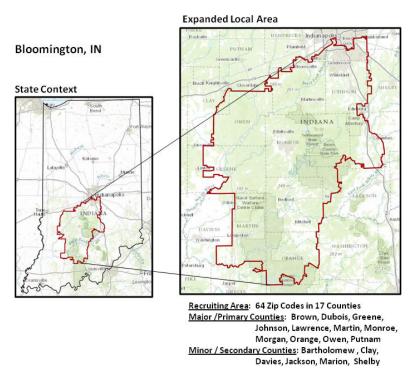


Figure 2.5. Bloomington study area.

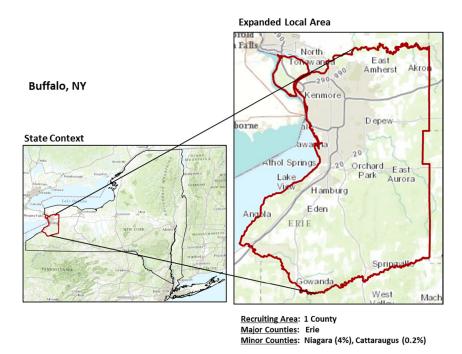


Figure 2.6. Buffalo study area.

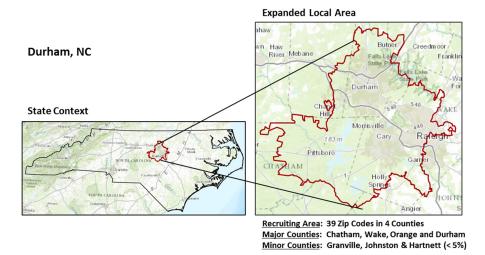


Figure 2.7. Durham study area.

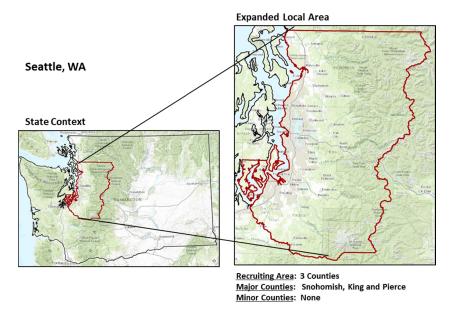


Figure 2.8. Seattle study area.

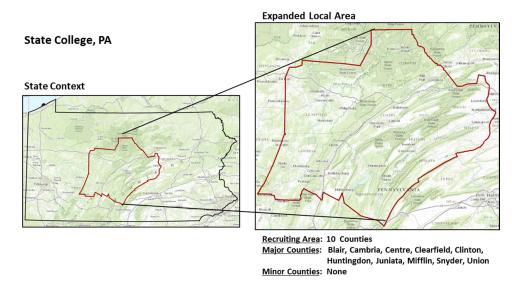


Figure 2.9. State College study area.

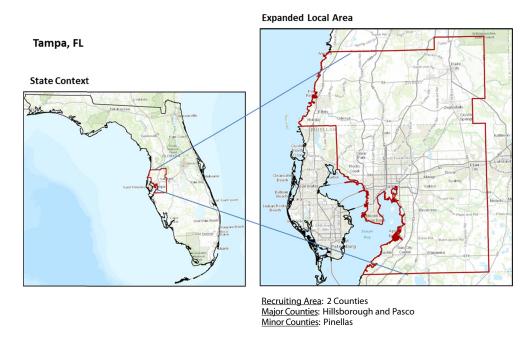


Figure 2.10. Tampa study area.

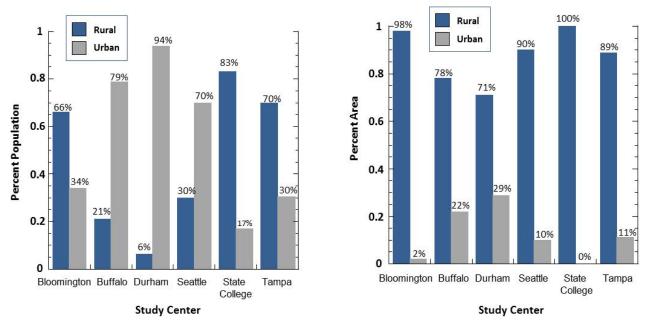


Figure 2.11. Percent rural versus urban character of each study center area by population (left graph) and land area (right graph).

(continued from page 13)

It may be most efficient to focus on one or two of the study areas when trying to extract trips from the NDS database. Providing data that characterize the population demographics, the roadway infrastructure, the crash history, the laws in place, and the rural or urban character of the area can help optimize the chances of finding sufficient trips to produce statistically significant results to a focused research question. This section

and several sections which follow (as well as data in Appendix B) summarize detailed characteristics of the study areas.

Table 2.6 provides the population by gender in 2010 census age groups (age 15 and above) within the targeted counties or zip codes that define each of the study areas. Total population over all ages (15 and above) in each study center area is also provided for comparison across the sites. Additional data on population demographics is provided

Table 2.6. Study Center Area Population by Gender in U.S. 2010 Census Age Groups (Over Age 14)^a

Age Group	Blooming	ton Study Ce	enter Area	Buffalo	Study Cent	er Areab	Durhan	n Study Ce	nter Area
(years)	Male	Female	Total	Male	Female	Total	Male	Female	Total
15–19	12,803	12,675	25,478	33,896	32,417	66,313	34,829	33,926	68,755
20–24	8,827	17,382	36,209	34,904	33,862	68,771	40,581	41,651	82,232
25–29	9,989	9,344	19,333	29,261	28,846	58,255	39,688	41,673	81,361
30–34	8,598	8,335	16,933	24,636	25,163	49,575	38,864	39,476	78,340
35–39	8,206	8,101	16,307	25,170	26,316	50,526	38,205	38,164	76,369
40–44	8,748	8,760	17,508	29,827	31,229	61,518	36,732	36,668	73,400
45–49	9,785	9,709	19,494	33,567	35,335	68,867	35,399	36,737	72,136
50–54	9,789	9,986	19,775	35,243	37,674	73,492	31,698	33,882	65,580
55–59	9,022	9,411	18,433	30,672	32,895	63,323	26,455	29,749	56,204
60–64	8,000	8,219	16,219	25,271	27,730	54,740	21,601	24,317	45,918
65–69	5,931	6,279	12,210	18,151	21,360	37,761	14,473	16,508	30,981
70–74	4,166	4,701	8,867	13,204	17,214	31,804	9,185	11,544	20,729
75–79	2,961	3,864	6,825	11,135	15,890	26,357	6,848	9,108	15,956
80–84	2,046	3,000	5,046	9,139	14,664	24,931	4,702	7,769	12,471
>84	1,482	3,164	4,646	7,060	16,547	23,697	3,851	8,708	12,559
Totals	120,353	122,930	243,283	361,136	397,142	758,278	367,710	384,295	752,005
	Saattla	Study Cente	Aroo		tate Colleg		Tampa	study Cer	ator Aroa
Age Group				Study Center Area			-		
(years)	Male	Female	Total	Male	Female	Total	Male	Female	Total
15–19	114,669	108,695	223,364	29,579	28,310	57,889	59,084	56,720	115,804
20–24	117,520	112,917	230,437	38,899	33,020	71,919	55,637	58,407	114,044
25–29	136,109	132,718	268,827	23,463	19,556	43,019	55,401	58,041	113,442
30–34	129,389	125,754	255,143	22,158	18,947	41,105	53,893	55,749	109,642
35–39	128,102	124,541	252,643	23,486	20,458	43,944	56,971	58,697	115,668
40–44	130,648	126,400	257,048	24,761	22,322	47,083	59,195	60,190	119,385
45–49	133,966	131,750	265,716	27,144	25,337	52,481	62,899	64,521	127,420
50–54	129,455	129,315	258,770	27,751	26,638	54,389	57,070	60,162	117,232
55–59	109,744	114,173	223,917	25,374	25,083	50,457	48,290	53,600	101,890
60–64	87,507	92,824	180,331	21,887	22,146	44,033	44,115	49,419	93,534
65–69	57,663	63,052	120,715	16,210	17,581	33,791	34,466	39,269	73,735
70–74	37,697	44,261	81,958	12,267	14,810	27,077	26,182	30,725	56,907
75–79	27,993	35,731	63,724	9,797	12,843	22,640	20,229	24,849	45,078
80–84	19,933	30,505	50,438	7,353	11,650	19,003	14,506	20,138	34,644
>84	18,309	36,864	55,173	5,567	12,355	17,922	10,937	20,181	31,118

^a Populations provided by zip codes (ZCTA) for primary recruitment area.

^bU.S. Census Bureau. http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml. Accessed April 1, 2014.

^c State of Washington Office of Financial Management. 2011. Census 2010, Summary file 1. General profile 1: Persons by race, age, and sex; urban and rural. http://www.ofm.wa.gov/pop/census2010/sf1/county.asp.

in Appendix B: Table B.1 and Table B.2 provide population by race and household income (all ages included); Table B.3 summarizes education attainment by gender for populations over 25 years of age.

Although the total population in Table 2.6 is useful for characterizing a study area, from a recruitment point of view for a driving study, an estimate of the number of licensed drivers in the study area (by age and gender) is clearly of interest. Licensed driver data are collected by state bureaus or departments of motor vehicles (DMVs), or by state departments of transportation (DOTs) or even state police; and the age groups for which data are available can differ from state to state. In addition, licensed driver data at the zip code level (relevant for two of the study areas) are not readily available. Table B.4 therefore provides licensed driver data for all sites at the *county* level by gender and in the age groups that were available. Similarly, Table B.5 provides study center vehicle registrations by vehicle type, also at the county level. For study areas that are defined by entire counties (Buffalo, Seattle, State College, and Tampa), the data provided at the county level directly translate to the study area. However, for the Bloomington and Durham study areas, which are defined by zip codes and incorporate only parts of multiple counties, Tables B.4 and B.5 may overestimate the stated quantities for the study area.

Motor Vehicle Crash Data for 2010

Information on historical motor vehicle crashes was acquired from the SHRP 2 Project S04 Roadway Information Database which was compiled by the Center for Transportation Research and Education (CTRE) at Iowa State University (Hunt et al. 2011; CTRE 2014). The crash data varied by study center and represented disaggregate crash data over numerous years and geographic areas. Year 2010 data were extracted for each center and geocoded to find the number of crashes that occurred within the defined boundaries of each study area. These data provide a representative snapshot of recent crash history. To better relate the results to the recruiting efforts of the S07 program, the crashes are provided by the number of drivers involved in fatal or injury crashes by age (Table 2.7). It is important to note that these crash data do not refer to crashes involving NDS participants. Crashes involving NDS participants are presented in Chapter 3.

Roadway Characteristics

Using the list of county or zip code areas supplied by the S07s, roadway characteristics were acquired for each study center from the Census TIGER 2000 data available through the Geography Network (ESRI 2000). For each study center, roadway data were downloaded for all counties in the recruitment area, and if required, data for zip code areas within those counties were extracted. The roadways within each test site area were then aggregated to indicate center-line miles for the major roadway categories shown in Table 2.8. This table is intended to provide a high-level comparison of roadways at each of the six study center sites.

State Highway Safety Laws Applicable to Each Study Center

The final characteristic of the study centers to be described concerns state highway safety laws. It has been recognized that driving behavior and driving behavior change may be affected by government regulations, laws, and policies (Hedlund 2000). To assist in use of the NDS data, this section presents a snapshot of selected driving laws in effect in 2013 during the data collection effort at each of the six study sites.

Since the NDS data collection was conducted over 3 years, it is important to remember that laws at the beginning of the data collection effort in 2010 may not have been the same as those at the end of the data collection effort in 2013. In addition, there is no information presented on the enforcement of the laws. Enforcement strategies and efforts may have varied during the data collection time frame as well as from site to site.

With that in mind, Table 2.9 summarizes laws in seven areas, namely

- Cell phone use and texting,
- Aggressive driving,
- Drug impaired and drunk driving,
- Younger driver licensing and license renewals,
- Older driving licensing provisions,
- Vehicle speed limits, and
- Safety restraint and child seat usage.

Table 2.7. Historical Data on Number of Drivers in Injury and Fatal Crashes in Each Study Center Area by SHRP 2 Age Group (2010)

	Bloom	Bloomington ^a		Buffalo		Durham		Seattle		State College		npa	Total A	Total All Sites	
SHRP 2 Age Group	Drivers in Injury Crashes	Drivers in Fatal Crashes	Total in Injury Crashes	Total in Fatal Crashes											
16–17	364	1	217	1	234	2	1,035	4	366	7	765	7	2,981	22	
18–20	734	12	741	3	698	5	2,811	20	1,460	14	2,356	23	8,800	77	
21–25	928	17	1,139	6	1,274	13	4,535	36	2,826	31	3,500	34	14,202	137	
26–35	1,211	21	1,273	9	1,982	18	7,521	43	4,377	43	5,387	74	21,751	208	
36–50	1,529	21	1,558	10	2,419	22	9,628	50	5,001	52	7,177	91	27,312	246	
51–65	1,106	15	1,217	13	1,479	18	6,472	46	3,367	37	4,617	67	18,258	196	
66–75	302	6	387	5	336	4	1,388	13	855	21	984	25	4,252	74	
75+	213	6	357	6	171	3	830	8	545	10	645	27	2,761	60	
NA	266	5	395		12		1,840	26	1,328	10	1,818	17	5,659	58	
Sum	6,653	104	7,284	53	8,605	85	36,060	246	20,125	225	27,249	365	105,976	1,078	
Drivers in all crashes	6,7	'57	7,3	337	8,6	590	36,	306	20,	350	27,	614	107	,054	

Note: NA = not available.

^aIncludes historical crash data for both primary and secondary study areas for Bloomington.

Table 2.8. Roadway Lengths for Primary, Secondary, and Local Roadways by Census Feature Class Codes (CFCC) in Six Study Center Areas

		Road Length (Center-Line Miles) at Six Study Centers								
CFCC	Roadway Description	Bloomington	Buffalo	Durham	Seattle	State College	Tampa			
A10	PRIMARY ROAD WITH LIMITED ACCESS OR INTERSTATE HIGHWAY	78.38	156.15	74.35	345.18	205.92	182.51			
A11	Primary road with limited access or interstate highway, unseparated	18.31	22.75	73.49	254.44	0.34	0.02			
A15	Primary road with limited access or interstate highway, separated	60.07	133.40	0.86	90.74	205.58	182.49			
A20	PRIMARY ROAD WITHOUT LIMITED ACCESS, U.S. and STATE HIGHWAYS	199.82	230.47	177.31	55.16	499.03	660.8			
A21	Primary road without limited access, U.S. and state highways, unseparated	175.07	190.29	155.44	55.16	284.26	367.22			
A25	Primary road without limited access, U.S. and state highways, separated	24.75	40.18	21.87		214.77	293.58			
A30	SECONDARY and CONNECTING ROAD, STATE and COUNTY HIGHWAYS	773.72	451.06	172.9	675.92	1,690.38	554.23			
A31	Secondary and connecting road, state and county highways, unseparated	680.15	451.06	171.17	664.22	1,656.36	441.40			
A35	Secondary and connecting road, state and county highways, separated	93.57		1.73	11.70	34.02	112.83			
A40	LOCAL, NEIGHBORHOOD, and RURAL ROAD, CITY STREET	9,634.10	3,960.63	5,134.14	20,353.74	14,997.79	12,350.99			
A41	Local, neighborhood, and rural road, city street, unseparated	9,630.04	3,954.17	5,129.50	20,342.12	14,995.06	12,339.68			
A45	Local, neighborhood, and rural road, city street, separated	4.06	6.46	4.64	11.62	2.73	11.31			
	Totals	10,686.02	4,798.31	5,558.70	21,430.00	17,393.12	13,748.53			

Table 2.9. State Highway Safety Laws Applicable in Each Study Center Area

Type of Law	Bloomington (Indiana)	Buffalo (New York)	Durham (North Carolina)	Seattle (Washington)	State College (Pennsylvania)	Tampa (Florida)
Aggressive driver actions defined by statute	At least three of the following: following too closely, unsafe operation, passing on the right off of roadway, unsafe stopping or slowing, unnecessary sounding of the horn, failure to yield, failure to obey traffic control device, speeding, repeatedly flashing headlights	No state law	Speeding and driving carelessly and heed-lessly in willful or wanton disregard of the rights or safety of others while committing at least two of the following violations: running a red light or stop sign, illegal passing, failing to yield right of way, following too closely	No state law	No state law Resolution passed to encourage drivers to drive courteously and defensively	At least two of the following: speeding, unsafe or improper lane change, following too closely, failure to yield right of way, improper passing, failure to obey traffic control devices (Not enforceable—violator is cited for specific infractions)
Handheld cell phone use	Not banned	Banned for all drivers, primary	Not banned	Banned for all drivers, primary	Not banned	Not banned
All cell phone use	Banned only for novice drivers <18 years old, primary	Not banned	Banned only for novice drivers <18 years old, primary	Banned for learner or intermediate driver, primary	Not banned	Not banned
Text messaging	Banned for all drivers, primary	Banned for all driv- ers, primary	Banned for all drivers, primary	Banned for all drivers, primary	Banned for all drivers, primary	Banned for all drivers (10/1/13), secondary
Drug-impaired driving per se laws for drugs (forbidding prohib- ited substances in driver's body)	Yes	No state law	Yes	Yes for THC ^a	Yes	No law
Drunk driving blood alcohol content (BAC) defined as illegal per se	0.08	0.08	0.08	0.08	0.08	0.08
Graduated driver licensing (GDL) program	Yes	Yes	Yes	Yes	Yes	Yes
Learner stage min. age (years/months)	15 with driver ed 16 w/out driver ed	16	15	15 with driver ed 15/6 without driver ed	16	15
Intermediate stage min. age (years/ months)	16/6 with driver ed 16/9 w/out driver ed (nighttime driving and passenger restrictions)	16/6 nighttime driv- ing and passen- ger restrictions	16 nighttime driving and passenger restrictions	16 nighttime driving and passenger restrictions; driver ed required, no traffic violations or drug or alcohol offenses ^b	16/6 nighttime driv- ing and passenger restrictions	16 and 17 (nighttime driving restrictions)

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Table 2.9. State Highway Safety Laws Applicable in Each Study Center Area (continued)

Type of Law	Bloomington (Indiana)	Buffalo (New York)	Durham (North Carolina)	Seattle (Washington)	State College (Pennsylvania)	Tampa (Florida)
Full privilege min. age (years/months)	18 (night) 17 (passenger) with driver ed 17/3 without driver ed	17 with driver ed 18 without driver ed	16/6	18	17 with driver ed and 12 months no crash or conviction; 18 without driver ed	18
Length of regular driver license renewal	Every 6 years	Every 8 years	Every 8 years	Every 5 years	Every 4 years	Every 8 years
Special provisions for mature driver license renewal (years)	For drivers 75–84, renewal every 3 years For drivers >84, renewal every 2 years	None	For drivers >65, renewal every 5 years	None	None	For drivers >79, renewal every 6 years with vision test
Speed limits for cars/ trucks (mph) Rural Interstates Urban Interstates Other limited access	70/65 55/55 60/60	65/65 55/55 55/55	70/70 70/70 70/70	70/60 60/60 60/60	65/65 55/55 65/65	70/70 65/65 70/70
Seat belts: age-related laws (years)	Primary >15 all seats	Primary <16 in rear seats All in front seats	Primary >15 in front seats Secondary >15 in rear seats	Primary >8 or >4'9" in all seats	Secondary >17 in front seats Primary 8–17 in all seats	Primary >5 in front seats 6–17 in all seats
Child seat: age-related laws (years)	<8: mandatory 8–15: seat belt allowed		<8 and <80 lbs: mandatory 8–15 (weigh 40–80 lbs): seat belt allowed	<8 and <4'9": mandatory 8–15, <8 and 4'9" or taller, children who weigh >40 lbs: seat belt allowed	<8: mandatory	<4: mandatory 4–5: seat belt allowed

Sources: Governors Highway Safety Association. 2013. Highway Safety Laws by State. http://www.ghsa.org/html/stateinfo/bystate/index.html. Accessed Dec. 20, 2013. Insurance Institute for Highway Safety. 2013. Highway Safety Topics and State Laws. http://www.iihs.org/laws/default.aspx. Accessed April 22, 2014.

^aTetrahydrocannabinol.

^b Washington State definition of other drug/prohibited substances provided in statute. Revised Code of Washington (RCW), Title 46 Motor Vehicles. http://apps.leg.wa.gov/rcw/default.aspx?Cite=46. Accessed April 22, 2014.

CHAPTER 3

Summary of Key Tasks and Performance

This chapter summarizes the major tasks and activities conducted by the six study centers during the NDS. The topics covered in the following sections include

- 1. IRB activities
- 2. Recruiting
- 3. Consent and assessment
- 4. Installations
- 5. Participant management and fleet maintenance (including crash investigations)
- 6. Deinstallations

In addition to describing the process and issues encountered as volunteer drivers were enrolled and monitored during this 3-year study, lessons learned during each step are summarized.

IRB Activities

Since the NDS involved human subjects, oversight by an Institutional Review Board (IRB) was required. The role of the IRB is to review all research protocols involving human subjects before the project start and then periodically while the project is under way to ensure that the rights of the participants are protected, that participants are not subject to unreasonable harm (either physical or emotional), and that data and information about the participants are kept confidential. Depending on the nature of the project and an individual institution's protocols, either a full review by the entire IRB committee, or an expedited review by a single qualified member of the committee is required. For multiyear projects like the NDS, an annual continuing review is also conducted. If there are any changes to the protocol during the course of the study, a formal modification, or amendment, describing the change must be submitted and reviewed by the IRB staff and possibly by the full IRB committee as well.

VTTI prepared the initial IRB application for the NDS. This application was given a full review by the IRB at Virginia Tech (VT) and by the IRB for NAS. The six study centers were

also required to have IRB oversight by their own (local) institution or, alternatively, be subject to oversight from an "IRB of Record." [The latter occurs when an IRB at one institution (in this case, Virginia Tech) assumes responsibility for human subject research being performed at another institution.] The NDS study protocol also acquired a Certificate of Confidentiality from the National Institutes of Health (NIH). This certificate, obtained by VTTI, covered all six study centers. A copy is provided in Appendix C.

All staff at each of the study centers who interacted with the participants were required to receive Human Subjects Training in a manner approved by the cognizant IRB. In preparing their local IRB applications, staff at the six study center sites incorporated information provided by VTTI into the application at their own institution. This included the research protocol, consent forms, compensation details, and safeguards for protection of study participants. One study center (Seattle) found it necessary to provide additional background about the study protocol and about naturalistic data collection in general (i.e., as conducted in other studies) to help its local IRB properly understand how participant confidentiality and privacy would be protected.

Table 3.1 summarizes the IRB type, the institution, and the specific IRB committee utilized at each NDS study center. Comments specific to each site are also provided. Note that four of the six sites (Bloomington, Seattle, State College, and Tampa) used their local IRB for oversight. Of these four, all but Tampa were required to undergo a full IRB review. The Tampa IRB did not require a full review because the study could be classified under Tampa's expedited review Category 6 (research involves the collection of data from voice, video, digital, or image recordings made for research purposes) and Category 7 [the research is performed on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or will employ a survey, interview, oral

Table 3.1. Summary of IRB Oversight Responsibility at Six Study Centers

Study Center	IRB Type	Institution Providing IRB Oversight	IRB Committee Name	IRB Review Level	Elapsed Time from Application to Approval	Comment
Bloomington, Indiana	Local IRB	Indiana University (IU)	IU IRB-B (Bloomington) IU IRB-1	Full	161 daysª	IU has five IRBs on two campuses. IRB-1 on Indianapolis campus conducted one continuing review; rest done by IRB-B. Information shared between two IRBs.
Buffalo, New York	IRB of Record	VT	VT IRB for Protection of Human Subjects	Full (VTTI)	NA	Initial full review by University at Buffalo's Social and Behavioral Sciences IRB Committee before adoption of VT IRB of Record.
Durham, North Carolina	IRB of Record	VT	VT IRB for Protection of Human Subjects	Full (VTTI)	NA	Initial full review by Westat IRB before planned adoption of VTTI's IRB as primary for all subsequent reviews and amendments.
Seattle, Washington	Local IRB	Battelle	Battelle Internal IRB	Full	115 daysª	After IRB approval was obtained, most amendment submissions were handled without need for full-board review.
State College, Pennsylvania	Local IRB	Penn State	Office of Research Pro- tection IRB	Full	58 days	Penn State has two IRBs in its Office of Research Protections (ORP), which meet monthly. ORP conducts site visit after approval.
Tampa, Florida	Local IRB	USF	USF Social and Behavioral IRB	Expedited	85 days	Application for IRB approval as well as communication with IRB was via secure website. IRB chair determined that full review not needed. Expedited review was conducted.

Note: NA = not available.

history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies].

The remaining two sites (Buffalo and Durham) each had an initial full review by their local IRB before the start of the study, but they subsequently adopted Virginia Tech's IRB as the IRB of Record during the execution of the study. Durham planned for and requested the IRB of Record (with concurrence from the local IRB) because the study team believed it would be more efficient given the multisite nature of the NDS and the likelihood that there would be periodic amendments to the study protocol. Buffalo requested the IRB of Record because the local IRB at the University at Buffalo had concerns about the NDS intent to retain data in the study from participants who were consented and started in the study but then withdrew early. The NAS and VTTI IRBs believed these data could be kept in the study based on precedents established for other research studies at the NIH. VTTI and the University at Buffalo ultimately signed an agreement allowing the VTTI IRB to assume responsibility for oversight of the study in Buffalo.

Table 3.1 also shows the elapsed time (days) from application submission to IRB approval to provide realistic timelines for the process as it transpired across all sites. Note, however, that delays in obtaining IRB approval (as occurred in Bloomington) were not due to inaction on the part of the IRB or the study center applicants, but rather to delays in obtaining the Certificate of Confidentiality for the entire SHRP 2 program.

IRB project approval was valid for 1 year. For each additional year of the study, a continuing review was conducted. Study centers for which a full IRB review was required for the initial application usually had full reviews during the annual continuing reviews.

IRB Process

At a large institution, it is not unusual for an IRB staff member to be assigned as a point person to a new research project to aid the researcher in navigating the IRB process, to explain how the IRB interprets different provisions, and to ensure consistency from study to study. In particular, this point

^a Bloomington submitted its application earlier than all other sites. Seattle and Bloomington experienced a delay of 2 months waiting for Certificate of Confidentiality from NIH.

person is usually called upon to assist if there are adverse incidents with the study.

Detailed documentation is required for each project, and each institution has its own forms and requirements. Some study center IRBs were more form-driven than VTTI. For example, in Bloomington, a typical set of forms included Documentation of Approvals, Study Protocol, Summary of Safeguards, a Children in Research form (required because minor drivers were involved), and an Investigators list. In addition, all consent, assent, and owner permission forms as well as recruitment materials and surveys had to be included as part of the documentation.

As required by the IRB, all those who were going to have direct contact with participants (crash investigators, assessment personnel, recruiters, schedulers, and installers) were required to have training in human subject research, either an investigators training course or certification from the Collaborative Institutional Training Initiative (CITI) or similar organization. One institution also required personnel to sign a statement annually that they had no conflicts of interest with the research work.

The items and dates listed in Table 3.2 illustrate the IRB approval timelines for VTTI, NAS, and the six study centers.

The study center site certification occurred only after IRB approval was obtained, the Certificate of Confidentiality was in place, and a site visit was conducted. The initial installation date is provided for each site (for reference) as are the annual IRB Continuing Review dates.

IRB Amendments

After initial IRB approval was obtained, study centers maintained regular communication with the IRB office; a variety of amendments were needed to address issues which came up during the course of the 3-year study. Most of the 18 amendment submissions were handled via an expedited review process (i.e., without needing a full-board review). Many were addressed in a few days, but several required 5 to 6 weeks. For example, changes to human subject participation and compensation of human subjects typically took more time and usually required a full review.

The first four amendments related to secondary drivers. The fourth amendment also addressed modifications needed after the NIH review for the Certificate of Confidentiality. Amendment 5 clarified participant withdrawal and dismissal

Table 3.2. Timeline for IRB Approvals and Certificate of Confidentiality

Item	VT IRB Buffalo and Durham	NAS IRB	Bloomington	Seattle	State College	Tampa
IRB tracking number	09-953	TRBX-P-05-01-A: Field Protocol	1005001386	0434	34363	Pro00001238
Interim VT approval (to start IRB application process)	11/6/2009	na	na	na	na	na
Initial VT/NAS/local site IRB submissions	2/23/2010	8/30/2010	6/21/2010	10/29/2010	7/23/2010	8/9/2010
Initial VT/NAS/local site IRB approvals	5/6/2010	8/30/2010	11/29/2010	2/21/2011	9/18/2010	11/2/2010
VT IRB of Record executed at local site	NY 10/22/2010 NC 8/24/2010	na	na	na	na	na
Certificate of Confidentiality submission (NIH)	7/21/2010	na	na	na	na	na
Certificate of Confidentiality approval (NIH)	10/14/2010	10/14/2010	10/14/2010	10/14/2010	10/14/2010	10/14/2010
Initial site certification (after IRB approval and site visit)	NY 9/14/2010 NC 9/09/2010	na	2/28/2011	2/22/2011	3/29/2011	11/11/2010
Initial Install Date	NY 10/25/2010 NC 11/08/2010	na	1/27/2011	2/23/2011	2/15/2011	11/16/2010
IRB Continuing Review 1	5/6/2011	6/21/2011	10/13/2011	7/26/2011	8/25/2011	10/7/2011
IRB Continuing Review 2	4/20/2012	6/21/2012	8/21/2012	5/23/2013	8/17/2012	11/1/2012
IRB Continuing Review 3	4/9/2013	6/18/2013	7/18/2013	Pending	7/5/2013	Pending
IRB Continuing Review 4	na	na	7/19/2013	na	na	na
Continuing Review expires	5/3/2014	6/18/2014	7/17/2014	5/31/2014	7/4/2014	11/1/2013

Source: Based on initial data provided by S. Lee, VTTI (Aug. 21, 2013).

Notes: na = not applicable.

protocol. Amendment 6 expanded recruitment, addressed the use of leased vehicles, and added a semiannual drawing to encourage recruits to become participants. Nonowned vehicles were added in Amendment 7, which also increased participant compensation. A NAS IRB request to revise the owner permission letter was the subject of Amendment 8. Amendment 9 revised the exit survey and revised the letter and e-mail to update participant payment. A call center at Battelle was approved in Amendment 9a. A slogan devised by an advertising agency was added to recruiting materials in Amendment 10. Materials to extend participation and address variable enrollment times were the topics of Amendments 11, 12, and 13. Amendment 14 enabled vehicles with persistent issues related to the tire pressure monitoring system (TPMS) to be removed from the study. This was the most challenging modification to approve because the participants had signed up to participate in the study for specific durations and altering the duration affected the financial compensation for those participants. While this situation was not ideal, it had to be balanced with the risks of having a false positive warning light illuminated on the participants' instrument cluster.

Promotional materials were added to the recruitment section of the protocol in Amendment 15. Amendment 16 allowed 4- to 7-month enrollees; it also authorized a \$25 gift card for providing pictures of secondary drivers so that trips driven by these secondary (consented) drivers could be identified and the data used. The total number of participants was raised to 3,300 in Amendment 17; and Amendment 18 allowed contact with secondary drivers for a photo and to ask if they were interested in follow-on studies. This brief summary of IRB amendments illustrates the variety of issues that were addressed during the conduct of the study. Table 3.3 lists the amendments along with the date that each was approved at VTTI and the study centers. As shown, amendments began in June 2010 and continued throughout the project up until August 2013.

Issues Encountered and Lessons Learned

The issues encountered and lessons learned described in this section represent an amalgam of inputs from all six study centers. One general observation at all six study centers was that for a study as large and as complex as the NDS, it is important to not underestimate the amount of time required to interact with the IRB.

Using the Virginia Tech IRB as the IRB of Record for two of the study centers (Buffalo and Durham) simplified the IRB process, resulting in significant time savings for those two centers since all 18 IRB amendments were prepared and submitted by VTTI staff. Although this approach may not be permitted at all institutions conducting this type of research, it was found to provide administrative and schedule benefits.

Communication with the IRB before an application is prepared and submitted is important to help the researchers prepare for the level of IRB review (full or expedited) that is most appropriate. In addition, maintaining good communication throughout the course of the study can help a complex project go relatively smoothly. One site found it beneficial to contact the IRB with even small problems (i.e., adverse events that did not rise to the level that required immediate notification) since the IRB was often able to help resolve these issues.

IRBs typically require that changes to the study protocol be documented by an amendment. However, to avoid unnecessary administrative delays, amendment submittals should be closely reviewed to reduce the number of submittals. For this reason, the strategy adopted was to bundle amendments together.

With long duration studies like the NDS, researchers need to anticipate that there might be staff turnover at the local IRB office. At one site, over the course of this 3-year study, five different point people were assigned to the project with the most recent person assigned for about 20 months. Although each point person was clearly committed to protecting human subjects, each wanted to see things presented in slightly different ways; that necessitated adjustments on the part of the research staff. Regardless of personnel changes and style differences, establishing a good rapport with IRB office staff who were managing the IRB documentation was extremely helpful in processing modifications and understanding the details that were most important to include in that documentation. Detailed document headers and footers (including document name and version number) are recommended.

Recruiting

Recruiting participants for the NDS turned out to be the most challenging part of the study. The study design was intended to provide a balanced sample of drivers by age and gender. However, obtaining the desired number of participants in the specified age groups in a timely way proved to be more difficult than expected. As a result, changes were made to the recruitment approach, to participant compensation, and to the list of acceptable vehicles. This section describes the recruiting activities and how they evolved over the course of the 3-year study. Lessons learned that can benefit future researchers are presented at the end of this section.

Requirements and Approach

Initially, participants were recruited for the NDS using a centralized recruiting approach. The Center for Survey Research (CSR) at Virginia Tech effectively assumed the role of national call center for all six study centers. CSR staff, using purchased lists, initiated cold calling of residents in each of the six study areas. Registration information for interested drivers identified by CSR were entered into Virginia Tech's mission control

Table 3.3. Amendments to IRB Documentation and Dates Approved

Item	VT IRB Buffalo and Durham	NAS IRB	Bloomington	Seattle	State College	Tampa
Amendment 1. Secondary driver options; various other	6/8/2010	na	na	na	na	na
Amendment 2. Further secondary driver clarifications	7/21/2010	na	na	na	na	na
Amendment 3. Further secondary driver clarifications; various other	9/23/2010	10/7/2010	na	na	na	na
Amendment 4. Mods required per NIH Certificate of Confidentiality review; further clarification of secondary drivers	10/15/2010	10/15/2010	na	na	na	na
Amendment 5. Clarify withdraw/dismissal protocol	10/22/2010	10/22/2010	na	na	na	11/10/2010
Amendment 6. Expand recruitment; use leased vehicles; add semiannual drawings	2/16/2011	3/16/2011	na	na	6/14/2011	5/31/2011
Amendment 6a. Recruitment	na	na	3/25/2011	5/13/2011	na	na
Amendment 6b. Drawings	na	na	6/2/2011	na	na	na
Amendment 6c. Leased vehicle	na	na	6/2/2011	5/13/2011	na	na
Amendment 7. Add nonowned vehicles, increase payment to \$500 per year	5/10/2011	5/26/2011	6/2/2011	5/26/2011	6/14/2011	6/29/2011
Amendment 8. Revise owner permission letter per NAS IRB request; may also include consistency review items	6/8/2011	na	7/22/2011	5/31/2011	8/25/2011	na
Amendment 9. Revise exit survey, mention Battelle call center, revise e-mail/letter to update payment	8/18/2011	9/2/2011	2/8/2012	10/3/2011	12/21/2011	9/26/2011
Amendment 9a. Battelle only, call center approval	na	na	na	7/26/2011	na	na
Amendment 10. Add Crowley Webb slogan to recruiting materials ^a	10/3/2011	10/25/2011	2/8/2012	2/2/2012	na	na
Amendment 11. Materials to extend participation up to 12 months	2/20/21012	4/6/2012	5/28/2012	5/24/2012	7/12/2012	6/10/2012
Amendment 12. Materials for variable enrollment of 8–24 months	3/27/2012	4/6/2012	5/28/2012	5/24/2012	7/12/2012	6/10/2012
Amendment 13. Add a phrase to the variable enrollment consent forms	4/18/2012	4/6/2012	5/28/2012	5/24/2012	7/12/2012	6/10/2012
Amendment 14. Remove vehicles with persistent TPMS issues	5/31/2012	8/1/2012	11/14/2012	8/29/2012	12/21/2012	8/15/2012
Amendment 15. Add promotional materials to recruitment section of protocol	10/10/2012	10/12/2012	11/14/2012	na	na	10/16/2012
Amendment 16. Allow 4–7 month enrollees; remove blanket process references; allow \$25 gift card for providing pictures of secondary driver(s)	2/12/2013	3/11/2013	6/25/2013	3/6/2013	6/7/2013	4/1/2013
Amendment 17. Increase number of participants to 3,300	4/19/2013	5/1/2013	6/25/2013	5/29/2013	na	Pending
Amendment 18. Contact secondary drivers for a photo and for follow-on studies	8/15/2013	Pending	Pending	na	na	Pending

Note: Early amendments are shown as not applicable (na) for sites that started later as these amendments were addressed in the site's original IRB submission.

^a Crowley Webb (advertising agency) provided the slogan, "Give a little time to safety research, we'll all get a lot in return."

software (MCS) which was accessible online by each of the study centers. Once entered into MCS, the recruit would be called by a scheduler from the local study center who would further explain and answer questions about the study. If the recruit agreed to participate, the scheduler would set up an appointment at the study center facility to review (and sign) the consent form, complete driver survey and assessment tests, and have technicians install the equipment. Once installation was complete, the "recruit" officially became an NDS "participant."

To be accepted into the NDS study, the driver and vehicle had to meet the following criteria. The driver must

- Have a valid driver's license;
- Own the vehicle (or have owner's permission);
- Drive a minimum of three times per week;
- Live within the study area—county or zip code (this was relaxed if close to boundary); and
- Drive at least 3,000 miles a year (originally aimed at older drivers but later eliminated).

The vehicle must

• Be on the eligible vehicle list, meaning the parameter identification (PID) code must be available from the vehicle manufacturer (the PID code allowed the DAS to read data from the vehicle bus);

- Be covered by liability insurance;
- Be currently registered; and
- Not be driven where cameras are not allowed (i.e., military bases and U.S. border crossings).

Recruiting activities formally began at the CSR call center in September 2010. After a few months it became apparent that the call center was not supplying sufficient participants in the required age and gender categories to support the planned participant enrollment and installation rates. In November 2010, the study centers were directed to initiate local recruiting to supplement the national call center efforts. Since the option to conduct local recruiting was included in the original study plans and protocols, nominal IRB approval had already been obtained for this activity. However, the sites were typically required to submit specific materials for local IRB approval throughout the study. Every different recruiting method and the associated recruiting materials usually needed to be submitted and approved as they were developed. The Bloomington IRB in particular, was very concerned with how compensation was presented. Use of materials from a local ad agency in Buffalo and establishment of a local call center in Seattle required IRB amendments (as noted in Table 3.3).

Figure 3.1 summarizes the sequence of steps going from recruit to participant and lists (on the left side) some of the

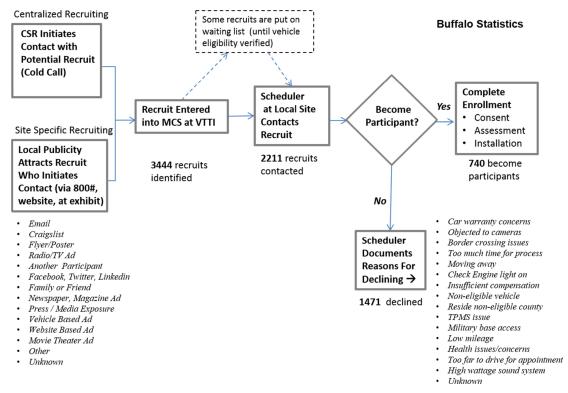


Figure 3.1. SHRP 2 recruit-to-participant sequence including recruiting approaches for Buffalo site.

recruiting methods used. As a representative illustration, statistics for the Buffalo site are provided at each stage of the process. These numbers show that as a result of both centralized and local recruiting, a total of 3,444 drivers in the Buffalo area expressed interest, registered, and were entered into the SHRP 2 MCS. Of these 3,444 recruits, 2,211 were contacted by local study center schedulers. (The remaining recruits remained on waiting lists to be available should someone in their age group drop out.) Of the 2,211 recruits contacted, 1,471 declined to participate for a variety of reasons, some of which are also listed in Figure 3.1 (on the right side). However, 740 recruits did agree to become participants.

Success rates for converting recruits to participants for each of the six study centers are summarized in Table 3.4. It is important to distinguish the total number of recruits from the number who were actually contacted. For example, some recruits were put on a waiting list because their age/gender group was already filled or a check had to be made to confirm vehicle eligibility. The names of these recruits were retained, however, in case other participants terminated early. Table 3.4 lists for each site the number of recruits in MCS, the number contacted, and the percentage who became participants.

Incentives and Methods

A number of recruiting incentives were employed at all study centers. These included

- Compensation of \$300/year (increased to \$500/year beginning in summer 2011). This level of compensation was provided to primary and additional primary drivers but not secondary drivers.
- \$50 in gas cards issued for keeping the first scheduled appointment for assessment and DAS installation. This policy was instituted to reduce the no-show rate and began in summer 2012.

- \$50 battery reimbursement if vehicle battery failed the voltage test before installation. (One site offered up to \$100 gas card for battery replacement.) If participant agreed to replace battery, the installation proceeded.
- Occasional \$10 or \$25 gas cards if the participant was specifically requested to visit the facility for a maintenance or a SSD swap appointment.

Additional recruiting incentives approved by the SHRP 2 program and employed at the discretion of each study center included

- A \$1,000 drawing held every 6 months for every 150 drivers enrolled at the time;
- \$25 gas cards issued throughout the study to participants who lived 20 to 30 miles (distance threshold was site-specific) or further from the study center facility; and
- Promotional items, such as water bottles and T-shirts, given away at exhibits or presentations.

Table 3.5 provides a list of recruiting methods and the number of recruits acquired at each site using each method (as summarized in MCS). Although some caution must be used in drawing conclusions from this table (see the following discussion), it does provide an indication of which approaches were most viable. Excluding the category "Other" (which contains multiple methods), the most successful recruiting method appears to be "TV/radio ad" for three of the sites (Buffalo, Durham, and Seattle) and "Craigslist" for the other three sites (Bloomington, State College, and Tampa). Additional recruiting approaches which showed some success included hearing about the study from another participant, receiving a phone call from a local call center (Seattle), exposure to newspaper or magazine ads, or viewing flyers or posters at a variety of venues. With most of these approaches, interested individuals were directed to a website (www.drivingstudy.org) or to a toll free phone number for more information.

Table 3.4. Percentage of Recruits Contacted Who Became Participants

Study Center	Total Recruits in MCS ^a	Total Recruits Contacted	Total Participants ^b	Percentage Contacted Who Became Participants
Bloomington	967	480	254	52.9%
Buffalo	3,444	2,211	740	33.5%
Durham	2,885	2,885	529	18.3%
Seattle	3,629	2,451	715	29.2%
State College	1,166	717	275	38.4%
Tampa	4,267	2,948	734	24.9%
Total	16,358	11,692	3,247	27.8%

^a Not counting duplicate entries for drivers entered more than once in MCS because they switched vehicles.

^bTotals include primary, additional primary, and AVT participants who were in the study at least 1 day (VTTI 2014).

Table 3.5. Number of Recruits by Method as Reported in MCS

Recruiting Method	Bloomington	Buffalo	Durham	Seattle	State College	Tampa	Total
Another participant	122	321	294	103	47	159	1,046
Craigslist	217	493	493	404	231	357	2,195
CSR national call center	5	31	24	8	14	25	107
E-mail	37	34	47	57	140	123	438
Facebook, Twitter, LinkedIn ad	7	81	25	63	12	121	309
Family or friend	33	107	122	199	17	111	589
Flyer/poster	71	191	187	199	96	301	1,045
Movie theater ad	1	3	3	2	14	15	38
Newspaper or magazine ad	65	123	260	45	74	242	809
WA call center (Seattle)	0	9	5	420	3	5	442
Press/media exposure	7	50	124	56	15	55	307
TV/radio ad	31	1,266	529	580	73	221	2,700
Vehicle-based ad	3	15	24	5	0	12	59
Website-based ad	40	50	28	238	22	76	454
Other ^a	267	463	454	810	339	2,095	4,427
Unknown	59	193	257	430	69	340	1,348
Blank	2	14	9	10	0	9	44
Total	967	3,444	2,885	3,629	1,166	4,267	16,358

Notes: CSR = Center for Survey Research. Recruits contacting the driving study via an 800 number and website are combined for each source. Values in *italics* indicate the most successful method for that study center (excluding "Other," which contains multiple methods).

The category of "Unknown" in Table 3.5 provided about 8% of the total recruits. It is likely that recruits whose initial exposure to the study occurred through the national call center are listed in the Unknown (or Blank) category because the recruiting method (source) field was not included in MCS at the beginning of the project. This belated introduction occurred because, initially, no other recruiting sources outside of the national call center were planned. This would account for the lower than expected number of recruits listed as coming into the study via the CSR call center.

The category of "Other" in Table 3.5 included a variety of approaches, some of which were common across all sites while some were unique to a particular site. A selection of these methods is listed in Table 3.6 along with the venue and the study center(s) which utilized the method.

Once it became apparent that the study centers had to take responsibility for recruiting their own participants, a number of approaches were pursued which targeted specific age categories, especially the hard-to-recruit younger (16–17) and older (76+) age groups for which shortfalls were most significant. One study center (Bloomington) convened a focus group of younger participants which led to that site's decision to hire a young recruiter to present a more youthful face for the project. This

young recruiter (formally and informally) attended university and community events to distribute project materials (flyers and promotional items) and sign up potential recruits. (Similar peer-to-peer recruiting was used in Buffalo and Tampa.) Another recruiter hired at the Bloomington site was a lifelong local community resident. This tactic helped root the project in the community, thus providing more local legitimacy. Having the assistance of these specialized recruiters also enabled the study center to stay in frequent contact with potential candidates, which led to converting 70% of those locally recruited (in the 16–17 and 76+ age groups) to actual participants.

The Buffalo study center hired a local marketing firm with experience recruiting participants for pharmacological studies. The firm was familiar with following study protocols, including recruiting under the control of an IRB. After consultation with the SHRP 2 NAS management (which included discussion of marketing concepts such as study branding and media outlets for the message), the Buffalo site was authorized to proceed. A logo and message content for posters, flyers, and billboards were developed as well as radio ads. All received IRB approval (see Amendments 10 and 15 in Table 3.3). Figure 3.2 shows a sample logo and message (left) and its use in a mall recruiting kiosk (right).

^a "Other" contains multiple methods (see Table 3.6 for further information).

Table 3.6. Examples of Recruiting Methods Included in "Other" Category

"Other" Recruiting Methods	Venue	Study Center
Exhibits/display tables (with DAS or possibly with DAS-equipped vehicle)	Colleges (student union, library, dining halls, campus expositions, new student orientations)	Tampa, Seattle, Bloomington
	Auto shows; auto plants	Buffalo, Seattle
	Open air markets	Tampa
	Shopping malls	Buffalo
	Fairs, festivals	Buffalo, Durham, Bloomington
	College parking operations	Bloomington
	Movie theater exhibit ^a	Tampa
Visits by NDS personnel; presentations	High school classes; driver ed, high school traffic safety fair	Seattle, Tampa, Buffalo
	Senior centers, assisted living facilities; senior wellness fair	Buffalo, Durham, Tampa, Seattle, Bloomington
	College sporting events	Durham
	American Automobile Association (AAA) driver safety class; American Association of Retired Persons (AARP) mature driver class	Durham, Seattle, Buffalo
	Farmers market	Durham
Neighborhood blogs		Seattle, Durham
Postcards with NDS information	Distributed at sporting events; put on cars at shopping centers; direct mailings to participants regarding other drivers in family; cold mailings to citizens in the correct county and age group	Durham, Seattle, Buffalo
Letters from vehicle manufacturer or National Academies		Seattle, Buffalo, Tampa
Advertisements at major college sporting events	College basketball games (Duke and University of North Carolina)	Durham

^a During blockbuster movies. Not to be confused with movie theater screen ads.



Figure 3.2. NDS logo and message used in posters, billboards, and flyers.

The Seattle site utilized a local call center to conduct cold calling for that area. This center (listed as WA call center in Table 3.5), was effective for recruiting across all age groups but was most effective for recruiting participants ages 76+. Phone calls from a locally based center with name recognition (rather than the national call center at VTTI) appear to have been better received.

It is important to note that much of the early recruiting was done under conditions which were subsequently changed. For example, 9 months into the recruiting effort, compensation levels were increased to provide more incentive for recruits to become participants. The acceptable vehicle types were also expanded from the original "prime" category to include "legacy" vehicles (June 2011) and eventually "basic" vehicles (Nov. 2, 2011), largely because many younger drivers and some older drivers did not own prime vehicles. In effect, the low recruiting rates early in the program drove changes in the study ground rules. It is likely that some recruiting methods or venues that were minimally effective early in the program (and were discontinued) might have performed better later

in the program. However, it is clear that the flexibility and willingness of the study center staff to adjust as the program evolved was instrumental in ensuring the eventual success of the data collection effort.

Effectiveness of Methods

The following paragraphs step through the major recruiting approaches and provide additional detail regarding their implementation and effectiveness.

Cold Calling

The objective of cold calling was to generate a representative sample. However, the number of recruits obtained from CSR cold calling was insufficient to support the program schedule. For example, in Bloomington, the cold calling approach generated only 20% of the total participants. It was particularly unsuccessful in reaching younger age groups, most likely because younger groups rely more on cell phones than landlines. The call center generated few participants under age 25 for Bloomington.

A number of factors led to this lack of success. The CSR call center at VTTI had little name recognition at the six study centers. Often, recruits contacted by the local scheduler (after recruit information was posted in MCS) did not remember speaking with the call center. It is believed that the centralized call center approach was too anonymous and impersonal. In addition, the process itself was too lengthy: the call center collected registration information from the recruit, then subsequently provided that information to the study centers—often meaning that the first contact by the local scheduler took too long to be productive. This was in contrast to the experience at the WA call center in Seattle which placed calls to residents in the Seattle recruitment area. This call center was local, had name recognition, and proved to be effective across all age groups, but especially for the 76+ age group.

Online Presence

There were a variety of avenues pursued by all sites which utilized online options to publicize the study. These included banner ads on university and (some) local DOT websites, as well as ads on Craigslist, Facebook, Twitter, and LinkedIn. NAS created a SHRP 2 NDS website which provided information on the study (www.shrp2nds.us) at all six study centers. (This link was later changed to www.drivingstudy.org to make it easier to remember.) The marketing firm used by the Buffalo study center subsequently created a website that was customized for New York, more streamlined (since it focused only on Buffalo), and easier to navigate.

At the Bloomington site, free advertisements were posted on university and local community colleges' online bulletin boards at 2-month intervals with the message tailored to 18–25-year-olds. These university ads were also very successful with individuals in the 36–65 age groups who were well acquainted with research and the university and were willing to contribute to a project deemed scientifically worthy.

Online ads were also posted on high school websites to reach parents as well as students in Bloomington. However, access to high school students via online methods was restricted in other areas (e.g., Buffalo) where e-mails could only go to administration officials at the schools.

Attempts at broadening the scope of the online presence via official government websites at some sites were administratively or organizationally impeded. For example, transportation-related websites like the Indiana DOT or the Bureau of Motor Vehicles cater to very specific temporary communications, such as construction closings and branch operations, and provided no place for announcements. However, this was not the case in Seattle where the Washington State DOT was very cooperative, allowing the Seattle site to place a recruiting announcement on its website. The advertising effort was very effective at attracting recruits, primarily for ages 26–50.

Advertisements on Craigslist reached a different community of individuals looking for small economic opportunities within their vicinity. Such advertising provided a moderate return, although perhaps selecting for participants with financial motivations.

At Durham, a Facebook ad targeting 16–17-year-olds ran for 10 days, generating 249 clicks. Duke University released a Facebook post along with an e-mail blast to students. Radio ads also ran on Sports Network Radio during Duke football games. A banner ad guaranteed for 250,000 impressions ran on goduke.com.

Exhibits and Presentations

A recruiting approach used by some of the study centers involved setting up NDS exhibits (or tables) at community events or at university venues. At these events, potential recruits could learn about the driving study, see the DAS instrumentation, speak with knowledgeable personnel near their own age from the study center and complete the registration forms immediately available at the exhibit. In Bloomington, notable opportunities for recruiting included university orientations for entering students, which targeted young participants (ages 17 and 18), who were new to the city and potentially seeking opportunities to engage in community projects.

For the Tampa study center, exhibits were the most efficient type of recruitment. Flyers, promotional items, and a DAS unit were part of every exhibit. For exhibits on the university

campus, undergraduate recruiters worked the booths, providing peer-to-peer interactions. Particularly successful was an exhibit at the USF Bulls (open air) Market, a well-established event held every Wednesday from 9 a.m. to 3 p.m. with approximately 10,000 visitors a day. Promotional items were successfully used to attract attention (although they may have increased the number of false recruits who were not really interested). Promotional items included 512 MB flash drives, pens, water bottles, slap bracelets, sunglasses, backpacks, bears, koozies (can coolers), tumblers, and T-shirts. A total of 34 Bulls Market NDS exhibits were held over a 17-month period, with an average of 14 people registered per exhibit for a total of 478 recruits. Exhibits at the library and at the student union on Tuesdays and Thursdays reached students not on campus on Wednesdays. At all on-campus exhibits, iPads were used to increase "likes" on the Facebook page. Exhibits were also held at dining halls.

Sixteen lobby exhibits at movie theater blockbuster movie premiers were held in Tampa, netting 737 recruits (one-third in age group 36–50) of which 23 became participants. Shopping mall exhibits showed some success; however, they were much more costly.

Unlike Tampa, exhibit tables at college campuses were not an effective recruitment method in Seattle or Buffalo. The success seen in Tampa with college-age recruits was likely because the Tampa study center was operated by the university, whereas the Seattle and Buffalo study center staff were effectively outsiders on the college campus. Tampa also had the benefit of being able to leverage the well-established Bull Market which was known to the student population and had high student traffic.

Another venue for a table type exhibit was used in Durham, where recruiting tables were set up outside the entrance to University of North Carolina (UNC) home football games to distribute postcards. Similar display tables were set up at UNC women's basketball games.

Some limited success was achieved at exhibits at local art and music festivals but less success at county fairs; this was not because of a lack of interest but because of the inability early in the program to accommodate the older vehicles owned by many of the fair goers. As noted earlier, the prime vehicle requirement was subsequently relaxed to include subprime, legacy, and basic classes of vehicles.

Presentations directed at the 66-year-old and above age groups were given at assisted and independent living communities for senior citizens and at senior centers. Each of these reached a different demographic of senior citizen, distinguished primarily by education and income. In Bloomington, early recruiting efforts at the senior center were dramatically less successful than those at the assisted and independent living communities because many senior center clients did not own the newer prime vehicles. When subprime, legacy, and

basic vehicles later became acceptable, people at the senior center were not interested in hearing about the lower restrictions. The lesson learned was that there is only one chance to make a first impression.

Presentations given at high schools in Tampa were successful in recruiting participants 16–17 years old. Undergraduate recruiters e-mailed teachers individually throughout the study center area and, with the permission of various teachers, schedules were set for the recruiters to go to the high school to a particular classroom. Presentations at senior homes were more difficult to schedule, as many senior homes were either not allowed to have presentations or not interested. However, exhibits at Senior Funfest events enabled seniors to come together and meet different vendors, play games, and eat food. Six participants were installed through these senior events in Tampa, with four participants being 76+.

Word of Mouth

Word of mouth can be a powerful tool. As already noted, one of Bloomington's more effective recruiting efforts came through hiring a lifelong local resident as a recruiter. The decision for a recruit to participate is, in many respects, a nonbinding social contract; and it is more difficult to renege on an agreement with a friend than it is with a stranger. The local resident recruiter gave a consistent persona to the project which led to an increased follow through by recruits. Even when the study center staff knew that certain recruits would not be eligible because their age cell was filled, they still called those recruits back to thank them for their interest. Often this would stimulate a conversation about other family members (particularly 16–17-year-olds) who might be interested.

Driving study T-shirts distributed free as promotional items to anyone who stopped at exhibits in Tampa served as word-of-mouth advertising, especially around the university campus. At all study sites, a number of recruits signed up because their parents or spouse were already in the study and they had seen the equipment in operation, which helped them overcome any hesitation about becoming a recruit.

Handing out flyers and telling people to tell their friends and family was vital for the project in Tampa as 116 participants were installed through this type of recruitment. In the 16–17 age cells, almost half of the total participants installed had signed up through word-of-mouth recruitment. Buffalo and Durham also had a number of participants recommended to the study by other participants.

For word of mouth to be effective, it is important that participants have a good experience. However, word of mouth could also become a disadvantage. For example, when some participants were lost because of battery discharge problems, a number of other participants dropped out even when their vehicle was not affected.

Radio/TV Ads

In Buffalo, a series of radio ads targeting specific age groups were found to be very effective. These ads, developed by a local ad agency, were broadcast over radio stations carefully selected for each age group. One of these scripts is provided as an example:

Radio Spot

(SOUND): Street ambiance

- *(WOMAN 1, 30s) "Every day on my way to work. . . . "
- *(MAN 1, 20s) "When I go to the gym..."
- *(WOMAN 2, 20s) "When I'm driving around with my friends...."

(MUSIC BEGINS)

(ANNOUNCER) "As a participant in a major driving study, you could contribute to important scientific research every time you use your car. This national program has the potential to make driving, roads, and even cars themselves safer for everyone. By taking part, you can help—just by doing the driving you'd be doing anyway."

*(WOMAN 1, 30s) "Like when we go the movies, when I take the kids shopping, anywhere..."

(ANNOUNCER) "Plus, participants will be compensated for taking part. So if you're over 16 and have a valid driver's license, visit [website] to find out if you might qualify to make a difference."

(MAN 2, 30s IN CAR) "Right now..."

(ANNOUNCER) "Give a little to this important project—we'll all get a lot in return. Detailed study information and enrollment applications are available at [website]."

Variations on this script were also used in Buffalo to successfully recruit the hard-to-reach age groups (16–17 and 76+). For example, for the 16–17-year-old age group, the four lines of script above (marked with an asterisk) would be replaced with "On my way to school . . . ," "Every Friday when we go to the football game . . . ," "When I am driving to my friend's house . . . ," "When we go shopping or when I'm running errands for my parents, anywhere. . . ."

The success with radio ads seen in Buffalo was not replicated in the more rural State College study area, where TV and radio ads were expensive and not very effective.

As another predominantly rural site, the Bloomington study area was situated in the middle of four medium to large media markets: Indianapolis, Terre Haute, Louisville, and Evansville. Other than the local National Public Radio (NPR) station, there were no high-power radio stations centrally situated in the study area. The Indianapolis market reached approximately

2.2 million people, but only 250,000 were in the primary study area. Thus, these methods of advertisement were not considered to have an adequate return on investment. An advertising plan to use a local low-power radio station to target younger drivers was considered; that station's signal reaches approximately half of the study area. However, the conclusion was that this would not be as productive as another round of newspaper ads and would cost about twice as much.

In Durham, radio ads ran twice a day (over two work weeks) during drive time on eight stations that are part of Triangle Radio Network for a total of 160 commercials. The Seattle site ran several radio campaigns on a variety of radio stations, ranging from 1 to 4 weeks; most campaigns included an online streaming component. Radio ads generally targeted the 16–17, 18–20, and 21–25 age groups, with 1 week of advertising on an FM talk radio station targeting drivers age 65 and older.

Television News Stories/Press

Having a TV news crew do a story on the project was beneficial since it gave credibility to the project. In Tampa, a local news channel visited the center and did a short story about the study. The study center saw relatively high pickup after the stories aired. A similarly positive response was noted in Buffalo after a TV news crew interviewed study center staff and filmed the equipment and installation facility. Durham had a similarly positive response in the fall of 2011 when two local stations did stories on the SHRP 2 project in the local news.

Newspaper and Magazine Ads

Traditional newspaper ads were effective in recruiting middle age and older participants at some sites (Buffalo, State College) and also younger people if the ad was specifically targeted at that group (as in Durham). Besides running ads in multiple newspapers and weekly publications, sites also ran ads in college and even high school newspapers (e.g., Durham).

Flyers/Posters/Banners

Flyers were a key recruiting tool for a variety of venues. Flyers were mailed, e-mailed, or posted on bulletin boards at colleges and universities, high schools, driving schools, senior centers, and collision shops. Flyers at freshman dorms were effective in capturing recruits between ages 17 and 19. A large banner (a variation on a poster) that hung on the State College campus was very helpful in recruiting college-age (17–24) subjects.

Other recipients of flyers or posters included associations (Visiting Nurses Association, Auto Dealers Association), Meals on Wheels, volunteer fire stations, local supermarket chains, and unemployment offices. Posters were generally not permitted at the DMV. Appendix D provides examples of the recruiting materials that were used at the various sites.

Movie Theater Ads

The Durham site ran animated recruitment advertisements on movie theater screens before the showing of the featured film. Ads were also run on movie theater screens at State College. As can be seen in Table 3.5, movie theater screen ads were not very effective (and could be expensive). This is in contrast to the success experienced by the Tampa site using exhibits in the movie theater lobby, staffed by NDS personnel.

IRB Amendments Related to Changes in Recruiting

Some of the changes to recruitment practices that were not included in the original IRB document required amendments to both the VTTI IRB and to the local study center IRB (see Table 3.3). For example, items that had to be approved by one or more IRBs included radio ad scripts, movie theater advertisements, TV ad scripts, print advertisements, a banner advertisement; and a listserv advertisement. Some IRBs also wanted to downplay the compensation aspects in any advertisement (in particular the dollar amounts) in favor of emphasizing that participating in the study would support research aimed at improving safety for the driving public. In these instances, after all other information on the study was provided, the ad might only say "participants will be compensated."

Site-Specific Recruiting Summary

The previous section described various recruiting methods and provided examples from individual study centers. This section briefly summarizes the recruiting activities and challenges by study center location.

Bloomington

Presentations or exhibits and ads on the university's online bulletin board were the most effective tools for the 18–25 (college) age demographic and also for individuals in the 36–65 age groups. Presentations at assisted living and independent living centers were most successful for recruiting individuals in the 66-and-above age brackets. The national call center generated no participants under age 25, in part, because most young people do not have landlines. Newspaper ads also generated a lot of interest. Rapid contact with all potential participants, even those that staff knew would be ineligible, helped maintain a word-of-mouth network with other highly sought-after participants, particularly 16–17-year-olds and 76+.

Buffalo

In Buffalo, the hardest ages to recruit were the 16–17-year-olds and drivers over age 76. The easiest ages to recruit were ages 51–65 and 66–75 years. The best recruiting method for the

hard-to-reach groups were the radio ads targeted at those age groups. Across all ages, the best recruiting methods were the radio ads, Craigslist (used late 2010 to early 2011), and recruits acquired through another participant. The least effective recruiting method in Buffalo was the movie theater screen ad.

Durham

In Durham, posting flyers at senior centers and retirement facilities was helpful in recruiting older participants, while TV/radio and newspaper ads targeted at younger people were most effective for those groups. Durham also advertised on one of its maintenance vehicles with a van wrap (a wrap is a graphic applied to the vehicle as a form of mobile advertising). The easiest group to recruit was middle aged men and women via ads in the newspaper, radio, and Craigslist. The hardest group to recruit was high schoolers. Younger recruits who became participants were most interested in the compensation, while the adults were more interested in supporting research.

Seattle

In Seattle, recruits ages 26–35, 36–50, and 51–65 were readily recruited. The remaining age groups were more challenging to recruit, especially those under 26 and over 76. Radio ads were particularly effective for recruiting participants between the ages of 18 and 35, and Craigslist ads were particularly effective for recruiting participants between the ages of 36 and 75. The WA call center was effective for recruiting across all age groups, but was most effective for recruiting participants ages 76+. (It is believed that this call center was more effective than the CSR at VTTI because it was local.) Another effective recruiting mechanism was the Washington State DOT weather traffic web page. Movie theater ads were not an effective recruitment method across all age groups, and press/media websites were only somewhat effective for ages 26–65.

State College

At the State College study center in central Pennsylvania, the youngest (16–17) and oldest age groups were the most difficult to attract; college-age recruits (18–24) were the easiest. The best methods for recruiting included newspapers (for middle age and older recruits), flyers (including the large banner ad on campus), Craigslist, and word of mouth. The worst methods were movie theater and TV ads which were not very successful and were expensive.

Tampa

For the Tampa study center, the age groups that were readily recruited (either because of a desire to support research or an

interest in the money) were between 26 and 75. Both traditional recruitment (flyers, ads) and exhibits were effective. The hard-to-reach age groups included participants aged 16-25 and seniors over 76. These youngest and oldest age groups were more concerned about privacy issues (relative to the middle age groups). The use of exhibits, word of mouth, and Facebook really helped recruit the youngest and oldest age groups. However, it is important to note that traditional recruitment and exhibits worked hand-in-hand. The majority of recruits aged 16-25 that became participants stated they heard about the driving study through flyers or word of mouth. These flyers were most likely distributed to them (or their friends) during an exhibit so, effectively, exhibits enabled more word-of-mouth recruitment. The plots in Figure 3.3 illustrate the timeline of advertising activities in Tampa relative to the number of participants installed from December 2010 to July 2013.

Reasons "Recruits" Did Not Become "Participants"

Besides documenting methods which were successful in obtaining recruits, it is also useful to look at reasons that recruits did not become participants. Table 3.7 lists some of the more common reasons cited by study center schedulers or by recruits (during conversations with the schedulers). The data in this table are presented in order from the most highly cited reason to the least cited reason (based on rankings observed in Buffalo and Tampa). The top five reasons shown in the table make up over 80% of the total.

It was observed that recruits who had information about the driving study from an ad, the website, or other source and had become educated about the study before talking with a program representative and becoming a recruit were less likely to decline to participate than someone contacted via cold call.

Final Participant Distributions by Age and Gender

The number of required participants in each age group and gender cell at each study center changed several times during the course of the 3-year study as per guidance from VTTI and NAS. Table 3.8 summarizes the final distribution of participants by age group and gender for the entire program. (Appendix E provides the same table for individual study centers.) *Age* is defined as age at time of recruitment. Note that AVT participants are captured in one category at the bottom of the table.

In Table 3.8, the following qualifiers hold:

• A participant is a "primary" driver or "additional primary" driver of a vehicle in which equipment was installed. All participants who were in the study at least 1 day are included in the table.

- Other adult drivers of installed vehicle are considered "secondary" drivers (with consent dated and a photo obtained) but are not counted in participant age group totals.
- All three types of drivers (primary, additional primary, and secondary) are assigned a unique driver ID number and are included in MCS.

Lessons Learned

The recruitment of participants proved to be the most difficult task for the study centers, in large part because they had not expected to do recruiting and thus had no plans in place to perform this task. Each study center therefore experimented with and applied slightly different strategies to recruit participants. All the various strategies were shared with the other centers. Some of the lessons learned during this process are as follows:

- Recruitment of participants should start early, as far as 3 months before the start of data collection. Most traditional recruitment activities (radio, newspaper, flyers, etc.) take time to produce recruits; that is, there is a delay between the ad and when people start calling and are able to schedule an appointment.
- Recruiting at the local study center is more efficient (and effective) than recruiting through a national call center.
 The knowledge of the local population can help in selecting the media with the best potential for attracting recruits.
- Recruits can lose interest and grow stale. Once a recruit registers, he or she should receive a follow-up call from the study center as soon as possible (preferably within a week). Based on the NDS experience, the half-life of a recruit is 2–3 weeks.
- Using recruiters in the same age group as the targeted individuals was useful.
- Once potential participants determined they were ineligible or that the compensation was inadequate, they rarely reconsidered participation. (You only get one chance to make a first impression.)
- It is important to keep good records of interactions with recruits. Call logs linking recruit identification numbers to dates of attempted calls and notes on response helped maintain a history of contact with recruits and enabled tailored follow-up with hundreds of recruits while ensuring confidentiality. These methods also helped cultivate relationships with interested candidates from the beginning of their involvement in the study through their deinstallation (and satisfied participants garnered additional recruits by word of mouth).
- The time lags built into the initial process using the national call center and MCS posting was too long to be effective. Several 17-year-old participants aged out of the 16–17 bracket

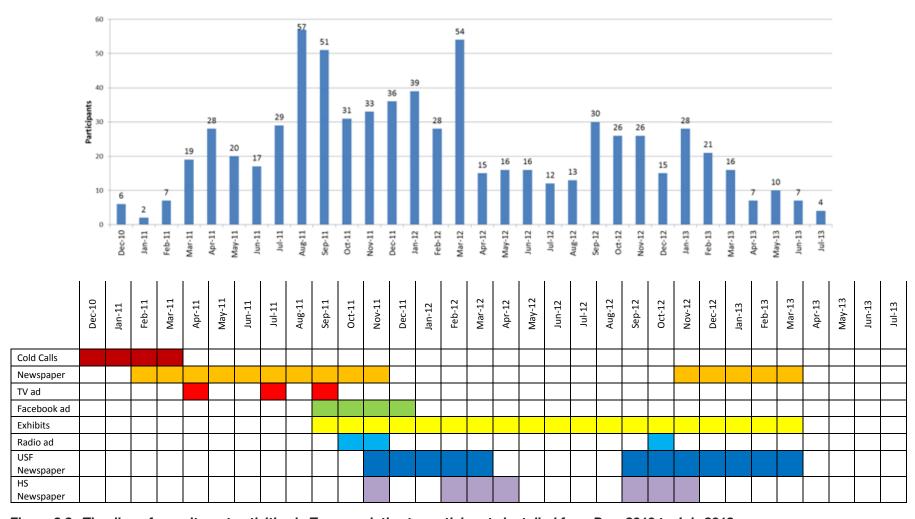


Figure 3.3. Timeline of recruitment activities in Tampa relative to participants installed from Dec. 2010 to July 2013.

Table 3.7. Reasons Recruits Did Not Become Participants

Reason	Comments
Recruit could not be contacted	Schedulers made six attempts for both Buffalo and Tampa recruits (varying the times of day and days of the week that attempts were made). If the recruit had voicemail or an answering machine, a message was left with center study hours. After six attempts, an e-mail or letter was sent (with center phone number) asking if the recruit was in fact still interested.
Changed mind about participating	Recruit agreed to installation but changed mind before installation.
Resident of noneligible county	Moderate issue. If recruits lived near a county border and did the majority of their driving in the eligible county, they were accepted. In Buffalo, the influx of residents outside the county became a larger issue once radio ads started.
Issues with outward-looking cameras in restricted areas	Cameras were an issue at border crossings and on active military bases. Use of cameras on military bases without permission was prohibited. The border-crossing restrictions were an issue mostly in Buffalo and Seattle given their proximity to the Canadian border.
Border-crossing issues	This was an issue mostly in Buffalo and Seattle given their proximity to the Canadian border.
Noneligible vehicle	Early in the study this was a concern for younger participants with older cars.
Objected to cameras and monitoring	The term <i>big brother</i> was used often by the older participants. Some thought cameras too invasive (i.e., those with children or who often carry passengers). Younger people (18–25) were most suspicious of cameras, of data being reported, and of the alcohol sensor.
Moving away	Recruit would not be in study area long enough to complete the study.
Too much time for process	Some recruits could not take 4 hours off work or out of personal time to complete the installation.
Did not want holes drilled in bumpers for front bracket	This was an issue in states that did not have front license plate holders that could be used to secure radar unit. These states were Florida, Indiana, North Carolina, and Pennsylvania. In Bloomington there was some success in combating this problem by purchasing color matched bumper plugs (www.bumperplugs.com) to fill the holes in a professional-looking way.
Health issues/concerns	Recruits felt they could not drive enough due to existing illness.
Multiple no-shows (for appointment)	This was a site-specific decision to not pursue recruit.
Concerns about car warranty and insurance; equipment might cause car problems	This was a big concern. Sometimes sites were able to overcome it. However, all warranties were different. Staff advised recruits to check with dealer (who usually said it would void the warranty).
Could not obtain vehicle owner's permission	Typically this was an issue with younger drivers whose parents would not provide permission.
Insufficient compensation	When compensation was increased, this became less of an issue (1 year increased from \$300 to \$500 and 2 years from \$600 to \$1,000).
Concerns about privacy of the data	Older people were wary about the study reporting data to the DMV or insurance company and having their license taken away.
Check-engine light was on	This excluded vehicles with apparent problems.
Equipment interfered with the vehicle's TPMS	This was a fairly large issue (especially at State College and Seattle) and resulted in the exclusion of many recruits with late-model (2007 and later) vehicles; a fair number of participants (several dozen) were dropped from the study because of TPMS concerns.
High-wattage sound system	This was primarily an issue with younger participants who had after-market sound systems installed. It was also difficult to screen these participants before their appointment, since they didn't always know what wattage their sound system was.
Project wants too much information	Recruits felt they needed to give up too much personal information to participate.
Too far to drive for appointment	Not an issue in general, though it did happen a few times in Tampa because that study area was larger than Buffalo (for example).
Not a good time (e.g., illness, other life issues)	No explanation needed.
Low mileage	Recruit did not drive enough. Common comment with older recruits.
Felt too old to participate	Staff assured them the study accepted all ages above 16 as long as they had a valid license. If they still declined, it was for health reasons or because they didn't think they'd be driving for much longer.
Spouse did not want equipment in car	No explanation needed.
Equipment too bulky; conspicuous	No explanation needed.
Unhygienic vehicles	These were rejected by study center.

Table 3.8. Participants by Age Group and Gender for All Test Sites

		Tota				
Age Group (years)	Gender	Primary Driver	Additional Primary Driver	Total by Gender	Total by Age Group	Secondary Driver ^b
16–17	Male	109	10	119	262	0
	Female	140	3	143		0
18–20	Male	233	4	237	526	4
	Female	284	5	289		4
21–25	Male	241	4	245	593	8
	Female	345	3	348		8
26–35	Male	156	2	158	308	12
	Female	148	2	150		17
36–50	Male	153	3	156	321	16
	Female	161	4	165		15
51–65	Male	154	3	157	339	19
	Female	181	1	182		23
66–75	Male	166	0	166	314	19
	Female	148	0	148		10
76+	Male	248	1	249	448	4
	Female	197	2	199		6
AVT	Both	135	0	135	135	0
Not specified		1	0	1	1	44
Total		3,200	47	3,247	3,247	209

^a Primary participants and secondary drivers with at least 1 day in the study are included.

by the time they were contacted. Recruits may also forget their initial interest or have looked for (and found) other opportunities that fit their interests.

- If a call center is used, adjust calling hours if a high number of no-answer and/or answering machine responses occur.
 In current times, call screening creates problems when trying to contact anyone over the phone.
- Once the hard-to-recruit groups are identified, focus efforts primarily on those groups, as the other groups will accumulate over the course of the project.
- Consider keeping information on all potential recruits in case criteria change and previously ineligible individuals become eligible.
- The distribution of promotional items attracted attention, bringing people to the exhibit where they could be told about the study. Promotional items (especially T-shirts worn around campus and the community) further promoted the driving study by word of mouth.

- Focus advertising toward larger newspapers which have more readers as opposed to multiple smaller avenues (such as playbills at arts centers).
- The use of the local evening news proved very beneficial to the recruitment process. The evening news reaches thousands of people and also legitimizes the project. (Some recruits initially thought the project was a scam.) This type of publicity early on might have enabled the call center to have a better success rate.
- For the highest recruiting returns, it is important to understand who you are targeting with each recruiting method so that areas of exposure are selected based on the interests and underlying motivations of that population. Craigslist ads and posted flyers are more likely to recruit individuals already seeking opportunities to participate in research or earn money. Groups not actively seeking these opportunities must be sold the project on other merits.

^b Secondary drivers are not counted toward "participant" age group total. Only secondary drivers with consent date and reference image are included in secondary driver totals. Note that age and gender are available for 79% of secondary drivers (if designations are unavailable, drivers are included in "not specified").

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- Other notes on the use of media in recruiting include:
 - In rural areas, radio and TV ads were expensive and not very effective, especially if only broadcast on public access stations. Newspapers, flyers, posters/banners, Craigslist, and word of mouth worked better in rural areas.
 - In urban areas, radio ads targeted at specific age groups and radio stations selected for that demographic were quite effective in recruiting the hard-to-reach age groups (Buffalo, Durham, Seattle).

Consent and Assessment Process

Consent Forms

Once the study center scheduler set up an installation appointment for a recruit, the appropriate consent form was sent to the recruit for review. There were different versions of the consent form for adult, minor, and secondary drivers. There were also additional versions in each of these categories depending on the length of time the participant was to be in the study. (Time in study was initially limited to 1 or 2 years, but later in the program shorter periods and longer periods of participation were accepted). Finally, there were versions of the consent form for a parent of a minor to sign as well as for the vehicle owner, if different from the participant driver. Regardless, in all of the versions, the salient points were the same. Appendix F provides an example of the consent form for an adult driver participating for 2 years.

Initially, the consent form was reviewed at the start of the installation appointment. However, it quickly became apparent that it took too long (about 45 minutes) for participants to read the 14-page document (and the equipment installation could not start until the consent was signed). NAS subsequently allowed the study centers to send the consent form in advance either by e-mail or U.S. mail. However, this did not guarantee that the recipient read it or reviewed the pictures of the equipment. When recruits arrived for the installation and did review the information, a few declined to participate. The most common reasons for this last-minute change were that they didn't realize they couldn't go into Canada (applies to Buffalo and Seattle sites), the equipment was bigger than they expected, they didn't realize there were cameras, or they didn't want holes drilled into their bumper (applies to the four states with no front license plate holder). Although all of these issues were previously explained on the phone, some recruits did not fully absorb them.

Sending the consent form in advance may have also acted as a deterrent. Some recruits were scared off by the legality of the consent language and the length of the document. Occasionally, recruits would call and cancel their installation appointment once they received and read the consent form.

Participant Intake Process

This section describes the sequence of steps that made up the participant intake process. When the participant arrived at the study center, the assessor greeted the individual, verified his or her identity (via driver's license photograph), confirmed that the driver had a valid (unexpired) license and vehicle registration, and requested proof of liability insurance. If these documents were present, the assessor began the "informed consent" process. This included providing a one-page information sheet describing the project and playing the informed consent DVD which contained a 10-minute video reenacting the intake process. Actors posing as recruit and assessor demonstrated the typical intake process and addressed any questions or concerns a participant might have. (This video was skipped if the participant previously viewed the video online or reviewed the consent form before the appointment). Once any questions were answered and the full consent form was reviewed, dated, and signed, the assessor and the participant walked to the installation area where the vehicle condition (existing scratches or other minor damage) was documented before work began on the vehicle. Explanations were provided regarding how equipment was to be attached (e.g., Velcro was used to attach the NextGen computer in the trunk, existing screw holes in the license plate holder were used to attach the forward radar whenever possible). (Holes did have to be drilled in the vehicle (bumper) in Tampa, Durham, Bloomington, and State College since vehicles in these states did not have front license plates.) Once the vehicle review was completed, installers began work, and the assessor and participant returned to the assessment area.

Back in the assessment area, information was collected to enable processing of compensation checks. This information included bank routing number, checking account number, bank name and address, and so on. All such private information was stored in a secure location. The participant was also asked for the names and phone numbers of any secondary drivers who might drive the vehicle (at least three times a week). If such drivers were named, the participant was provided a copy of the Secondary Driver Consent Form to take home and share with the secondary driver(s) along with instructions for completion and return of the forms. Table 3.9 summarizes the participant intake process.

Participant Assessment Tests and Surveys

The next step in the intake process was the administration of assessment tests and surveys by the assessor. The objective of the assessment tests was to establish a baseline in functional capabilities of the driver with regard to perception, cognition, and psychomotor and physical abilities. The surveys or questionnaires enabled psychological testing and documentation of health, medical conditions, and medications as well

Table 3.9. Participant Intake Process

Category	Process Step
Arrival	Participant arrived at the NDS facility • Assessor greeted participant • Assessor and participant proceeded to driver assessment facility
Driver and vehicle documents	Assessor reviewed documents brought by participant • Valid driver's license; note birth date for those under age 18 • Valid vehicle registration • Proof of vehicle liability insurance
Consent	Assessor reviewed information about project and vehicle instrumentation with participant Participant viewed informed consent video and reviewed consent form Assessor answered any questions—called senior staff as necessary Assessor obtained two signed copies of consent form (one for participant, one for project file)
Vehicle review	Participant and assessor reviewed vehicle condition; discussed equipment placement/attachment Assessor instructed installers to perform installation
Compensation	Assessor obtained participant auxiliary data • Voided check for direct deposit (selected sites) • Participant auxiliary data was stored in secure location at all times during intake process
Assessment tests	Assessor proceeded with participant assessment tests and surveys

as safe driving knowledge and history. The tests and surveys were selected by the SHRP 2 program and were administered uniformly (using the same protocols) at all the NDS study centers. Participants were informed that they could decline to do any of the tests or surveys.

The assessment test process was essentially the same at each site, with perhaps some slight differences in the order that tests were administered. The lead assessor at each site was either an experienced employee of the company (or university) operating the study center or was a consultant with the credentials to serve in this role. At two sites (Buffalo, Tampa), the lead assessor was a registered occupational therapist, who was also a certified driver rehabilitation specialist. At other sites, the lead assessor either held a degree in a related field (e.g., sociology) or was a trained interviewer. After receiving SHRP 2 training at VTTI, the lead assessors trained other assessors who might be study center staff with a degree in psychology or marketing and/or undergraduate or graduate students in a healthrelated field, transportation, or engineering. In particular, assessors needed to have good interpersonal and communication skills with an ability to adapt to changing circumstances. All received specialized training to conduct SHRP 2 participant enrollment and driver assessments. This included verbal training on obtaining participant consent and administering tests, as well as hands-on training using other trainees to perform mock enrollments. Additionally, all of the assessors completed Human Subjects Training.

The assessment tests and surveys were usually completed by participants in about 2 hours. The tests were conducted in a comfortable setting while the NDS instrumentation was being installed in the participant's vehicle. Table 3.10 lists the various assessment tests with a brief description of each test. Figure 3.4 shows an illustration of the clock drawing test: the drawing on the right is appropriate while the drawing on the left suggests a possible Alzheimer's or dementia-related issue. Figure 3.5 shows the instrumentation used for the vision and grip strength tests. Illustrations in both figures are adapted from the VTTI assessment test training briefing.

Note that the CPT-II test and three of the four DHI tests were computer-based. Results of these tests were automatically uploaded to MCS on the VTTI server via the SHRP 2 NDS Participant Portal. Results of the Optec Vision testing, the Jamar Grip Strength test, and the Rapid Pace Walk test were scored locally and entered into MCS by the assessor. The hand-drawn clock test was scanned into the computer and also uploaded to MCS by the assessor.

Table 3.11 lists the names of the various surveys that each participant completed during the intake process. Some of the surveys were confidential, as indicated. Examples of the type of questions asked are included in the table to provide an indication of the nature and content of each survey. The full list of survey questions is not provided in this report, but sample surveys are available in the appendix of the VTTI S06 report (Dingus et al. 2014). The last two surveys were administered at the end of the study period for each participant when the SHRP 2 equipment was removed from the vehicle.

The surveys completed on the computer were also automatically uploaded to MCS via the Participant Portal. If for some reason the surveys could not be completed at the study center facility, participants were given a paper copy of the surveys along with a facility-addressed, postage-paid envelope in which to return the completed survey. Alternatively, a website link (with username and password) could be provided to the participant. If secondary drivers were identified, the

Table 3.10. Participant Assessment Tests

Assessment Test Name	Test Description or Purpose	Notes
Clock drawing test	Indicator of Alzheimer's or other dementia	Participant draws clock face and indicates time "ten minutes after eleven"
Conners' Continuous Performance Test (CPT-II V.5)	Measures of Attention Deficit Hyperactivity Disorder (ADHD) and impulsivity; measures of attentional lapses; ~12 minutes ^a	Interpretation of results requires clinical training; results should be used only with other sources of information
Optec 6500 Vision Testing	Acuity (far/near, binocular) Contrast sensitivity (night, no glare, right and left eye) Stereo depth perception (binocular) Contrast sensitivity (day, no glare, right and left eye) Color perception (binocular) Contrast sensitivity (night, glare, right and left eye) Peripheral vision (right and left eye)	Participant should wear the vision correction they typically wear while driving, including any specific glasses for night driving. No sunglasses.
Jamar Grip Strength Test	Used to approximate upper body strength	Measured twice with each hand using second to narrowest grip distance; 15 seconds between each trial
Driving Health Inventory (DHI)	Rapid Pace Walk Test (tests walking mobility and lower body strength)	Timed walking task; 10 ft back and forth
	Visualizing Missing Information (tests visual perception, ability to complete a shape) ^a	Several trials, varying difficulty
	Useful Field of View (UFOV) (tests visual information processing speed) ^a	Image flashed on screen, duration varies. Two questions asked.
	Trail Making (timed connect-the-dots; two tests) ^a	Numeric values in ascending order; Alpha and numeric values in ascending/alternating order

^a Computer-based test.

participant was also given paper copies of the demographics and driver history surveys (numbers 2 and 3 in Table 3.11) for the secondary drivers to complete and return.

Once the assessment and survey process was completed, the assessor provided the participant with an exit letter and a glove box letter. The latter was provided so that if the participant was stopped by a police officer and questioned about the equipment, an official explanation could be provided. (This letter could also be used if a participant was questioned at a U.S. border crossing.) A copy of this letter is provided in Appendix G.

When the vehicle was ready, the assessor and participant met the installation technician and together performed an inspection of the vehicle and noted the location of the installed

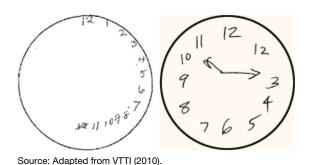
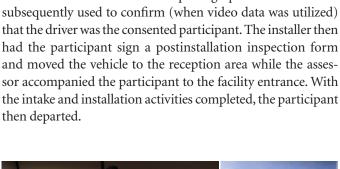


Figure 3.4. Clock drawing test.

equipment. The participant then sat in the driver's seat where three digital photographs were taken using the camera mounted near the rearview mirror. These photographs were stored and then departed.





Source: Adapted from VTTI (2010).

Figure 3.5. Optec 6500 Vision Testing machine and Jamar Grip Strength tool.

Table 3.11. Participant Surveys

No.	Name of Survey	Description/Purpose	Examples of Questions Asked or Information Collected	No. of Questions
1	Barkley's Quick Screen	Assess ADHD tendency in past 6 months	If easily distracted, if difficulty organizing tasks, if loses things, if often restless	6
2	Demographics Questionnaire	Characterize driver via census-type descriptive data	Gender, date of birth, ethnicity, work status, household income, miles driven per year, number in household, do they drive, etc.	45
3	Driving History	Confidential survey about driving education, experience, violations, and crashes	Annual mileage, years driving, number and type of tickets, number and severity of crashes, etc.	17
4	Driving Knowledge	Assess general knowledge of rules of the road	Meaning of traffic signs/control devices, roadway markings, speed limits, rules on right of way, etc.	20
5	Driving Behavior Questionnaire taking tendencies through curves or catching air, illegal turns, driving, using cell phone, eating, reading wh not wearing seat belt, etc.		Frequency of running red lights, driving drowsy, speeding through curves or catching air, illegal turns, drinking and driving, using cell phone, eating, reading while driving, not wearing seat belt, etc.	32
6	Vehicle's Integrated Systems Feature Identification	Document cell phone, navigation, and music technology in vehicle	Information on integrated vehicle cell phone or Bluetooth, if voice recognition, if OnStar/Sync or Safety Connect, if navigation system or vehicle MP3 system, how music controlled, etc.	12
7	Medical Conditions and Medications	Document driver medical status and number and type of medications	Age, gender, weight; if medical conditions relate to vision, hearing, heart, stroke/brain, vascular, nervous system, respiratory, kidney, bone, etc. List current medications; if affect ability to drive.	37
8	Modified Manchester Driver Behavior Questionnaire	Confidential survey for driver to judge own driving errors and traffic violations	Frequency that driver will pass on right, tailgate, forget where car parked, run light as yellow goes red, speed, fail to note pedestrian, bicyclist, hostility toward other drivers, hit something backing up, etc.	24
9	Perception of Risk Questionnaire Confidential survey for driver to assess own crash risk if engaged in various actions		If run red light or stop sign, change lanes suddenly, follow emergency vehicles with siren on, drink and drive, use cell phone, race, drive with worn tires, turn without signaling, etc.	32
10	Sensation-seeking Confidential survey on types of activities, people, or things driver likes or how he/she feels about an activity		Likes wild versus quiet parties, likes (or dislikes) seeing movie twice, would try (or never try) marijuana, prefers friends who are unpredictable or reliable, would/would not try new foods, etc.	40
11	requirements, sleep patterns, quency of node		Work hours, if shift work, amount of sleep, if naps, frequency of nodding off, use of caffeine, alcohol, tobacco, sleeping aids, etc.	60
12	Exit Survey	Have driver assess own stress level during study, if impact on driving, rate study experience	Level of life stress during study, rate driving ability/safety, if driving altered or restricted during study, if pushed incident button during study.	10
13	Medical Conditions and Medications Exit Survey	Document whether driver medical condition or medications are same or changed since start of study	Similar questions as no. 7.	40

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Feedback on Consent and Assessment Process

VTTI's informed consent video explaining the main points of the consent form was considered by the assessors to be very useful. It answered the majority of participant questions in a concise manner.

As might be expected over the course of a 3-year program, there were a few technical issues associated with administering multiple assessment tests remotely. For example, there were times when the VTTI computer connection was down, or individual tests or logins would not work. A suggestion was made that in future studies, a local computer system should also be made available so that tests could be administered even if the remote server was down or the connection was having problems. There were also times a test's software license (not accessible at local site) would expire which prevented software from opening. This type of issue is more likely to arise in multi-year studies.

The study center assessors noted that it would be convenient to be able to repeat sections of the Driving Health Inventory suite without repeating the entire suite. For some administrations, one part of the testing failed while the rest was successful. It would also be convenient if the tests administered by the assessor were grouped together and kept separate from the tests that required participant interaction with the touch screen. This would expedite the process by not requiring the frequent switching of seats.

Quality control of the test results is extremely important. The study centers were able to upload documents to MCS, but it would be helpful if those documents could be reopened at the local site for verification purposes.

The length of the surveys should be reviewed. Feedback from many participants indicated that the surveys were too long. In particular, some of the elderly found the length of the vision tests to be frustrating. The UFOV test was also frustrating for older drivers who couldn't see the small car and truck appear on the screen.

Several questions on the surveys should be reviewed before being used again as they appeared ambiguous, confusing, or did not have relevant answer options. For example, the question "How much coffee do you drink?" did not offer "none" as an option. Similarly, the demographic survey asked for household status with the answer options of "two parent," "one parent," "live alone," or "other." This was confusing for participants who lived with a significant other or were married without children. Older participants with a living spouse and grown, independent children were also unsure how to answer this question. These participants chose "other" for lack of a relevant option.

The sleep survey also contained a question that some participants could not accurately answer. When asked for their work schedules, the option "retired" was not listed. Some participants were unsure if volunteering within their community should be considered work.

Some survey questions contained obvious bias regarding alternative lifestyles that many participants found ridiculous or even offensive, and again, some did not contain relevant options.

Finally, there was feedback related to operational use. Each survey opened in a new window which needed to be saved and closed before navigating back to the main screen. Participants who were not comfortable on a computer had some difficulty with this process. They often forgot to save their data before closing the window or became confused by the number of open windows. Hard copies were available for any participant who preferred them, and it is recommended this be an option for future studies utilizing surveys.

Installations

Installation Facility Characteristics

Installation facilities were established at each of the six study centers. These facilities were situated near the areas used for participant assessments so equipment could be installed in the consented participant's vehicle while they were completing the assessment tests and surveys. Study centers were required to provide one installation bay per 150 DAS units assigned to their site. Thus, as a minimum, the Buffalo, Seattle, and Tampa sites were required to provide three installation bays; Durham was required to provide two installation bays; and the State College and Bloomington sites were required to provide one installation bay. The capability to perform two installations per day per bay was also established. Table 3.12 summarizes the locations and selected characteristics of each of the installation facilities.

The initial DAS installation training for operations managers and senior technicians from each site was performed at a workshop conducted by VTTI in Blacksburg, Virginia. This training provided the technicians with experience working with the DAS hardware and the InstallWare software tool. The InstallWare software communicated installation data such as component serial numbers and vehicle information to the VTTI database. The software also permitted installers to calibrate the accelerometers in the head unit and check the alignment of cameras. The initially trained individuals then trained additional staff at their own study center facilities.

Most of the installation technicians employed at the study center sites had prior experience working on automotive systems. This included installation of automotive stereo and alarm systems as well as general automotive repair work. At the Seattle study center, Battelle subcontracted with Roush Industries to provide installation technicians. Roush was able

Table 3.12. Facility Characteristics

Study Center	Installation Facility	No. of Vehicle Bays	Maximum DAS Units Assigned to Site
Bloomington	The Indiana University Motor Pool garage and mechanics were used to perform the installations. The Motor Pool also provided up to four bays (if needed) and office space to conduct intake and assessments. The Motor Pool was staffed with project-related mechanics from 6 a.m. to midnight to handle the occasional unscheduled vehicle maintenance task.	2	150
Buffalo	Installations were performed by a subcontractor (Calspan Corporation) at its facility which is colocated with CUBRC (same building). The facility is located across the street from the Buffalo Niagara Airport, which provided an easy reference point for participants.	3	450
Durham	Installations were performed at a Westat facility by salaried employees. The facility was centrally located in the NC Triangle area near the Raleigh-Durham airport.	2	300
Seattle	Installations were performed by a subcontractor (Roush Industries) at a Battelle- leased facility in Tukwila, Washington, a suburb south of Seattle. The location was centrally placed within the three-county recruitment area, with easy access to I-5.	3	420ª
State College	Installations were performed in a high-bay, unheated space belonging to the Larson Institute and College of Engineering in a laboratory building about 5 miles from the main campus. The installation site was in the same building as the participant testing and intake site, about a 3-minute walk from the participant office/waiting area.	1	150
Tampa	Installations were performed by USF Center for Urban Transportation Research (CUTR)-employed technicians in a research park facility on the USF campus. The facility was located on the outer perimeter of the campus adjacent to a major road (Fowler Ave.) and was within walking distance of the main CUTR facilities.	3	450

^a Due to DAS equipment shortages, the Seattle allotment of DAS units was reduced to 420.

to provide the study center with highly trained technicians who held the appropriate Automotive Service Excellence (ASE) and state certifications. Similarly, at the Buffalo study center, CUBRC contracted with Calspan Corporation to provide installation technicians and facilities. At the Bloomington center the installation technicians were full-time university employees at the Motor Pool who had multiple ASE certifications. Technicians at all study center sites received training on the protection of human subjects in research.

Installation Process

The DAS components are shown in the schematic provided in Figure 3.6. The major DAS components were

• Head unit to be mounted on the front windshield near the rearview mirror. (The head unit contained four cameras, accelerometers, an illuminance sensor, an infrared illuminator, a passive alcohol sensor, and a GPS sensor.)

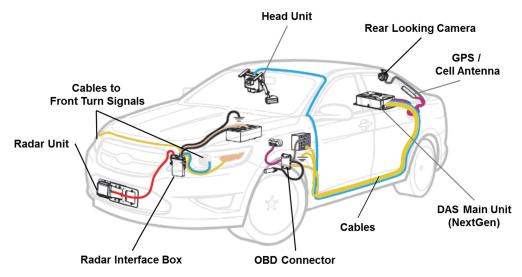


Figure 3.6. Schematic showing main DAS components.

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- Radar unit to be mounted on the vehicle front bumper.
- Radar interface box to be mounted in the engine compartment.
- Rear-looking camera to be mounted on the rear window.
- GPS and cell phone antennae to be mounted on the rear window.
- DAS main unit to be installed in the vehicle trunk.
- Cabling to connect the various DAS components and the vehicle systems.

Installation of the DAS in a participant's vehicle was a multistep process which varied slightly among vehicle types and from study center to study center. The general steps employed in the process are as follows:

- The participant was greeted at the facility entrance lobby by a study site representative (e.g., receptionist, assessor, installation technician, scheduler).
- The participant was asked to provide his/her driver's license, registration, insurance card, and keys to the vehicle. Once ownership and insurance status was verified, the participant was asked if there was anything in the vehicle they needed to get and if the vehicle was free of guns, medications, or dangerous items.
- The participant was escorted to an assessment room to complete the consent process.
- The vehicle was driven to the installation area by a technician.
- The technicians inspected the vehicle to determine if it was eligible for DAS installation. If the vehicle was found to be ineligible, it was driven back to the reception area and reasons for rejection were explained to the participant.
- Once accepted, the technicians recorded the odometer reading, battery voltage level and condition, tire pressure, and tire tread condition; the technician also took pictures of the vehicle, documenting any preexisting damage, and created a vehicle checklist document for the participant.
- After completing the consent process, the participant was escorted to the installation area and the technician showed the participant the DAS equipment, described where it would be installed in the vehicle, and answered any questions. The participant was asked to sign the checklist document noting that everything was in order.
- The assessor escorted the participant to the area used for assessment testing and completion of the survey questionnaires.
- The technicians started installation of equipment by scanning the participant ID number into the InstallWare software and edited any missing/wrong information about the vehicle.
- All necessary components were scanned into the InstallWare software.
- The radar was installed on the front bumper using a license plate bracket. Only two study centers had state laws that

- required front license plates (Buffalo and Seattle). At the other centers, license plate brackets were purchased from automobile dealers to permit installation of the radar.
- The radar interface box (RIB) was secured in the engine bay and connected to constant power and ignition switch power on the fuse box. The headlight and turn signal cables were connected if needed. [Some vehicles did not need these connections implemented because the information was available from the vehicle Controller Area Network (CAN) bus.]
- The plastic panels under the steering wheel were removed to access the internal fuse block, brake switch, and OBD port. The network box was installed and connected to constant and ignition power. If needed, a connection was made to the brake signal cable from the brake switch.
- The head unit was aligned, its attachment location on the windshield was cleaned, and primer was applied to the windshield. The head unit was attached to the windshield and the power cable was connected and routed down the A-pillar to the rear of the vehicle.
- The door sill panels on the driver side were opened, and cables were run from the fuse box, vehicle network connection, and head unit to the car trunk. The door sill panels were then reinstalled.
- The camera on the rear windshield and the General Packet Radio Service (GPRS) antenna were installed and cables routed down the C-pillar into the vehicle trunk.
- Once all cables were routed, the NextGen (DAS) was installed using cable ties or industrial Velcro in the trunk under the deck or under the trunk bed; in some cases, it was installed on the driver-side quarter panel. Cables were connected on the NextGen, and all panels and carpet were put in place.
- The NextGen was connected to the installer laptop via Ethernet cable, and InstallWare software was run to initialize the NextGen software.
- The alignment board was centered in front of the vehicle using two laser alignment tools attached to the left and right windows. The board was then used to align the front radar and forward-looking cameras.
- The offset from vehicle centerline and height of head unit from ground level was measured and entered into the InstallWare software.
- InstallWare software was run and checks were made to ensure that all turn signals, brake, headlight, and speed data were obtained. Measurements of vehicle width were entered into the software.
- The rear camera was aligned to ensure video coverage of the vehicle's rear blind spots. The image was checked on the InstallWare software.
- The participant was invited to sit in the driver seat, adjust the seat and mirrors; then the following three photos were





Figure 3.7. Installation of cabling from head unit to DAS NextGen computer in trunk: (a) kick panel on driver side removed and (b) connection of cabling to NextGen.

taken using InstallWare software and the driver camera in the head unit: one looking forward, one glancing at the rearview mirror, and one looking at the mirror directly. The participant was shown where components were installed and where the "incident" button was located.

- The participant was escorted back to the waiting area until the installation was completed.
- Photos were taken of the vehicle after installation for the vehicle checklist document.
- The last check was the "shakedown" software check which was an on-the-road test to ensure all sensors worked as expected. If any abnormalities were detected, the component was swapped with a new one.

- The vehicle was driven to the reserved parking spot, and the participant was asked to sign the after-installation checklist document.
- The participant was given a letter to keep in the glove box in case of questioning from the police about the equipment and was free to go.

The next two figures illustrate typical installation operations. Figure 3.7 illustrates wires being routed from the head unit in the passenger compartment to the DAS NextGen computer in the vehicle trunk. Figure 3.8 shows the installation of the radar unit on the vehicle front bumper and the RIB in the engine compartment.



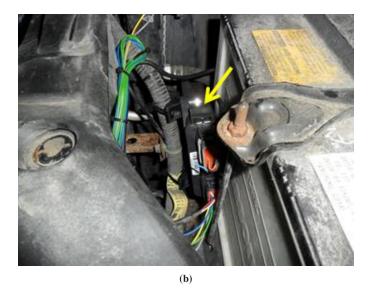


Figure 3.8. Installation of radar unit components: (a) installation of radar unit on front bumper and (b) installed RIB.

Installation Scheduling Strategies

During the course of the program, the actual number of installations completed per day ultimately depended on the success in recruiting participants in the required age groups and DAS equipment availability. Additional factors affecting the number of installations performed per day were the number of last-minute participant cancellations, participants failing to show up for their scheduled appointment (i.e., no-shows), and rejected vehicles. To minimize no-shows, schedulers at the study centers instituted procedures to provide the participant with reminders of their appointments through phone calls, e-mails, or text messages. Usually a confirmation was sent out at the time the appointment was made, and a reminder was sent out 1 or 2 days before the appointment. In addition, as the program progressed, to encourage participants to show up for their installation appointments, they were given a \$50 gas card at the time of the installation. Occasionally, bad weather or especially good weather led to a large number of no-shows and cancellations. For example, during January and February 2012, Buffalo had a 40% to 50% no-show rate largely due to adverse weather conditions. Attempts were made to reschedule cancellations and no-shows whenever possible.

Overbooking was considered as a strategy to overcome noshows and increase the rate of installations (i.e., the study center would schedule four installations and hope only three participants would show up). However, this strategy was only used at one site during periods of peak installations, and backup personnel were on call in the event that all of the scheduled participants showed up.

Installation Rates and History

Table 3.13 shows the actual number of installations performed each month at the six study centers. The numbers include all installations performed at the study site each month. These include installations of equipment into new participants' vehicles as well as reinstallation of equipment into new vehicles of existing participants.

The sizeable month-to-month variations shown in the table at all of the study center sites was not anticipated at the beginning of the program. As discussed earlier, the installation rates were strongly affected by the availability of recruits and equipment. For example, the spikes in installments shown for the Buffalo study center in March 2012 and January 2013 resulted from relatively large numbers of recruits attracted to the program by radio advertisements that aired in the preceding months. Figure 3.9 provides a graph of the total installations per month summed over all six study centers.

Table 3.14 provides a summary of installation appointment statistics for all six study center sites. Of 5,142 appointments

Table 3.13. Number of Installations by Month at Each Study Center

Year	Month	Bloomington	Buffalo	Durham	Seattle	State College	Tampa	Total
2010	October	0	4	0	0	0	0	4
	November	0	10	8	0	0	6	24
	December	0	13	5	0	0	8	26
2011	January	1	13	20	0	0	2	36
	February	8	6	21	3	6	7	51
	March	10	15	20	10	9	16	80
	April	14	26	15	24	15	26	120
	May	14	12	13	22	11	21	93
	June	12	9	29	39	17	17	123
	July	15	20	28	46	16	27	152
	August	16	31	30	36	18	55	186
	September	19	46	30	32	10	52	189
	October	13	35	9	28	12	33	130
	November	16	38	23	26	7	31	141
	December	11	45	35	25	9	40	165
2012	January	5	34	29	44	10	42	164
	February	8	26	27	35	8	34	138

(continued on next page)

Table 3.13. Number of Installations by Month at Each Study Center (continued)

Year	Month	Bloomington	Buffalo	Durham	Seattle	State College	Tampa	Total
	March	15	70	9	22	7	59	182
	April	4	14	16	34	5	19	92
	May	9	14	17	29	6	19	94
	June	5	16	7	30	4	21	83
	July	8	17	15	29	8	14	91
	August	4	27	8	27	9	16	91
	September	8	21	6	32	4	36	107
	October	3	26	15	37	13	28	122
	November	6	32	11	21	10	28	108
	December	4	26	26	12	8	14	90
2013	January	3	51	27	21	8	33	143
	February	2	24	18	21	10	23	98
	March	1	16	12	17	10	19	75
	April	5	6	4	7	3	7	32
	Мау	9	11	4	6	7	14	51
	June	0	13	5	13	5	7	43
	July	6	2	3	10	6	6	33
	August	0	0	0	1	1	1	3
	September	1	0	0	0	1	0	2
	October	0	0	0	0	0	0	0
	November	0	0	0	0	0	0	0
	December	0	0	0	0	0	0	0
Total		255	769	545	739	273	781	3,362

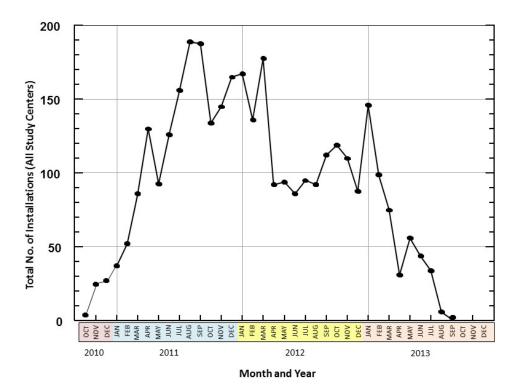


Figure 3.9. Total installations by month summed over all six study centers.

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Table 3.14. Installation Appointment Statistics – Totals for All Study Centers

Year	Month	Appointments Scheduled	Number of Cancellations and No-Shows	Number of Vehicles Rejected at Site	Percentage of Cancellations and No-Shows (By Month)	Percentage of Appointments with Vehicles Rejected	Percentage of Cancellations and No-Shows (Program to Date)
2010	October	7	2	1	28.6%	14.3%	28.6%
	November	33	5	4	20.0%	16.0%	21.9%
	December	36	3	7	6.8%	15.9%	13.2%
2011	January	64	14	9	21.9%	14.1%	17.1%
	February	98	35	4	35.7%	4.1%	24.8%
	March	137	46	7	33.6%	5.1%	28.0%
	April	169	45	9	26.6%	5.3%	27.6%
	May	160	47	10	29.4%	6.3%	28.0%
	June	179	56	3	31.3%	1.7%	28.7%
	July	221	56	4	25.3%	1.8%	28.0%
	August	277	89	5	32.1%	1.8%	28.8%
	September	241	52	4	21.6%	1.7%	27.7%
	October	190	48	1	25.3%	0.5%	27.5%
	November	214	57	3	26.6%	1.4%	27.4%
	December	236	66	10	28.0%	4.2%	27.5%
2012	January	258	80	9	31.0%	3.5%	27.8%
	February	214	68	10	31.1%	4.6%	28.1%
	March	260	64	11	24.6%	4.2%	27.8%
	April	131	38	8	29.0%	6.1%	27.8%
	May	139	36	4	25.9%	2.9%	27.7%
	June	130	35	9	28.5%	6.9%	27.8%
	July	152	53	7	34.9%	4.6%	28.1%
	August	164	58	10	35.4%	6.1%	28.4%
	September	182	52	18	28.6%	9.9%	28.4%
	October	230	77	23	33.5%	10.0%	28.7%
	November	202	58	29	28.7%	14.4%	28.7%
	December	135	37	11	27.4%	8.1%	28.7%
2013	January	201	48	16	23.9%	8.0%	28.4%
	February	163	52	19	31.9%	11.7%	28.6%
	March	95	31	10	32.6%	10.5%	28.6%
	April	40	17	8	42.5%	20.0%	28.8%
	May	73	10	9	13.7%	12.3%	28.5%
	June	49	7	6	14.3%	12.2%	28.4%
	July	55	12	10	21.8%	18.2%	28.3%
	August	2	0	0	0.0%	0.0%	28.3%
2013	September	na	na	na	na	na	na
Total		5,142	1,456	308	28.3%	6.0%	28.3%

Note: na = not applicable.

scheduled across all sites, 28.3% were no-shows or cancellations (who did not reschedule), and 6% of the appointments resulted in vehicles being rejected at the installation site. However, 3,378 appointments (65.7%) resulted in a successful installation. Detailed data for the individual study centers is provided in Appendix H.

Figure 3.10 shows the number of installation appointments per month for the six study center sites. Early in the program the number of installation appointments was restricted by the availability of DAS equipment and the number of available recruits in the hard-to-recruit demographic cells. This graph also shows the temporal variability in scheduled appointments experienced at all the sites. This variability created challenges with regard to efficiently scheduling manpower to perform the installations.

Figure 3.11 shows the cumulative percentage of no-shows and cancellations for four of the six study center sites. As noted, by the end of the study, the cumulative percentage of no-shows ranged from a high of about 32% (Seattle study center) to a low of 22% to 24% (Buffalo and State College study centers, respectively).

Reasons for Rejected Recruit Vehicles

Participant vehicles were occasionally rejected at the time of installation due to problems with vehicle condition. Figure 3.12 provides a graph showing the number of vehicles rejected per month for five of the six study center areas (i.e., Buffalo, Durham, Seattle, State College, and Tampa). Also shown is the percentage of monthly appointments resulting in vehicles rejected for installation. The graph indicates higher vehicle rejection rates occurred later in the program (i.e., September 2012 through February 2013). During this period, recruitment activities focused on younger and older drivers. The fact that younger drivers typically had older vehicles may be a possible explanation for the high vehicle rejection rates experienced during this period. In general, reasons for vehicle rejections included

- Check-engine or other dashboard warning light(s) on;
- Alternator voltage below threshold;
- Incorrect vehicle description (convertible versus hard top);
- Damaged, missing, noncompatible front bumper;
- Generally poor (or unhygienic) vehicle condition;
- Insufficient documentation (insurance, etc.);
- Installed after-market electronics (e.g., a large speaker system which draws a lot of energy);
- TPMS;
- Cracked windshield;
- Leaking trunk;
- Inaccessible OBD location;
- Window tint;
- Vehicle fluid leaks (radiator, fuel, oil, water); and
- Head liner attached to the roof—no place for cables.

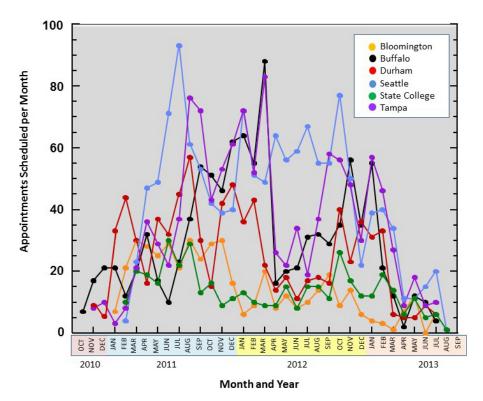


Figure 3.10. Number of installation appointments per month.

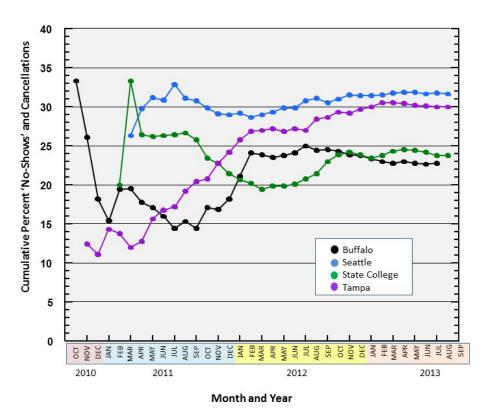


Figure 3.11. Cumulative percentage of no-shows and cancellations at four study centers.

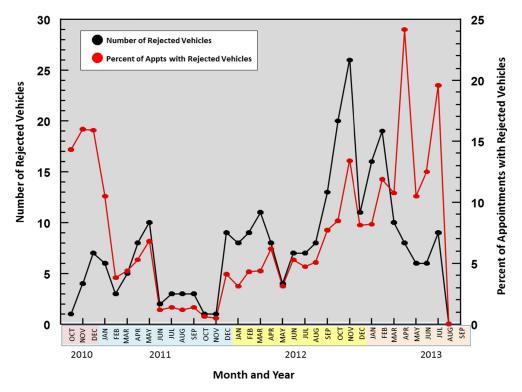


Figure 3.12. Vehicle rejection rates by month for five study centers.

Time Required for Installations

Figure 3.13 is a scatter plot showing the reported times required for DAS installations at the Buffalo and Seattle test sites over the entire program. The installations have been numbered in the order in which they occurred, with "1" being the first installation. Also shown on the plot is a linear least squares fit to the data for each of the two study centers.

As shown on the graph, the installation times at the Buffalo study center were longer than the corresponding times at the Seattle site. For example, the average installation time in Buffalo was 2 hours and 22 minutes compared with 1 hour and 22 minutes in Seattle. Furthermore, approximately 83% of the installations in Buffalo were completed in 3 hours versus 99% in Seattle. One explanation for the difference in installation times between the two sites is how the sites defined installation time. In Buffalo, installation time included the time for equipment installation and check-out as well as the time for preinstallation activities such as inspecting and photographing the vehicle, reporting the inspection to the participant, and answering any questions the participant might have about the equipment to be installed. In Seattle, installation time was defined as including only the time to install and check out the DAS equipment. The inclusion of inspection and sign-off times in the Buffalo data could easily account for 30–40 minutes of the difference in site installation times. A second factor contributing to the difference in installation times between the two sites is that Buffalo routinely used two technicians per installation, while Seattle allocated its four technicians across whatever vehicles were in the shop at any given moment. In this way, the Seattle technicians could parse their time between vehicles and activities (e.g., installs, maintenance, SSD swaps). The exception occurred when two technicians traveled for off-site maintenance appointments and SSD swaps; in these situations, only two technicians were

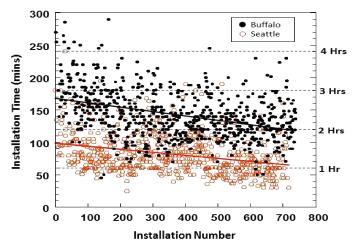


Figure 3.13. DAS equipment installation times at Seattle and Buffalo study centers.

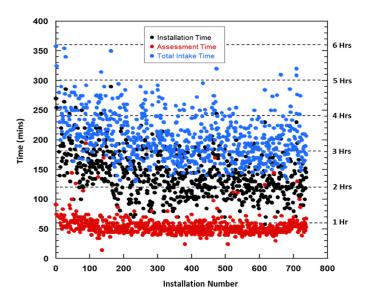


Figure 3.14. Total intake process times for participants at Buffalo site.

available for activities in the shop. Also of note are the least squares fits to the data. These fits indicate similar reductions in installation times as technicians at the sites gained experience with installations.

As noted earlier, an important activity during the participant intake process was the participant assessment activities. Figure 3.14 provides a comparison of the installation and assessment times for each of the Buffalo study center participants. As in the previous graphs, the installation and assessment times have been numbered in the order in which they occurred, with "1" being the first participant enrolled in the program. Also shown on the graph is the total participant intake time. The total intake time is the elapsed time from when the participant walked in the door to when he or she walked out the door. This included times required for participant consent and assessment as well as equipment installation. At the beginning of the program it was assumed that the total participant intake process could be completed in 4 hours or less. Data shown in Figure 3.14 confirm this assumption; approximately 82% of Buffalo study center participants had total intake times of 4 hours or less. The State College study center site had similar experience with the majority of its participants completing the intake process in less than 3 hours.

Participants Switching Vehicles by Site

Some participants required more than one installation of DAS equipment. This occurred most frequently when participants changed their vehicle while they were enrolled in the study and opted to continue in the study with their new vehicle. Table 3.15 summarizes the percentage of primary participants at each study center who switched vehicles, had

Study Center	No. of Primary Participants ^a	No. of Primary Participants Who Switched Vehicles	Percentage of Primary Participants Who Switched Vehicles
Bloomington	246	10	4.1%
Buffalo	725	52	7.2%
Durham	528	14	2.7%
Seattle	704	36	5.1%
State College	269	2	0.7%
Tampa	728	52	7.1%
Total	3,200	166	5.2%

Table 3.15. Percentage of Participants Who Switched Vehicles During Study

DAS equipment installed in their new vehicle, and continued their time in the study.

Number of Vehicles by Make and Year at Each Study Center

The installation process had to accommodate a large variety of participant vehicle makes and model years. Table 3.16 provides a summary of the participant vehicle makes enrolled in the study for the six study center sites.

Figure 3.15 shows the number of total vehicles in each vehicle model year for all study centers. The model years of vehicles enrolled in the program ranged from 2013 to 1987. A large proportion (72.4%) of the vehicle fleet comprised vehicles in the 2005–2013 model years.

Finally, participant vehicles were characterized according to the nature and quality of data that could be obtained from the vehicle. Four vehicle designations were employed during the program, namely prime, subprime, legacy, and basic. The definitions of these vehicle categories were provided previously. Figure 3.16 summarizes the available data on the categories of vehicles in the participant fleets at four of the six test sites. As is evident, the majority of vehicles in the fleets at the four sites were prime vehicles.

Lessons Learned on Installations

The following list summarizes installation-related observations and lessons learned from the six study center sites.

 Keep participants informed about any delays that might occur during the installation process. In general, participants were cooperative and accommodating when problems arose.

- It is important to record as accurately as possible the condition of the vehicle (as determined during the preinstallation vehicle inspection and the installation process). It was easier to address participant complaints and comments regarding vehicle problems that arose during the program by referring to the installation and inspection records.
- When planning an installation, careful thought should go into how wires associated with the equipment are routed and secured, especially when hiding them behind interior trim panels and under seats and carpet. The deinstallation process can be simplified and expedited by strategically routing the cables and securing them to objects that are easily accessible or that do not require substantial disassembly of interior trim parts. This can reduce how much of the vehicle will need to be dismantled during the removal of the wires.
- Reference sources are of great assistance during the installation process. Commercially available maintenance manuals that encompass all vehicles proved very useful in determining the routing of wires and locating power lines on vehicles.
- The age of vehicles must be considered when installing the DAS equipment. While the power taps provided by the program worked well with the mini-style fuses in most newer vehicles, they did not work well in vehicles that have the older larger-style fuses. Using these power taps in a fuse box that has the larger-style fuses can result in a loose power connection that will affect DAS or RIB performance.
- Some vehicles seem to be very sensitive to power taps into circuits that are tied to the vehicle computer. Even though the circuits being used only operated a solenoid for a vent valve, for example, several vehicles were encountered that had issues with this process, while many others did not. As more and more circuits are controlled by the vehicle computer on new vehicles, more thought should go into how to provide power to the equipment.

^aOnly primary participants were considered since they owned or otherwise had responsibility for vehicle (i.e., additional primary and secondary drivers were not included).

Table 3.16. Number of Participant Vehicles by Make at Each Study Center

Vehicle Make	Bloomington	Buffalo	Durham	Seattle	State College	Tampa	Total
Acura	0	1	4	8	0	4	17
Audi	0	0	0	1	1	0	2
BMW	0	3	3	1	0	1	8
Buick	7	17	5	7	4	5	45
Cadillac	1	0	3	9	1	4	18
Chevrolet	18	117	27	30	33	40	265
Chrysler	2	7	5	9	1	4	28
Dodge	2	19	4	10	3	16	54
Ford	25	125	92	105	36	116	499
Geo	1	0	2	1	2	0	6
GMC	5	5	5	4	0	6	25
Honda	35	63	91	110	39	103	441
Hyundai	19	38	22	51	13	77	220
Infiniti	1	2	1	4	0	4	12
Jeep	5	10	9	14	6	9	53
Kia	13	26	12	24	8	22	105
Lexus	0	3	4	6	0	7	20
Lincoln	0	3	4	0	0	3	10
Mazda	6	9	14	18	4	13	64
Mercedes	0	0	1	0	1	2	4
Mercury	4	18	6	13	3	9	53
Mini	0	0	2	4	0	0	6
Mitsubishi	1	4	4	2	0	10	21
Nissan	13	60	46	63	19	84	285
Oldsmobile	0	4	0	3	0	1	8
Plymouth	0	0	1	0	0	1	2
Pontiac	11	35	6	10	5	12	79
Saab	0	0	0	2	1	0	3
Saturn	1	18	7	9	5	19	59
Scion	1	5	4	5	0	4	19
Subaru	4	11	5	29	4	4	57
Suzuki	0	2	5	1	0	2	10
Toyota	72	147	139	159	79	186	782
Volkswagen	6	7	7	16	4	7	47
Volvo	0	1	4	6	1	4	16
Unknown	2	9	1	5	0	2	19
Total	255	769	545	739	273	781	3,362

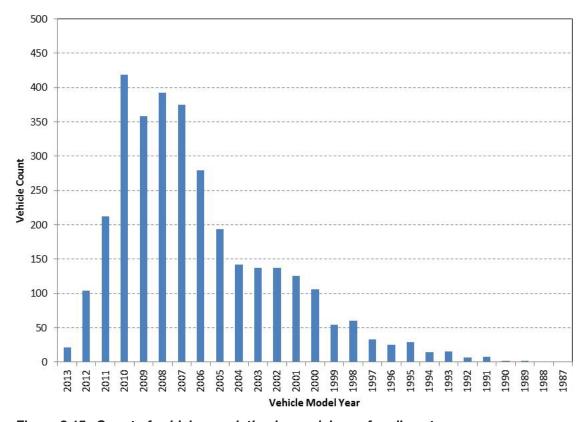


Figure 3.15. Count of vehicle population by model year for all centers.

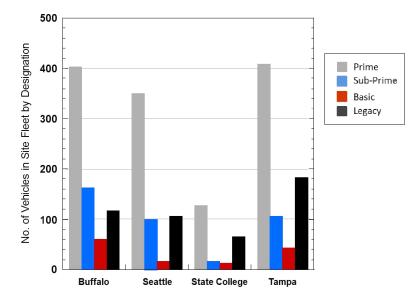


Figure 3.16. Number of study center vehicles by vehicle designation for four sites.

Participant Management and Fleet Maintenance

This section discusses the tasks and strategies associated with management of the participants and maintenance of the fleet of NDS vehicles. Participant management tasks included providing general support to the participants by answering questions about incentive payments, scheduling vehicle maintenance appointments, and answering participant or garage mechanic's questions should they arise during routine non-NDS maintenance and servicing activities, and so on. Fleet maintenance-related tasks included care and upkeep of the instrumentation in the participants' vehicles, replacing a SSD which had reached its storage capacity, or repairing/replacing damaged NDS equipment. These tasks could be performed either at the study center facility or at an off-site location more convenient to the participant. In the latter case, it was necessary to send one or more technicians to the off-site location. When maintaining the vehicle, every attempt was made to accommodate the participant's schedule and preferences.

To appreciate the size and scope of this task, it is helpful to consider the total number of vehicles in the field over the 3 years of the study. Figure 3.17 provides the total vehicles—summed over all six study centers—which were in the field each month from October 2010 through October 2013. Plots for individual study centers are provided in Appendix I.

It is of interest to consider the number of participant-months that drivers spent in the field. Figure 3.18 summarizes these data for all sites. At the beginning of the study it was anticipated that most drivers would participate for 12 months but some

would participate for 24 months, providing a total of 3,102 participants and 46,800 participant-months (or 3,900 data-years) in the field (Campbell 2010). As noted in Figure 3.18, the actual distribution of participant time in the study differed from the initial plan as some drivers participated for less than 12 months and some for more than 24 months. The deviation from the original plan was due primarily to difficulty obtaining recruits and the availability of DAS equipment. However, the study centers exhibited considerable flexibility in adapting to the program requirements and were able to provide the program a total of 3,247 participants (104.7% of plan) and 46,866 participant-months in the study (100.1% of plan). The latter represents 3,905 data-years. (Note that the 3,247 participants includes 131 participants in the study for less than 4 months). The figures just cited do not include the additional data that will be available from the 209 (verified and consented) secondary drivers. Data for individual sites is presented in a table in Appendix J.

Maintenance of Vehicle Fleet

A Request Tracker (RT) system was implemented by VTTI to help monitor the fleet of NDS vehicles. This system enabled the communication of messages, known as RT tickets, between VTTI and the study centers. The RT tickets were used to track issues in several areas, including problems related to vehicles in the field (e.g., issues with instrumentation, alerts that the SSD was almost full), notices that participant survey data or photos were missing in MCS, or technician-identified problems with inventory or equipment at the installation site.

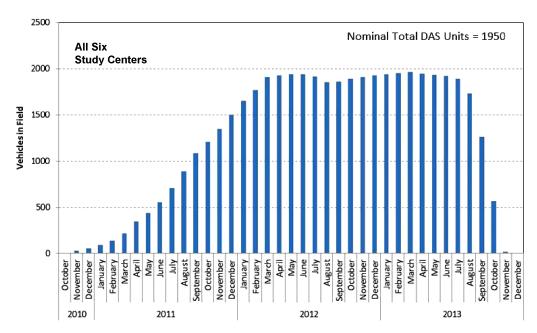


Figure 3.17. Total instrumented vehicles in field each month (all six study centers) over 3-year period.

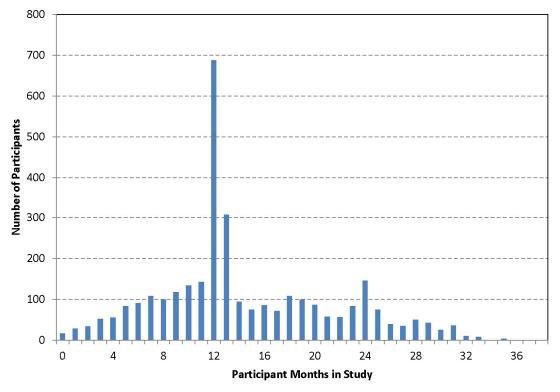


Figure 3.18. Number of participants versus months in study.

These tickets were vehicle centric (identifying problems with specific vehicles) as opposed to issue centric (identifying all vehicles with a specific problem). However, not all maintenance requests had an associated RT ticket. Some maintenance issues reported by participants to the test facilities were easily corrected without contacting VTTI and/or creating an RT ticket. (For example, radio interference could often be addressed by simply moving the computer in the trunk.)

Table 3.17 summarizes the number of RT tickets issued at each site over the 3 years of the study. Some of these RT tickets were duplicate warnings for the same item (e.g., a drive was 70% full, 80% full, 90% full). As might be expected, the number of RT tickets at each site was roughly proportional to the size of the fleet at that site.

The NextGen SSD in each vehicle had a data capacity of 128 GB. The SSD was expected to reach its storage capacity after 4 to 6 months, depending on frequency and length of driving trips. Whenever the driver started the car, an automated "health check" would be performed to determine if all DAS components were functioning properly and communicating with the NextGen computer in the vehicle. The health check also determined the currently used capacity of the SSD. The DAS would assemble a health check message containing the component and SSD status and send the message to the VTTI server through the cellular link in the DAS. When a SSD was 70% full, the RT ticket system would issue a warning to the appropriate study center that a SSD swap would soon be required for the vehicle.

The large number of SSD swaps that needed to be performed required a strategy to efficiently accomplish the task. The initial notice of the SSD exceeding 70% capacity was usually followed up at most centers with a search for the specific vehicle on the MCS. The MCS would provide a date at which the system predicted the drive would reach 100% capacity.

Table 3.17. RT Tickets Used to Track Participant Maintenance Issues

Study Center	No. of RT Tickets	Notes
Bloomington	748	Used own in-house system for managing maintenance. RT system generated inputs into the in-house system.
Buffalo	1,979	RT tickets were used to generate participant appointments for vehicle maintenance or SSD swaps.
Durham	1,350	
Seattle	1,719	Of these, 1,542 were vehicle-related. The tickets from the RT system were imported into the internal participant management data- base for scheduling and tracking.
State College	1,096	
Tampa	2,684	
Total	9,576	

Due to differences in the amount of driving by each participant, the date could be as short as 30 days or as long as 8 months. These data would provide additional information to each center to permit efficient scheduling of maintenance actions on a month-to-month basis.

Differing maintenance scheduling strategies were employed by the six centers. For example, the Durham study center started contacting the participant when an RT ticket indicated the SSD had reached 70% capacity. At the Tampa study center, when the SSD reached 75%, the participant was called with a request to schedule an appointment for a SSD swap. If it was difficult to reach the participant, repeat calls were made every other day and notes about the call (e.g., if voicemail was left) were recorded. After three attempts to call the participant, an e-mail was sent requesting that he or she schedule an appointment within five business days. If contact was not made within five business days of the e-mail, a letter was sent notifying the participant that if contact was not made in a timely manner, participation in the study—and payments—were in jeopardy. The Buffalo study center followed a similar process with regard to contacting participants.

The Buffalo study center evaluated the amount of time left until the drive was expected to be filled and planned appointments so that the drive level would not exceed 90%. If other maintenance actions were required, these appointments would be combined to increase the efficiency of the maintenance activities.

The State College study center also tried to integrate tasks to swap SSDs with other maintenance calls. The strategy was successful because they found that participants with SSDs in the 80% full range would take a while before hitting the 90% mark.

At the Bloomington study center, RT tickets (for both maintenance and SSD swaps) were prioritized based on impact on the collection of data. SSDs greater than 90% full, dangling head units, or obscured camera views were high-priority maintenance activities. Maintenance activities in the next priority level were SSDs less than 80% full, vehicles with communication issues, and last, misaligned cameras. Maintenance priorities also depended on VTTI's requests and the availability of parts. In general, the Bloomington study center took advantage of all maintenance visits to perform a SSD swap.

The Seattle study center began calling drivers to schedule SSD swaps when their drives were 70% full. It was their experience that, in some cases, once the drives reached 70% of storage capacity they would reach full capacity within a couple of weeks. The Seattle study center also performed SSD swaps at all maintenance appointments, regardless of how full the drive was. Furthermore, if a driver was not seen in 6 months or more, an SSD swap was scheduled regardless of how full the drive was to avoid data loss in case of crash, theft, or the like.

As might be expected, it was much easier to get participants to return phone calls and schedule appointments when they were owed a payment for participation. Therefore, even if their drive still had storage capacity, if a payment was due (and it was thought that the drive would fill up before another payment was due), an SSD swap would be scheduled when the payment was made.

Figure 3.19 summarizes the available data on the distribution of days between SSD swaps in the Buffalo study center fleet. The data set includes 993 SSD swaps. The time between swaps includes the number of days between the installation date and the first drive swap and then the number of days between subsequent drive swaps. Some participants had only one drive swap while others had as many as six or seven swaps during their time in the study. The vertical axis in the graph shows the number of SSD swaps for each of the bins. Also shown is the percentage of the total number of SSD swaps for each bin. About 54% of the drives were swapped after being on the road between 100 and 200 days. About 2% needed to be swapped in less than 50 days and 2% were swapped after 500 days.

Table 3.18 summarizes data on the number and type of service calls at each of the study centers. Some calls were dual purpose (equipment maintenance and SSD swap). Available data from five of the six centers indicate that, on average, 65% of the service calls were SSD swap only. The remaining 35% were a mix of equipment maintenance only and dual purpose calls. Over 7,500 service calls (on-site and off-site) were performed across all six study centers.

The retrieved drives were returned to the study center and the encrypted data transferred from the SSD to a

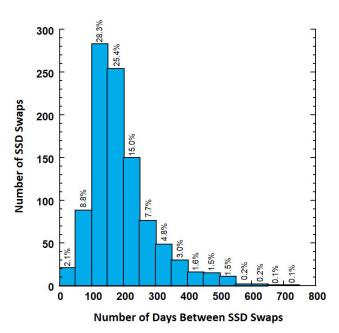


Figure 3.19. Days between SSD swaps at Buffalo study center.

Table 3.18. Number and Type of Service Calls Required to Maintain Vehicle Fleet

Service Call Type	Bloomington	Buffalo	Durham	Seattle ^b	State College	Tampa	Row Total (six sites)
SSD swap ONLY	470	993	c	1,199	236	1,246	
Percentage of total calls	72%	60%		69%	59%	67%	
Equipment maintenance ONLY	20	443		0		522	
Dual purpose: SSD swap and equipment maintenance	166	207		540	163	88	
Total all calls	656	1,643	1,213	1,739	399	1,856	7,506

^a Durham tracked total service calls only. Thus, row totals for six sites are not provided except for "Total all calls."

local VTTI-provided staging server and then to VTTI via a secure high-speed network (either Internet2 IP or National LambdaRail). The network was required to be capable of sustained 100-Mb/sec throughput with capacity for bursts of 200–300 Mb/sec. At VTTI, processing and quality control checks were performed before addition of the data to the NDS database. The final SHRP 2 NDS database is expected to approach two petabytes (2,000 terabytes) in size (Campbell 2012).

Top Maintenance Issues

At the Bloomington study center, the top maintenance issues could be divided into two categories: those occurring regularly with a low impact and those with a low frequency but a high impact. In the first (regularly occurring) category, the primary issues included NextGen DAS communication issues, misaligned cameras, and dangling head units (typically because of glue failure in hot conditions). These happened often but required relatively straightforward fixes. In the less frequent but high-impact group, radio interference, hybrid vehicle battery draining, and DAS system interference with the TPMS happened with lower frequency, but could take up to a day and multiple appointments to remedy.

The Seattle, Tampa, Buffalo, and Durham study centers also experienced communication difficulties, rear camera misalignment, and problems with radar units. The Durham study center typically received notification of damage to the radar unit from participants, rather than through the RT ticket system. The Tampa study center had problems with the RIB because it overheated on occasion and failed to receive radar unit signals. These and other examples of participant vehicle maintenance issues (not including routine SSD swaps) which appeared in the RT ticket system are listed in Table 3.19 in the major issue categories defined by VTTI (Dingus et al. 2014). These categories (column 1) are listed in order of highest occurrence (communications) to lowest occurrence

(radio-frequency interference). However, not all maintenance problems generated an RT ticket.

Many issues identified in the list occurred infrequently but are included to show the variety of real-world maintenance issues which NDS technicians had to troubleshoot and resolve to maintain the vehicle fleet.

Mobile Maintenance

The study centers leased or purchased one or two vehicles to use for off-site maintenance and SSD replacement tasks. Cabinets were installed in the vehicles to store basic tools (including metric and standard wrench and socket sets, screw drivers, electric drills, and a heat gun) and spare DAS equipment needed to maintain the DAS units in the field. The vehicles were equipped with DC to AC inverters to provide power to hand tools and computers. The vehicles were also equipped with navigation systems and electronic toll transponders to permit efficient travel to and from maintenance locations. Figure 3.20 shows a picture of the exterior and the interior of one such maintenance vehicle (2010 Ford Transit Connect).

In general, the off-site maintenance worked quite well and was particularly effective when performing SSD swaps. The rate of participants not keeping these appointments was low (e.g., 3.9% at the Buffalo study center). To set up an off-site maintenance appointment the scheduler would contact the participant to arrange for a convenient time and place. The participant needed to be present at the appointment both to provide access to the vehicle and occasionally to accept a payment. Instructions on how to reach the participant at the off-site location were noted by the schedulers during the initial contact with the participant. Examples of these instructions are "use the doorbell," "call on arrival" to gain access to an apartment or office building garage. On a few occasions, maintenance work had to be rescheduled because there was not a safe (off the street) place for the technician to work on the vehicle. In Pennsylvania's mountainous terrain, there

^b Seattle performed SSD swaps at all maintenance appointments (whether the drive was full or not). Thus, theoretically, Seattle did not perform any exclusive maintenance appointments. The data are categorized for the main purpose of the appointment (1,199 primarily SSD swap and 540 primarily maintenance). The majority of Seattle appointments were conducted at the study center facility, not in the field.

^c Dashes indicate data not collected or total not available for all six sites.

Table 3.19. Examples of Participant Vehicle Maintenance Issues Addressed by NDS Technicians

Category	Examples
Communication/telemetry issue	Communication issues, errors, or no communication for some time Failure to transmit advanced health checks NextGen computer not showing in database
Camera/video issue	Front, face, and/or hands video not available or blurry Hands camera obscured; hands video upside down Front or face camera obscured Rear, hands, or face camera misaligned All four video views unavailable
Administrative request	Object hanging from mirror or other requests not requiring visit to vehicle
General maintenance	DAS computer (NextGen) needed replacing Return of defective DAS, radar, or head unit RIB missing all signals (overheating) RIB needs updated firmware SSD swap needed due to crash Battery drainage; grounding issues NextGen on continuously Break-in and theft of equipment
Dangling head unit	Head unit dangling or fell off (glue failed in hot conditions)
Synchronization	NextGen swap, real-time clock issue
Radio-frequency interference	Interference with TPMS Interference with radio

were instances when the technician could not fully complete a maintenance call because of poor cell phone coverage (e.g., if the scheduler had to be contacted from the field, or if the technician wanted to update vehicle equipment status with VTTI). Hilly terrain in Seattle made it difficult at times to find a level surface to recalibrate head units, so most maintenance activities requiring calibrations were performed at the Seattle study center. In urban environments, carrying cash to pay participants at off-site appointments was, at times, a safety concern.

Driver-Related Support

Each center had a main phone number which was provided to participants should questions or problems arise. Calls from participants were received for a variety of reasons, some of which are listed in Table 3.20. The data in this table are presented in order from the most highly cited reason to the least cited reason (based on rankings observed in Buffalo and Tampa).





Figure 3.20. SHRP 2 van supporting off-site fleet maintenance and SSD swaps.

Table 3.20. Reasons Participants Called Study Center Number

Reason Participant Called	Notes/Resolution				
Returning study center call	Scheduling appointment for installation, maintenance, or SSD swap.				
Question about payments	When next due? Did they miss one?				
Update address or contact information	Update participant contact information in file.				
Believed SHRP 2 equipment was causing vehicle issues	Study center would schedule a maintenance appointment to have the vehicle and equipment inspected. If vehicle was inoperable, study center had it towed to a mechanic for further inspection by mechanic and study center technicians.				
Could not pass inspection or get routine dealer maintenance because of NDS equipment	Study center scheduled a maintenance appointment to temporarily disconnect the equipment.				
Had appointment and could not remember where facility was	Schedulers would provide direction to the facility.				
Could not remember how long their term was	Schedulers would provide the information to the participant.				
Called regarding a crash	If minor, a maintenance appointment was scheduled to inspect equipment and replace SSD. If vehicle was totaled, a deinstall was scheduled to be performed in the field, at a mechanic's facility, or at a tow yard. If participant wanted the video data after a crash, VTTI was informed and investigated further as needed.				
Knew interested candidate; was study center still accepting recruits?	Participant would be provided instructions to allow recruit to sign up on the website or 1-800 number.				
Called about the cell phone study	Participant directed to a VTTI number. ^a				
Forgot a personal item at the facility	Schedulers would arrange for the participant to pick up the item.				
Technicians left tools in their vehicle	Participants would voluntarily drop off tool at facility.				
Would they get a discount on their insurance because they were in the study?	Participation in the NDS would not provide an insurance discount.				
Question about border crossing or driving on military base	If participant needed to cross the border into Canada, the Buffalo site scheduled a maintenance appointment and temporarily removed the head unit camera. Note that a number of Buffalo participants regularly traveled into Canada with the DAS fully functional and did not have any issues. Tampa provided a similar service if participant intended to visit a military base. The Seattle site did not offer to remove head units; they simply screened out those who intended to cross the border and discouraged participants from crossing. (Seattle received one call from the border regarding the equipment. It is believed that other participants crossed, based on conversations with participants, but heard of no other incidents.) Bloomington refused those who required occasional access to the military base unless they promised to use different vehicles when visiting the base.				
Did the NDS count as community service?	Participation in the NDS would not count as community service.				
Did study center see footage of so-and-so cutting them off in traffic?	Participants mistakenly believed that the centers could observe all video coming from the vehicles.				

^a The cell phone study was a National Highway Traffic Safety Administration (NHTSA) initiative to determine the use of cell phones during driving activities.

Crash Investigations

During the course of the study a number of participant vehicles were involved in crashes. A process to investigate these crashes was established. This process included investigations by trained crash investigators collecting and reporting event information. The data acquired during the investigations were uploaded to VTTI for inclusion in the SHRP 2 NDS database.

There were three methods of notification when a participant was involved in a crash. The first and most common notification occurred when participants called the study center number (or sent an e-mail) to indicate that they were in a crash, as per instructions in the consent agreement. The

second was incidental notifications from participants, either when they spoke with research staff during appointment scheduling or when SSDs were swapped and equipment was repaired. (These were usually lower-level crashes, and the participant assumed it was not necessary to contact the study center.) The third and least common was notification by VTTI. The Bloomington and Buffalo study centers learned of only one crash from VTTI. The Durham study center learned of none that way.

Once notified of a crash event, the study center staff went through the crash investigation rubric provided by VTTI to determine if an investigation was warranted. Crashes which were property damage only (PDO) with no injuries and/or minor vehicle damage were not investigated. Seventy-eight such PDO crash events were reported to the sites by participants. The other more serious crash events were assigned to a particular crash investigation level depending on factors such as severity of the crash, injuries sustained, air bag deployment, and crash type. The study centers were permitted to upgrade the investigation level if they believed information of use to the NDS could be obtained. The two crash investigation levels were defined:

- Level 1. These crashes involved a higher level of vehicle damage, and vehicle occupants may have incurred minor injuries (e.g., bruises). These crashes were investigated by trained crash investigators who conducted an interview with the participant and obtained the police accident report (PAR), if one was issued. In addition, photographs of the crash site were acquired from a Google Earth application, and photographs documenting the damage to the vehicle were acquired.
- Level 2. These crashes were characterized by a higher level of vehicle damage and vehicle occupant injuries. Level 2 crashes were also investigated by trained crash investigators who obtained measurements of physical evidence (e.g., roadway grade, surface type, roadway curvature, vehicle heading angles) in relation to a reference point and reference line. These measurements were used to make a scaled diagram of the crash site. The investigators also created a sketch of the crash site which included travel lanes, lane markings, traffic controls, physical evidence, and sidewalks. As with Level 1 crashes, photographs of the crash site and the vehicle were taken, and the investigator conducted an interview with the participant and acquired the PAR if one was issued.

Over the 3-year study, the six study sites were made aware of a total of 188 crash events. Crash investigations were performed and documented for 110 of these events. Table 3.21 shows the number of crash events which were reported by participants in each of the study areas. The numbers include events that were PDO events and not investigated, as well as the number of crashes assigned to each of the two investigation levels.

So far, by reviewing the vehicle data, VTTI has confirmed the occurrence of 372 crashes. As the review of the vehicle data continues, additional crashes can be expected to be identified. Thus, according to the data, participants did not report a significant number of crashes. This may be because the VTTI-confirmed crashes include low-risk/low-severity events, such as curb strikes, which the participants did not believe to be of interest and therefore did not report to the study centers.

Fortunately, no fatal crashes occurred during the study. Although there were some injury crashes, none of the injuries were life-threatening. Figure 3.21*a* shows a crashed vehicle which sustained Level 1 damage (bumper fascia, quarter panel, and hood damage only; no structural damage and no air bag deployment). Figure 3.21*b* shows another vehicle which sustained Level 2 damage (extensive driver-side damage with air bag deployment).

In general, the cooperation of the participants in the crash investigations was very good. Only one participant refused to discuss the incident with the investigator. Some of the challenges that crash investigators encountered during the program are as follows:

- Some crash investigations were conducted under time and situational constraints, which may have compromised the quality of the investigations and retrieval of equipment. For example, at the Bloomington study center, one deinstallation was done at a salvage yard 15 minutes before the participant's vehicle was due to be compacted. Often mechanics at the repair shop where the crashed vehicle was taken had already started to remove equipment before the study center technicians arrived.
- Because virtually all crashes which the sites became aware of were reported by participants, the study center sometimes did not receive notification until months (or even a year) after the crash. Vehicles were often already repaired and often there were no pictures available to be included in the crash report. However, in some cases, the investigator was able to get pictures of crash damage from the body shops or from the participant.

Table 3.21. Number of Crash Events Reported to Centers and Investigations in Each Level by Center

Event/Investigation	Bloomington	Buffalo	Durham	Seattle	State College	Tampa	Total
No investigation	11	26	6	20	8	7	78
Level 1 investigation	5	12	17	30	6	9	79
Level 2 investigation	4	3	0	18	3	3	31
Total events	20	41	23	68	17	19	188
Total investigations	9	15	17	48	9	12	110



(a)



Figure 3.21. Examples of Level 1 and Level 2 crash damage sustained by NDS vehicles: (a) Level 1 crash with damage to vehicle, no airbag deployment and (b) Level 2 crash with damage to vehicle, airbag deployed.

- With a large, rural geographical study area, crashes happening in other regions of the state were difficult to investigate. Finding the crash site, collecting crash reports from local police, and finding the salvage yard to which the vehicle was taken provided challenges for investigators.
- It was noted by a number of the crash investigators that the investigations (particularly Level 2) could have benefited from information acquired by the in-vehicle instrumentation. For example, a driver's poor memory of the crash location was problematic to the investigation, and the police reports were not always available in a manner timely to the investigation. Furthermore, crashes that occurred in remote rural areas were often at a nonspecified location on

- a roadway or freeway with no cross streets. In these cases the vehicle GPS position at the time of the crash would have been a valuable input to the crash investigation.
- At the Seattle study center, the procedures for the Level 2 site investigations had to be adjusted due to Washington State Patrol restrictions. Investigator access to freeway crash sites was not allowed for safety reasons. Since there was often only one investigator traveling to the crash site and it was unsafe to stop and photograph a location on the freeway, the investigator would use images from Google Earth as a stand-in for site documentation for freeway crashes. For verification, the investigator subsequently drove by the crash site to visually confirm that the Google Earth images accurately depicted the crash site.
- Google Earth images were used to draw a site diagram for these circumstances; these drawings were not to scale. Notes were included in the case files for which access to the site was restricted by local authorities.
- Generally, PARs were not available until 2 weeks after the crash, but in some cases it was several weeks or months before they became available. Although PARs can be ordered from the state within 5 days of the crash using the electronic PAR (EPAR) number or the driver's first and last name, due to the usual delay in notification, this was often not an option. In addition, drivers often provided only the investigating officer's case number and not the state EPAR number. If the crash date was not accurately reported by the driver, this would make ordering the PAR more difficult and time consuming.

Lessons Learned on Participant Management and Fleet Maintenance

During the program, each site developed its own set of lessons learned when working with the participants. A number of these lessons were implemented during the course of the program to improve the efficiency of working with the public. Some of these lessons were

- Ensure that participants are aware of the schedule for payments and when the payments will be made. A large number of phone calls to the centers during the program were from participants asking about the status of their payments. In the participant's waiting area of the Buffalo study center, a poster was put up to notify the participants that their first payment would be made in the first week of the month following their installation. This notice reduced, but did not eliminate, the number of calls regarding payment. (In the future, a simpler payment schedule might be beneficial.)
- Once equipment was installed, participants were generally very good at keeping their maintenance appointments. The percentage of participants not making their maintenance

appointments (including SSD swaps) was low (3.9% at the Buffalo study site). One of the strategies developed to cope with no-shows was to have cross-trained staff that could perform another function if the participant didn't show up.

- Scheduling maintenance trips by considering the number of participants in neighboring towns increased the efficiency and number of maintenance actions that could be scheduled in a given day. This strategy reduced technician travel times between maintenance visits.
- Having an internal (local) database to track information including participant call records, consent form versions, appointment history, and participant contact information proved to be very valuable.
- Participants moved and changed phone numbers with surprising frequency. It was helpful to check on their current address and phone number whenever the need arose to contact them or to schedule an appointment with them.
- Text messaging and e-mailing were very effective for contacting and scheduling younger participants.
- Due to the participants' work schedules, many sites adopted alternate work hours. Many sites had evening and Saturday hours to accommodate the participants.
- It appears that participant reports alone should not be counted on to determine the number of crash events. This conclusion was reached based on the apparent difference between the number of crash events that the study centers were made aware of (by the participants) and the number of crash events detected by the vehicle accelerometers. However, it is yet to be determined what fraction of these

unreported events may have been simple curb strikes which were discounted by participants.

Deinstallations

DAS deinstallation activities during the NDS could be divided into the following two categories:

- Deinstallations that routinely occurred during the course
 of the program. These deinstallations occurred when participants either completed their time in the study or left the
 study before their planned completion time. An example
 of the former was 1-year participants who completed their
 time in the study. Other reasons for deinstallations were
 participants changing vehicles, participant death or illness,
 or leaving the study because they were moving.
- Deinstallations of the participant fleet at the end of the program. These deinstallation activities were scheduled to begin at all study centers on September 1, 2013, and were expected to be completed by November 30, 2013. However, some deinstallations were performed in August as some participants completed their time in the study and were not extended for an additional short period (i.e., 1 or 2 months). Most of the planned deinstallations were completed on schedule by the end of November with only a few extending into December 2013.

Figure 3.22 illustrates the number of deinstallations per month for two of the larger study centers (i.e., Buffalo and

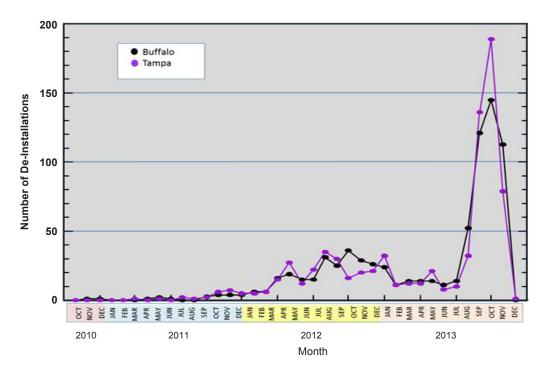


Figure 3.22. Deinstallations per month at Buffalo and Tampa study centers.

Tampa). The graph shows the relatively low deinstallation rate at the beginning of the study (October 2010 to March 2011), followed by a period in which deinstallations were performed on the 1-year participants (April 2012 to February 2013), followed by the fleet end-of-program deinstallation activities (September 2013 to December 2013).

The procedures were similar in both sets of deinstallation activities and involved removal of equipment from participant vehicles as well as the completion of exit surveys by the participant. This final opportunity to interact with the participant was used to request that any missing or incomplete assessment tests be completed.

In general, most of the deinstallations were performed at the study center installation sites. Some deinstallations were performed in the field when necessary. Some of the reasons for performing the deinstallations in the field included (1) participant could not drive to the study center, (2) the vehicle was not functioning, and (3) the vehicle had been sold and the deinstallation took place where the vehicle was located.

The general process used for on-site deinstallations at all of the study centers is described as follows:

- The participant was greeted at study center entrance, lobby, or reception area.
- The participant provided the keys to the vehicle and was directed to the assessment area to complete the exit surveys. If the participant was missing any of the assessment tests or surveys, they were asked to complete them at this time.
- The participant was provided with the login information and access to a computer to take the exit survey and medical condition survey.
- The vehicle was driven to the deinstallation area by a technician.
- The technician photographed the vehicle and noted any damage. The condition of the vehicle was recorded on the vehicle condition checklist. Once the technician completed the vehicle inspection, the technician reviewed the results with the participant. The participant was requested to sign the completed vehicle condition checklist to document the condition of the vehicle before deinstallation.
- The technician utilized the VTTI-supplied DeinstallWare software to scan the vehicle ID bar code and confirm the vehicle information before starting the deinstallation.
- The technician(s) removed equipment from the vehicle and used the DeinstallWare software to inventory all components removed from the vehicle. The radar was removed but the license plate bracket was left on the bumper if one was used during installation.
- The radar interface box was deinstalled and all connections to headlights and turn signals were removed (if previously

- connected). The SHRP 2 equipment fuses were replaced with conventional fuses in the fuse box under the hood.
- The head unit was removed from the windshield, and any remaining residue from the adhesive was cleaned off.
- The network box, OBD connector, and brake signal were removed, and SHRP 2 fuses were replaced in the fuse box under the dash board.
- All cables were removed from door sills, and panels were replaced.
- The rear camera and antenna were removed from the rear windshield, paying attention to the window tint if any. The rear window was cleaned of any adhesive residue.
- All cables were removed from the vehicle C-pillar and all panels replaced.
- The NextGen was removed from the trunk and all cables and components accounted for.
- A final quality check was made to confirm that all internal panels, carpet or felt, and weather stripping was put in place.
- Vehicle odometer reading was entered into the Deinstall-Ware software, and the participant status was changed to "complete" or "dropped out" depending on reason for deinstallation.
- Photographs of the vehicle were taken again to document the (postdeinstallation) vehicle condition for the vehicle condition checklist.
- The vehicle and keys were returned to the participant. The vehicle condition checklist was signed by the participant, and the participant was thanked for his or her participation in the program.

Deinstallation Scheduling and Activities

Deinstallations were scheduled in the same manner as installations. Because a large number of deinstallations had to be performed in a 3-month period at the end of the program, no-shows were a concern before the process was undertaken. However, the no-show rate for deinstallations turned out to be considerably lower than the no-show rate for scheduled installations. Table 3.22 provides information on the deinstallation no-show rates experienced at the study centers, times to complete the deinstallations, and numbers of off-site deinstallations performed.

Only a few problems were experienced when performing off-site deinstallations. These problems included inclement weather, lack of safe or convenient off-street parking for the car during the deinstallation, fewer tools available than for on-site deinstallations, need to perform the deinstallation with the participant watching, and difficulty synchronizing laptops in the field. The latter problem required synchronizing the laptop when the technician returned to the study center.

Study Center	Deinstall No-Show Rates	Times for Deinstallation Activities	Comments
Bloomington	14% average	75 minutes average	Six deinstallations were performed in the field (in one case in a corn field).
Buffalo	6.1%	30 to 60 minutes	30 deinstallations needed to be performed in the field during the course of the program due to vehicles that could not be driven. The vehicle problems were not related to DAS equipment.
Durham	1%	30 to 40 minutes	Only 4 to 6 deinstallations were performed in the field. All others were performed at the study center site.
Seattle	2%	15 to 20 minutes when deinstalling one vehicle at a time; 20 to 30 minutes when deinstalling two vehicles simultaneously	About 10 deinstallations were performed in the field.
State College	2%	75 minutes (mean time)	Only a small number of deinstallations were

30 to 60 minutes

Table 3.22. Study Center Deinstallation and No-Show Summary

DAS Equipment Condition

Tampa

Some issues concerning the DAS equipment and vehicle condition were discovered by study center technicians during the end-of-program deinstallations:

6.4%

- The Durham study center reported two participants had added after-market stereo equipment to their vehicles after the installation of the DAS equipment. The stereo equipment installer had spliced into the power line going to the DAS. This did not result in any reported problems with the DAS equipment.
- All study centers reported evidence of wear and tear on the DAS equipment, ranging from signs of water presence on (and in) the NextGen to damage to the NextGen cover and wiring from impact by heavy objects. However, none of the affected vehicles appeared to suffer DAS equipment malfunctions as a result of the observed wear and tear.
- Several study centers noted that a number of participants arrived for the deinstallation with a damaged radar.
 An example of the radar damage observed is shown in Figure 3.23.

Problems Reported by Participants at the Deinstallation

During the deinstallation process a number of participants at the study centers reported issues they had encountered during their time in the program. Primary among these issues was loss of radio reception. Generally, the problem was with low-power stations on the AM radio band. Many times the participant did not report this to the study center and just put up with the problem. Another relatively common issue concerned the TPMS warning lights illuminating. Participants at a number of sites had their TPMS warning lights illuminated



performed in the field.

(a)



(b)

Figure 3.23. Illustration of undamaged and damaged radar unit: (a) Undamaged radar installed next to license plate and (b) Damaged radar (missing cover) next to license plate holder.

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when they arrived at the study center for their deinstallation. In many cases the TPMS light system was reset by the technician at the study center during the deinstallation process, or the warning light went off by itself shortly after the deinstallation was completed.

Problems Noted by the Study Centers During the Deinstallation Process

There were several lessons learned and observations made during the deinstallation process:

- The GPS/cellular antenna mounted in the rear window was destroyed in a high percentage of deinstallations. This was primarily due to the soft flexible base of the antenna being damaged in the process of removing it from the window.
- Older car models were particularly difficult to deinstall.
 The plastic components such as kick panels and moldings were very brittle. Removing some of the panels broke their fastening elements. In many cases, replacement parts for these vehicles were difficult to acquire as they were no longer available.
- Some study centers (Buffalo, Seattle, State College, and Tampa) noted issues with corrosion between the provided license plate screws and the brass inserts in the license plate frame on the radar unit. This corrosion problem also extended to the radar alignment screws.
- Several study centers developed a protocol to check features
 of the vehicle before returning it to the participant. These
 included checks to ensure proper postdeinstallation functioning of features such as the instrument lights, electronic
 and mechanical latches, lights, turn signals, radio, and air
 conditioner.

Driver-Related Activities

While the DAS equipment was being deinstalled from the participant's vehicle, the participant was escorted to the

assessment area to complete two exit surveys. The first exit survey asks participants to assess their stress level during study, whether it affected their driving, and if their driving was altered or restricted. They were also asked to rate their experience as a participant in the study. The second survey revisited the medical conditions and medications survey to document any changes since the start of the study.

Participants were provided with access to a computer and instructions to log-on to the website to complete the survey online. They were also provided the option to complete the surveys at a later time. This latter method proved problematic, as many participants would not complete the surveys after leaving the study center.

Participant Exit Survey Experiences

Study centers reported the following observations regarding the participant exit survey experience:

- The Seattle study center noted that almost all drivers over the age of 76 could not use a computer well enough to complete surveys online. To alleviate this problem the Seattle study center created a more user-friendly paper version of the exit surveys with a large font to make the survey easier to read.
- A few drivers refused to complete the medical exit survey, possibly due to its length and the fact that they had completed a similar survey at the beginning of the study.
- The medical conditions and medications exit survey was not completed as reliably as the exit survey. A number of participants remarked that they forgot their medication information and wanted to finish the survey at home.
- Participants could not be counted on to complete the exit surveys on their own. Initially the Tampa study center was providing the participant login information to facilitate participants completing their survey at home. This method was not effective; a large number of participants who did not complete the survey at the study center did not complete the survey at a later time.

CHAPTER 4

Issues Encountered and Lessons Learned

As an introduction to this chapter, it is important to note that the study center activities went remarkably well, especially considering the complexity of the project. VTTI, TRB SHRP 2 staff, and the study centers communicated weekly via teleconferences throughout the program. At these conferences, project status and problems that may have arisen were discussed. In the case of the latter, solutions or workarounds were identified. In general, the tools, procedures, equipment, and training provided by VTTI were effective in supporting study center activities.

This chapter summarizes the issues encountered and lessons learned during the S07 NDS data collection activities at the six study centers. These observations are presented as they relate to the following study center activities: IRB process, recruiting, participant consent and assessment, DAS equipment installation, participant management and fleet maintenance, DAS equipment deinstallations, equipment management, and program management. Many of the lessons learned have been cited in preceding chapters but are repeated here to provide a consolidated list.

IRB Process

- Establishment of good communication with IRB committees, both in advance of application submission and during execution of project, is essential for smooth operation of a complex program such as the NDS.
- Allowing the Virginia Tech IRB to serve as the IRB of Record for two of the study centers resulted in significant time savings for those two centers, given the number of IRB amendments (18 total) that had to be processed during the 3-year study.
- The timing of IRB amendment submittals should be carefully considered to ensure the least number of submittals, and thus delays, in executing the project. Bundling small amendments together could improve the efficiency of the process.

 Over the 3-year project performance, some study centers experienced changes in personnel in their IRB committee. This resulted in changes in IRB management styles and required additional time from project staff to manage the amendment process.

Recruiting

- Recruiting participants for the NDS turned out to be one of the biggest challenges facing the program. It is recommended that recruitment of participants start early, at least 3 months before they are needed in the study. In general, the study centers found young (16–21 years of age) and old (76+) participants to be the most difficult to recruit. The establishment of an earlier focus on efforts to recruit those two age groups would have been beneficial to the program.
- For the highest recruiting returns, it is important to understand whom you are targeting with each recruiting method so that areas of exposure are selected based on the interests and underlying motivations of that population. Craigslist ads and posted flyers are more likely to recruit individuals already seeking opportunities to participate in research or to earn money. Groups not actively seeking these opportunities must be sold the project on other merits.
- Once a recruit registers, timely follow-up with that recruit (preferably within a week) is important. Study centers found that if the follow-up contact with a recruit extended beyond 2–3 weeks, the recruit frequently lost interest in participating.
- The compensation offered to recruits, as well as the study inclusion criteria, changed during the project. Once potential participants were told they were ineligible, or they determined that the compensation was inadequate, they rarely reconsidered participation (i.e., you only get one chance to make a first impression).

- Obtaining a spot on the local evening news reached thousands of people and also legitimized the project. (Some recruits initially thought project was a scam.)
- Radio ads targeting specific age groups and radio stations selected for the desired demographic were quite effective in urban study areas in recruiting both easy and hard-to-reach age groups. In rural areas, TV and radio ads were expensive and not very effective. Newspapers, flyers, posters/banner ads, Craigslist, and word of mouth appeared to be more effective in the rural areas.
- Craigslist ads were particularly effective for recruiting participants between the ages of 36 and 75.
- Promotional items (especially T-shirts worn around campus and the community) further promoted the driving study by word of mouth.
- In some study centers, advertising was permitted on a state DOT traffic map website. When permitted, the website banner ad was a very effective recruiting method. Exhibits, kiosks, and booths were effective recruitment tools at some of the study centers, especially if the venue was carefully chosen for the desired age group (e.g., a well-established, weekly open air market on a college campus successfully targeted 18–25-year-olds at one study site).
- For the highest recruiting returns, it is important to understand whom you are targeting with each recruiting method and message. One study center had significant recruiting success by employing the services of a professional marketing agency to tailor the recruiting messages to the interests of the targeted population.

Consent and Assessment

- It was helpful to send the consent form to recruits before they arrived for their installation appointment. This enabled them to review the forms ahead of time and not delay the intake/installation process. (However, sending the consent form did not guarantee they would read it.)
- The VTTI-provided 10-minute video explaining the main points of the consent form was very useful. The video was particularly helpful if a local IRB required that a participant be questioned about the consent form to verify that they had read and understood it.
- Feedback obtained from participants suggested that the vision assessment test was very long, and some vision tests were difficult (and frustrating) for older (and even some younger) drivers.
- When the participant completed the tests, the study center needed to upload the test results to VTTI. Once uploaded the study center did not have the ability to reopen and check files that had been sent. The ability of the study center to check the uploaded files would have improved the process.

- In some cases, if one part of a test was unsuccessful, the entire test had to be repeated (e.g., the DHI suite). The process would be improved and more efficient if only the unsuccessful portion of the test had to be repeated.
- It would have been more convenient if the tests administered by the researcher were grouped together and kept separate from the tests that required participant interaction on the touch screen. This would have expedited the process by not requiring the frequent switching of seats.
- Participants reported that some survey questions did not have relevant answer options, and they felt some survey questions contained obvious bias (e.g., regarding alternative lifestyles) which they found ridiculous or even offensive.
- Feedback from participants indicated they felt the questionnaires were too long and some questions were unclear or did not have appropriate choices for responses for some classes of recruits.
- In some cases, conducting multiple computer-based assessment tests proved to be a challenge. The process was complicated by requiring the participant to close a window and go back to the original screen to launch a new window for the next test. Enabling the participant to step through all tests in one continuous process might have simplified the procedure, especially for the older participants.

Installations and Associated Tools

- It is important to keep participants informed about any delays that might occur during the installation process. In general, participants were cooperative and accommodating when problems arose.
- It is also important to accurately document the condition of the vehicle (as determined during the preinstallation vehicle inspection and the installation process). Proper documentation made it easier to address vehicle problems that arose during the program by referring to the installation and inspection records.
- Reference sources are of great assistance during the installation process. Commercially available maintenance manuals that encompass all vehicles proved very useful in determining the routing of wires and locating power lines in vehicles.
- When planning a new installation, careful thought should go into how wires associated with the equipment are routed and secured, especially when hiding them behind interior trim panels and under seats and carpet. The deinstallation process can be greatly facilitated by strategically routing the cables and securing them to objects that are easily accessible or that do not require substantial disassembly of interior trim parts. This can reduce how much of the vehicle will need to be dismantled during the removal of the wires.

- Some vehicles were very sensitive to power taps into circuits that are tied to the vehicle computer. For example, even though the circuits that were used only operated a solenoid for a vent valve, several vehicles were encountered that had issues with this process, while many others did not. As more and more circuits are controlled by the vehicle computer on new vehicles, careful thought should go into how to provide power to the equipment.
- The age of vehicles had to be considered when installing the DAS equipment. While the power taps provided by the program worked well with the mini-style fuses in most newer vehicles, they did not work well in vehicles that have the older, larger-style fuses. Using these power taps in a fuse box that has the larger-style fuses can result in a loose power connection that will affect DAS or RIB performance.
- The field data collection efforts were supported by a number of computerized applications that supported all aspects of the study center activities. Of particular importance in this regard were the activities associated with the installation and testing of the DAS equipment and the maintenance of study center equipment inventories. In general these applications performed well. The following suggestions and observations provide insight into the use of these applications in a project that involves working with the public—the expectations of seamless software functionality were encountered on a daily basis:
 - O Software critical to the successful completion of installations should be beta-tested at a limited number of study centers (or a single study center) before its release to all study centers. If beta-tested, any problems uncovered could have been addressed quickly by the developers and inconveniences to participants and study center staff could have been reduced.
 - On most occasions when problems arose during installations, the required outside technical support was available. However, there were some installations during which technical support was needed but not available. In some of these cases, the participant had to schedule another appointment and return to the study center to complete the installation. This inconvenience to the participant could have been avoided by ensuring technical support availability during all scheduled installations.

Participant Management and Fleet Maintenance

Participants were compensated for their time in the study. It
was important for participants to be informed of the schedule for payments and the dates these payments were to be
made. A large number of phone calls to the centers early in
the program were from participants asking why they had
not yet received their compensation. In the participant

- waiting area of the Buffalo center, a poster was put up to notify participants that their first payment would be made in the first week of the month following their start in the study. This notice reduced, but did not eliminate, the number of calls regarding payments. (In the future, a simpler payment schedule would be beneficial.)
- Once equipment was installed, participants were generally very good at keeping their maintenance appointments.
 The percentage of participants not making their maintenance appointments (including SSD swaps) was low. One way to cope with the inefficiencies caused by no-shows was to have cross-trained staff that could perform another function if the participant didn't show up.
- Some maintenance was performed off-site at the participants' homes or work places. Scheduling maintenance trips by considering the number of participants in neighboring towns increased the efficiency and number of maintenance actions that could be scheduled in a given day. This strategy reduced travel time between maintenance visits.
- Having an internal (local) database to track information (including participant call records, consent form versions, appointment history, participant contact information) proved to be an essential tool.
- Participants moved and changed phone numbers with surprising frequency. It was helpful to check on their current address and phone number whenever scheduling an appointment with them.
- Text messaging and e-mailing were very helpful for scheduling younger participants (a dedicated study cell phone was used).
- Directions were sent to participants repeatedly throughout the study.
- Having appointments available on evenings and Saturdays was critical to scheduling some recruits.
- Contact information was always confirmed when speaking with participant or whoever answered, and additional contact options were requested if not already listed—cell phone, work and home numbers, e-mail address, and preferences for contact. Besides best times for contact, also noted preferred method of communication (i.e., text? voicemail? letter?).
- If voicemail did not have a personally recorded outgoing message or recorded name, assumed that this participant does not check voicemail.

Deinstallations

• The GPS/cellular antenna mounted in the rear window was destroyed in a high percentage of deinstallations. This was primarily due to the soft flexible base of the antenna being damaged in the process of removing it from the window.

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- Older car models were particularly difficult to deinstall.
 The plastic components such as kick panels and moldings were very brittle. Removing some of the panels broke their fastening elements. In many cases, replacement parts for these vehicles were difficult to acquire as they were no longer available.
- Several study centers (Buffalo, Seattle, State College, and Tampa) noted issues with corrosion between the provided license plate screws and the brass inserts in the license plate frame on the radar unit. This corrosion problem also extended to the radar alignment screws.
- Several study centers developed a protocol to check features of the vehicle before returning it to the participant.
 This included checks to ensure proper postdeinstallation functioning of features such as the instrument lights, electronic and mechanical latches, lights, turn signals, radio, and air conditioner.

Equipment Management Issues

- At the beginning of the study and several points throughout, the logistics of keeping a sufficient supply of DAS systems or individual parts was difficult.
- An inventory software tool was needed by study centers to keep track of equipment that was issued to the center and its status. If such a tool had been made available, it would have been very useful. (One site designed its own about halfway through the project.)

• In some cases there was an insufficient supply of extra kits/ parts to support participant vehicle maintenance activities. This resulted in the need to make multiple trips to service participant vehicles.

Program Management

- The most useful information exchange strategy was weekly teleconference calls between the study centers, VTTI, and NAS. The wiki (a VTTI web-based information sharing site) worked for a while, but it seemed that after some point, the technicians either did not want to enter additional information or did not have the time to enter more information.
- The program management team had to be flexible to accommodate the changing needs of the study. Challenges arose in dealing with some unhappy participants, even though every effort was made to accommodate their needs.
- Additional challenges arose when participants claimed that
 the installed equipment caused malfunctions or damage to
 their vehicles. Even when it was clear that the claims had
 no merit, it was easier to reimburse the costs of fixing the
 problem than try to prove that the equipment did not cause
 the damage.
- It was suggested that any future study provide incentives to engage participants who are not the type to sign up for a safe driving study. It is possible that the participants tended to be those who are more safety minded and more aware as drivers than the average population.

CHAPTER 5

Concluding Remarks

The SHRP 2 NDS project represents the largest and most ambitious naturalistic driving study conducted to date. One of the key objectives of the project was to collect unique data to enable studies of the role of driver performance and behavior in traffic safety and how driver behavior affects the risk of crashes. These studies, just getting under way now, will provide new understanding of how the driver interacts with the vehicle, the traffic environment, roadway characteristics, traffic control devices, and other environmental features. This understanding is essential to developing policies and countermeasures to reduce the number and severity of roadway crashes.

This final report provides a summary of one of the principal components of the SHRP 2 NDS, namely the Safety Project S07, In-Vehicle Driving Behavior Field Study. This project successfully collected SHRP 2 NDS data at six study centers located in Bloomington, Indiana; Buffalo, New York; Durham, North Carolina; Seattle, Washington; State College, Pennsylvania; and Tampa, Florida. These study centers encompass more than 21,000 sq. mi., contain about 7.6 million registered vehicles of all types, and have a population of approximately 6.5 million people of driving age (>15 years).

Under the direction of the Transportation Research Board of the National Academies, and with the support of VTTI, teams at each of the six study centers successfully

- Identified and contacted more than 16,358 people who expressed some interest in participating in the study. Of these, 3,247 individuals, in targeted demographic age and gender cells, were eventually enrolled as participants in the study. This compares favorably with the goal of enrolling 3,100 to 3,300 participants established at the onset of the program.
- Conducted a series of participant assessment tests to establish
 a baseline in driver functional abilities with regard to perception, cognition, and psychomotor and physical abilities. In
 addition, participants completed surveys or questionnaires
 providing psychological information and documentation
 of health, medical conditions, and medications as well as
 safe driving knowledge and history.

- Performed 3,362 installations of DAS equipment into approximately 35 different makes of participant vehicles.
- Maintained and managed the fleet of participants and vehicles for approximately 38 months (i.e., the first installation occurred in October 2010 and the final deinstallation occurred in December 2013). These activities included accessing and swapping SSDs and downloading data to VTTI, investigating crashes involving participants, replacing malfunctioning DAS equipment, and deinstalling DAS equipment from the participant vehicles at the end of the study.
- Participants reported 188 crash events to the six study center sites. None of these crashes involved a fatality or a severe injury. This is lower than the number of crashes expected at the beginning of the study and also lower than the number of crashes identified by VTTI through its review of data obtained from the vehicles. Thus, it appears that there were crashes that were not reported by the participants to the study centers.

In summary, the S07 program activities at the six study centers have contributed to the collection of a rich set of NDS data. Most of the instrumented vehicle data include information on vehicle speed, acceleration and braking, all vehicle controls, lane position, and forward radar (indicating headway distance to objects in front of the vehicle) as well as video views forward, to the rear, and on the driver's face and hands. The vehicles instrumented by the study centers traveled 49,657,037 miles during 6,650,519 trips of which an estimated 5,400,000 trips (81%) were made by consented participants (based on driver ID) and are available to researchers (VTTI 2014). At the beginning of the program, a target of 3,900 data-years in the field was established. The six study centers obtained 3,905 data-years in the field, or 100.1% of the goal.

In closing, many participants were sad to see the study end. They enjoyed participating in the study and expressed interest in participating in any follow-up studies. This bodes well for the future of naturalistic studies.

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APPENDIX A

Classification of Towns and Cities in Study Center Areas

Table A.1. Towns and Cities in Bloomington Study Area (Indiana)

Primary Region	Region Type	Area (sq. mi.)	Population	Population Density (people/sq. mi.)	Classification	County
Nashville	Town	1.015	803	790.77	Rural	Brown
Bloomfield	Town	1.377	2,405	1,746.54	Rural	Greene
Newberry	Town	0.493	193	391.52	Rural	Greene
Trafalgar	Town	2.638	1,101	417.44	Rural	Johnson
Bedford	City	12.161	13,413	1,102.92	Rural	Lawrence
Mitchell	City	3.281	4,350	1,325.66	Rural	Lawrence
Oolitic	Town	0.783	1,184	1,512.78	Rural	Lawrence
Crane	Town	0.118	184	1,555.40	Rural	Martin
Shoals	Town	1.886	756	400.83	Rural	Martin
Bloomington	City	23.357	80,405	3,442.43	Urbanized	Monroe
Ellettsville	Town	4.240	6,378	1,504.32	Rural	Monroe
Stinesville	Town	0.108	198	1,826.60	Rural	Monroe
Bethany	Town	0.095	81	854.88	Rural	Morgan
Martinsville	City	4.508	11,828	2,623.77	Rural	Morgan
Morgantown	Town	0.378	986	2,609.75	Rural	Morgan
Paragon	Town	0.344	659	1,917.59	Rural	Morgan
French Lick	Town	1.768	1,807	1,022.23	Rural	Orange
Orleans	Town	1.710	2,142	1,252.58	Rural	Orange
Paoli	Town	3.757	3,677	978.73	Rural	Orange
West Baden Springs	Town	1.096	574	523.56	Rural	Orange
Gosport	Town	0.385	826	2,144.94	Rural	Owen
Spencer	Town	1.261	2,217	1,758.46	Rural	Owen
Total in All Cities and	Towns	66.759	136,167	2,039.68		
Total in Unincorpora	ted Areas	2,520.760	155,620	63.42		
Total Primary Region	1	2,587.5	291,787			

(continued on next page)

Table A.1. Towns and Cities in Bloomington Study Area (Indiana) (continued)

Secondary Region	Region Type	Area (sq. mi.)	Population	Population Density (people/sq. mi.)	Classification	County
Columbus	City (part)	17.384	23,746	1,365.94	Rural	Bartholomew
Jonesville	Town (part)	0.011	21	1,991.50	Rural	Brown
Princes Lake Town	Town	1.520	1,312	863.09	Rural	Brown
Switz City	Town	0.225	293	1,301.33	Rural	Greene
Worthington	Town	0.808	1,463	1,810.36	Rural	Greene
Bargersville	Town	4.926	4,013	814.67	Rural	Johnson
Franklin	City	13.006	23,712	1,823.11	Rural	Johnson
Greenwood	City	21.231	49,791	2,345.20	Urbanized	Johnson
New Whiteland	Town	1.461	5,472	3,744.41	Rural	Johnson
Whiteland	Town	3.219	4,169	1,294.92	Rural	Johnson
Beech Grove City	City (part)	0.114	588	5,136.02	Rural	Johnson
Homecroft	Town	0.242	722	29,688.84	Rural	Johnson
Indianapolis	City	116.611	185,634	1,591.90	Urbanized	Marion
Southport	City	0.628	1,712	2,725.23	Rural	Marion
Alfordsville	Town	0.068	101	1,481.12	Rural	Martin
Loogootee	City	1.571	2,751	1,751.19	Rural	Martin
Brooklyn	Town	0.682	1,598	2,343.36	Rural	Morgan
Indianapolis	City (part)	5.606	6,168	1,100.28	Urbanized	Marion
Monrovia	Town	1.773	1,063	599.72	Rural	Morgan
Mooresville	Town	6.342	9,326	1,470.58	Rural	Morgan
Total in All Cities and	d Towns	197.430	323,655	1,639.42		
Total in Unincorpora	ted Areas	1,015.020	99,100	97.34		
Total Secondary Reg	gion	1,212.5	422,755			

Table A.2. Towns and Cities in Buffalo Study Area (New York)

Region	Region Type	Area (sq. mi.)	Population	Population Density (people/sq. mi.)	Classification	County	
Buffalo	City	52.5	261,310	4,977	Urbanized	Erie	
Lackawanna	City	6.1	18,141	2,974	Urbanized	Erie	
Tonawanda	City	4.1	15,130	3,690	Urbanized	Erie	
Alden	Town	34.5	10,865	315	Rural	Erie	
Amherst	Town	53.5	122,366	2,287	Urbanized	Erie	
Aurora	Town	36.4	13,782	379	Rural	Erie	
Boston	Town	35.8	8,023	224	Rural	Erie	
Brant	Town	24.8	2,065	83	Rural	Erie	
Cheektowaga	Town	29.5	88,226	2,991	Urbanized	Erie	

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Table A.2. Towns and Cities in Buffalo Study Area (New York) (continued)

Region	Region Type	Area (sq. mi.)	Population	Population Density (people/sq. mi.)	Classification	County
Clarence	Town	53.6	30,673	572	Rural	Erie
Colden	Town	35.7	3,265	91	Rural	Erie
Collins	Town	48.2	6,601	137	Rural	Erie
Concord	Town	181.5	8,494	47	Rural	Erie
Eden	Town	39.8	7,688	193	Rural	Erie
Elma	Town	34.5	11,317	328	Rural	Erie
Evans	Town	41.56	16,356	394	Rural	Erie
Grand Island	Town	33.3	20,374	612	Rural	Erie
Hamburg	Town	41	56,936	1,379	Urbanized	Erie
Holland	Town	35.8	3,401	95	Rural	Erie
Lancaster	Town	37.9	41,604	1,098	Urbanized	Erie
Marilla	Town	27.6	5,327	193	Rural	Erie
Newstead	Town	51.1	8,594	168	Rural	Erie
North Collins	Town	43	3,523	82	Rural	Erie
Orchard Park	Town	38.6	29,054	753	Rural	Erie
Sardinia	Town	50.4	2,775	55	Rural	Erie
Tonawanda	Town	20.4	58,144	3,606	Urbanized	Erie
Wales	Town	35.6	3,005	84	Rural	Erie
West Seneca	Town	21.4	44,711	2,089	Urbanized	Erie
Cattaraugus	Reservation	25.7	2,001	78	Rural	Erie
Tonawanda	Reservation	1.8	10	6	Rural	Erie

Table A.3. Towns and Cities in Durham Study Area (North Carolina)

Region	Region Type	Area (sq. mi.)	Population	Population Density (people/sq. mi.)	Classification	County
Pittsboro	Town	3.8	3,743	981	Rural	Chatham
Morrisville	Town	8.1	18,576	2,296	Urbanized	Wake
Carrboro	Town	6.1	19,582	3,195	Urbanized	Orange
Holly Springs	Town	14.5	24,661	1,705	Urbanized	Wake
Apex	Town	14.5	37,476	2,588	Urbanized	Wake
Durham	City	88.1	228,330	2,592	Urbanized	Durham
Cary	Town	51.1	135,234	2,645	Urbanized	Wake
Raleigh-Cary	City	133.5	403,892	3,025	Urbanized	Wake
Chapel Hill	Town	20.9	57,233	2,737	Urbanized	Orange
Other		804	58,557	73	Rural	

Table A.4. Towns and Cities in Seattle Study Area (Washington)

Region	Region Type	Area (sq. mi.)	Population	Population Density (people/sq. mi.)	Classification	County
Algona	City	1.3	3,014	2,332	Rural	King
Arlington	City	9.3	17,926	1,937	Urbanized	Snohomish
Auburn city	City (part)	28.0	62,761	2,244	Urbanized	King
Auburn	City (part)	1.7	7,419	4,485	Urbanized	Pierce
Beaux Arts Village	Town	0.1	299	3,531	Rural	King
Bellevue	City	32.0	122,363	3,827	Urbanized	King
Black Diamond	City	6.0	4,151	690	Rural	King
Bonney Lake	City	7.9	17,374	2,187	Urbanized	Pierce
Bothell	City (part)	5.7	17,090	3,017	Urbanized	King
Bothell		6.5	16,415	2,544	Urbanized	Snohomish
Brier	City (part)	2.1		2,858		Snohomish
-	City		6,087	,	Urbanized	
Buckley	City	3.9	4,354	1,124	Rural	Pierce
Burien	City	7.4	33,313	4,489	Urbanized	King
Carbonado	Town	0.4	610	1,465	Rural	Pierce
Carnation	City	1.2	1,786	1,545	Rural	King
Clyde Hill	City	1.1	2,984	2,826	Rural	King
Covington	City	5.9	17,575	2,998	Urbanized	King
Darrington	Town	1.7	1,347	815	Rural	Snohomish
Des Moines	City	6.5	29,673	4,564	Urbanized	King
DuPont	City	5.9	8,199	1,399	Urbanized	Pierce
Duvall	City	2.5	6,695	2,713	Urbanized	King
Eatonville	Town	1.8	2,758	1,513	Rural	Pierce
Edgewood	City	8.4	9,387	1,115	Urbanized	Pierce
Edmonds	City	8.9	39,709	4,459	Urbanized	Snohomish
Enumclaw	City (part)	4.2	10,669	2,515	Urbanized	King
Enumclaw	City (part)	0.0	0	0	Urbanized	Pierce
Everett	City	33.5	103,019	3,080	Urbanized	Snohomish
Federal Way	City	22.3	89,306	4,011	Urbanized	King
Fife	City	5.7	9,173	1,613	Urbanized	Pierce
Fircrest	City	1.6	6,497	4,115	Urbanized	Pierce
Gig Harbor	City	6.0	7,126	1,198	Urbanized	Pierce
Gold Bar	City	1.0	2,075	2,013	Rural	Snohomish
Granite Falls	City	2.2	3,364	1,540	Rural	Snohomish
Hunts Point	Town	0.3	394	1,348	Rural	King
Index	Town	0.2	178	787	Rural	Snohomish
Issaquah	City	11.4	30,434	2,674	Urbanized	King
Kenmore	City	6.2	20,460	3,326	Urbanized	King
Kent	City	28.6	92,411	3,228	Urbanized	King
Kirkland	City	10.8	48,787	4,522	Urbanized	King
Lake Forest Park	City	3.5	12,598	3,568	Urbanized	King
Lake Stevens	City	8.9	28,069	3,162	Urbanized	Snohomish

(continued on next page)

Table A.4. Towns and Cities in Seattle Study Area (Washington) (continued)

				Population Density		
Region	Region Type	Area (sq. mi.)	Population	(people/sq. mi.)	Classification	County
Lakewood	City	17.2	58,163	3,387	Urbanized	Pierce
Lynnwood	City	7.8	35,836	4,573	Urbanized	Snohomish
Maple Valley	City	5.7	22,684	3,965	Urbanized	King
Marysville	City	20.7	60,020	2,902	Urbanized	Snohomish
Medina	City	1.4	2,969	2,067	Rural	King
Mercer Island	City	6.3	22,699	3,591	Urbanized	King
Mill Creek	City	4.7	18,244	3,906	Urbanized	Snohomish
Milton	City (part)	0.5	831	1,536	Rural	King
Milton	City (part)	2.0	6,137	3,119	Urbanized	Pierce
Monroe	City	6.1	17,304	2,862	Urbanized	Snohomish
Mountlake Terrace	City	4.1	19,909	4,908	Urbanized	Snohomish
Mukilteo	City	6.4	20,254	3,163	Urbanized	Snohomish
Newcastle	City	4.5	10,380	2,334	Urbanized	King
Normandy Park	City	2.5	6,335	2,513	Urbanized	King
North Bend	City	4.3	5,731	1,343	Urbanized	King
Orting	City	2.7	6,746	2,473	Urbanized	Pierce
Pacific	City (part)	1.8	6,514	3,573	Urbanized	King
Pacific	City (part)	0.6	92	153	Rural	Pierce
Puyallup	City	13.9	37,022	2,658	Urbanized	Pierce
Redmond	City	16.3	54,144	3,325	Urbanized	King
Renton	City	23.1	90,927	3,932	Urbanized	King
Roy	City	0.5	793	1,634	Rural	Pierce
Ruston	Town	0.3	749	2,917	Rural	Pierce
Sammamish	City	18.2	45,780	2,512	Urbanized	King
SeaTac	City	10.0	26,909	2,682	Urbanized	King
Seattle	City	83.9	608,660	7,250	Urbanized	King
Shoreline	City	11.7	53,007	4,540	Urbanized	King
Skykomish	Town	0.3	198	635	Rural	King
Snohomish	City	3.4	9,098	2,648	Urbanized	Snohomish
Snoqualmie	City	6.4	10,670	1,666	Urbanized	King
South Prairie	Town	0.4	434	1,119	Rural	Pierce
Stanwood	City	2.8	6,231	2,213	Urbanized	Snohomish
Steilacoom	Town	2.0	5,985	2,933	Urbanized	Pierce
Sultan	City	3.2	4,651	1,477	Urbanized	Snohomish
Sumner	City	7.5	9,451	1,258	Urbanized	Pierce
Tacoma	City	49.7	198,397	3,990	Urbanized	Pierce
Tukwila	City	9.2	19,107	2,084	Urbanized	King
University Place	City	8.4	31,144	3,697	Urbanized	Pierce
Wilkeson	Town	0.5	477	1,016	Rural	Pierce
Woodinville	City	5.6	10,938	1,952	Urbanized	King
Woodway	City	1.1	1,307	1,180	Rural	Snohomish
Yarrow Point	Town	0.4	1,001	2,753	Rural	King

Table A.5. Towns and Cities in State College Study Area (Pennsylvania)

Region	Region Type	Area (sq. mi.)	Population	Population Density (people/sq. mi.)	Classification	County
State College	Borough	4.5	42,034	9,259	Urbanized	Centre
Altoona	City	9.8	46,320	5,069	Urbanized	Blair
Lewistown	Borough	2.0	8,338	4,139	Urbanized	Mifflin
Johnstown	City	6.1	20,814	4,097	Urbanized	Cambria
DuBois	City	3.3	7,794	2,430	Urbanized	Clearfield
Other		6,706.0	622,218	93	Rural	

Table A.6. Towns and Cities in Tampa Study Area (Florida)

Region	Region Type	Area (sq. mi.)	Population	Population Density (people/sq. mi.)	Classification	County
Dade City	City	3.4	6,437	1,921	Urbanized	Pasco
New Port Richey	City	4.6	14,934	3,503	Urbanized	Pasco
Port Richey	City	2.7	2,671	1,271	Rural	Pasco
San Antonio	City	1.2	1,138	948	Rural	Pasco
Zephyrhills	City	6.4	13,288	2,107	Urbanized	Pasco
St. Leo	Town	1.9	1,340	837	Rural	Pasco
Tampa	City	170.6	333,073	1,862	Urbanized	Hillsborough
Temple Terrace	City	7	24,541	3,600	Urbanized	Hillsborough
Plant City	City	22.7	34,721	1,500	Urbanized	Hillsborough
Lutz	City	27.1	19,344	710	Rural	Hillsborough
Town N County	Town	24.4	78,442	2,972	Urbanized	Hillsborough
Other		1,862.0	1,163,994	625	Rural	

APPENDIX B

Additional Data on Population Demographics, Licensed Drivers, and Vehicle Registration for Each Study Center Area

Table B.1	Study Center Population by Race from 2010 Census Data
Table B.2	Study Center Population by Household Income
Table B.3	Study Center Population by Education Attainment of Adults
Table B.4	Number of Licensed Drivers by Gender and (Available) Age Groups for Counties in Study Center Areas
Table B.5	Vehicle Registrations by Vehicle Type for Counties in Study Areas

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Table B.1. Study Center Population by Race from 2010 Census Data

	Bloomington ^a		Buffa	llO ^b	Durha	am ^a	Seattle ^c		State College		Tampa	
Race	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total Study Center Population	291,787	100.0	919,040	100.0	987,284	100.0	3,439,809	100.0	747,518	100.0	1,693,923	100.0
One Race	286,737	98.27	902,518	98.2	963,067	97.6	3,255,941	94.7	738,609	98.8	1,644,794	97.1
White	271,179	92.94	735,244	80	643,023	65.1	2,474,896	71.9	700,577	93.7	1,285,921	75.9
Black or African American	5,044	1.73	123,931	13.5	204,912	20.8	191,967	5.6	21,071	2.8	225,773	13.3
American Indian and Alaska Native	847	0.29	5,908	0.6	4,576	0.5	36,819	1.1	937	0.1	6,425	0.4
Asian	7,796	2.67	23,789	2.6	61,157	6.2	392,961	11.4	11,183	1.5	51,872	3.1
Native Hawaiian and other Pacific Islander	97	0.03	219	0.0	488	0.1	28,209	0.8	179	0.02	1,195	0.1
Some other race	1,774	0.61	13,427	1.5	48,911	5.0	131,089	3.8	4,662	0.6	73,608	4.3
Two or More Races	5,050	1.73	16,522	1.8	22,118	2.2	183,868	5.3	8,909	1.2	49,129	2.9
White, American Indian, Alaska Native	1,285	0.44	2,359	0.3	2,485	0.3	29,095	0.8	1,674	0.2	5,794	0.3
White; Asian	1,298	0.44	2,768	0.3	5,873	0.6	56,530	1.6	1,767	0.2	8,182	0.5
White; Black or African American	1,437	0.49	6,215	0.7	5,726	0.6	33,014	1.0	3,416	0.5	12,890	0.8
White; some other race	378	0.13	1,362	0.1	3,068	0.3	15,315	0.4	667	0.1	9,825	0.6
Hispanic or Latino (of any race)	5,633	1.93	41,731	4.5	NA ^d	NA ^d	309,476	9.0	14,157	1.9	361,171	21.3
Mexican	3,344	1.15	3,992	0.4	NA ^d	NA ^d	221,357	6.4	NA	NA	77,258	4.6
Puerto Rican	593	0.20	29,400	3.2	NA ^d	NA ^d	16,237	0.5	NA	NA	112,482	6.6
Cuban	216	0.07	1,214	0.1	NA ^d	NA ^d	4,027	0.1	NA	NA	71,588	4.2
Other Hispanic or Latino	1,480	0.51	7,125	0.8	NA ^d	NA ^d	67,855	2.0	NA	NA	99,843	5.9

Note: NA = not available.

^a Data for Bloomington and Durham are provided for zip code areas in primary study center area. 2010 Census. For Bloomington, these are based on the 39 primary recruiting zip codes.

^b U.S. Census Bureau. http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_DP_DPDP1. Accessed Aug. 14, 2013.

cState of Washington Office of Financial Management. 2011. Census 2010 Redistricting Data [P.L. 94-171] for Washington, County Summary, Table 2: Population by Race and Hispanic or Latino Origin, for all ages and for 18 years and over. http://www.ofm.wa.gov/pop/census2010/data.asp (choose county to access excel tables).

^d Hispanic information only available at the county level.

Table B.2. Study Center Population by Household Income

Household Income	Bloomington		Buffalo ^b		Durhamº		Seattle ^d		State College®		Tampa	
and Benefits	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total households	112,630	100%	379,478	100%	380,187	100%	1,354,240	100%	289,834	100.0%	585,913	100%
Less than \$10,000	12,453	11.06	33,513	8.8	22,198	5.8	70,984	5.2	23,158	8.0	39,252	6.7
\$10,000 to \$14,999	7,881	7.00	22,676	6.0	15,582	4.1	48,532	3.6	20,125	6.9	28,696	4.9
\$15,000 to \$24,999	13,669	12.14	44,062	11.6	32,733	8.6	100,275	7.4	38,744	13.4	64,068	10.9
\$25,000 to \$34,999	12,725	11.30	41,113	10.8	36,027	9.5	111,798	8.3	35,899	12.4	66,094	11.3
\$35,000 to \$49,999	16,598	14.74	51,993	13.7	49,549	13.0	169,282	12.5	46,248	16.0	89,428	15.3
\$50,000 to \$74,999	20,949	18.60	68,720	18.1	65,229	17.2	250,060	18.5	56,614	19.5	111,189	19.0
\$75,000 to \$99,999	12,931	11.48	46,733	12.3	46,497	12.2	192,382	14.2	32,069	11.1	72,632	12.4
\$100,000 to \$149,999	10,260	9.11	44,870	11.8	59,451	15.6	233,903	17.3	24,931	8.6	68,950	11.8
\$150,000 to \$199,999	2,809	2.49	14,100	3.7	26,684	7.0	91,836	6.8	6,429	2.2	24,202	4.1
\$200,000 or more	2,355	2.09	11,698	3.1	26,237	6.9	85,188	6.3	5,616	1.9	21,402	3.7
Median household income (\$)	\$42,	917	\$48,8	305	\$64,4	160			\$40	,000	\$51,9	905
Mean household income (\$)	\$56,	300	\$64,9	959	\$85,1	114	\$86,7	29	\$54	,819	\$68,0	071

^a 2007–2011 Census estimates for 39 primary zip codes.

^b http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_11_5YR_DP03.

For the zip code tabulation area (ZCTA)-level file, the data were compiled using the 2011 Census American Community Survey (ACS) 5-year estimates.

^dU.S. Census Bureau. (n.d.). Selected Economic Characteristics (Report DP03). Retrieved from http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t (As with most of the data submitted, we combined the individual county figures to reach a three-county total. In the income table above, we calculated the mean income from the three individual county numbers; but without the data from each county, we cannot come up with a median figure.) Accessed Nov. 7, 2013.

ehttp://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?fpt=table. Selected Economic Characteristics 2010–2012 American Community Survey 3 yr. Estimates, Accessed July 21, 2014.

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Table B.3. Study Center Population by Education Attainment of Adults

		Bloomington			Buffalo	O ^a		Durham ^b			
Educational Level	Male	Female	Total	Male	Female	Total	Male	Female	Total		
Population	87,475	91,955	179,430			623,194	296,523	325,359	621,882		
Less than 9th grade	4.3%	3.4%	3.8%	3.0%	3.9%	3.5%	4.4%	3.1%	3.7%		
9th to 12th grade, no diploma	9.6%	8.7%	9.1%	7.3%	7.2%	7.2%	5.3%	4.5%	4.9%		
High school graduate (includes equivalency)	35.2%	34.6%	34.9%	29.8%	28.1%	28.9%	15.3%	15.6%	15.5%		
Some college, no degree	18.8%	20.7%	19.8%	19.4%	17.6%	18.5%	16.2%	17.5%	16.9%		
Associate's degree	6.2%	7.1%	6.7%	9.7%	12.9%	11.4%	6.0%	7.8%	6.9%		
Bachelor's degree	13.8%	14.1%	14.0%	17.4%	16.2%	16.8%	31.1%	31.8%	31.5%		
Graduate or professional degree	12.1%	11.4%	11.7%	13.5%	14.0%	13.7%	21.7%	19.7%	20.7%		
Total %	100%	100%	100%	100%	100%	100%	100%	100%	100%		
		Seattle ^c			State College			Tampa ^d			
Educational Level	Male	Female	Total	Male	Female	Total	Male	Female	Total ^f		
Population	1,175,688	1,211,305	2,386,993			494,733			1,131,398		
Less than 9th grade	3.3%	3.5%	3.4%			4.1%			4.7%		
9th to 12th grade, no diploma	5.6%	4.8%	5.1%			8.4%			9.1%		
High school graduate (includes equivalency)	22.1%	22.0%	22.1%			46.0%			31.3%		
Some college, no degree	22.2%	23.6%	23.0%			14.0%			21.6%		
Associate's degree	8.5%	10.2%	9.4%			7.6%			9.1%		
Bachelor's degree	24.0%	23.1%	23.5%			12.2%			16.4%		
Graduate or professional degree	14.3%	12.8%	13.6%			7.8%			8.0%		
Total %	100%	100%	100%			100%			100.2%		

Note: 2010 Census data based on adult population 25 years and older.

^a Provided as a percentage of Erie County population 25 years and older. http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_11_1YR_S1501 &prodType=table. Accessed Aug. 14, 2013.

^b From estimates from the American Community Survey (ACS) by ZCTA S1501: Educational Attainment Population 25 years and over.

[°]U.S. Census Bureau, Educational Attainment Population 25 Years and Over, 2012 American Community Survey 1-Year Estimates (Report No. S1501). http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t. Accessed Nov. 7, 2013.

^d 2007–2011 American Community Survey 5-year estimates.

^e Bloomington—for 38 primary zip codes.

¹Data for Pasco and Hillsborough counties provided as a percentage of total population 25 years and over.

Table B.4. Number of Licensed Drivers by Gender and (Available) Age Groups for Counties in Study Center Areas

	Bloon	nington ^a			Buff	falo ^b			Dur	'ham ^c	
SHRP 2 Age Group	Male	Female	Total	SHRP 2 Age Group	Male	Female	Total	SHRP 2 Age Group	Male	Female	Total
16–17	2,054	1,987	4,041	16–17	3,111	2,851	5,962	16–17	12,893	12,557	25,450
18–20	5,864	5,573	11,437	18–20	9,054	13,354	22,408	18–20	22,856	23,108	45,964
21–25	10,978	10,457	21,435	21–25	24,515	25,679	50,194	21–25	46,015	48,424	94,439
26–35	21,286	20,236	41,522	26–35	41,041	47,250	88,291	26–35	107,872	112,027	219,899
36–50	32,467	31,764	64,231	36–50	61,018	80,933	141,951	36–50	152,683	156,296	308,979
51–65	31,659	31,559	63,218	51–65	57,826	84,743	142,569	51–65	100,781	111,355	212,136
66–75	11,813	12,025	23,838	66–75	24,064	33,183	57,247	66–75	28,526	32,015	60,541
75+	6,553	7,403	13,956	75+	28,318	35,440	63,758	75+	16,777	20,257	37,034
Total	122,674	121,004	243,678		248,947	323,433	572,380		488,403	516,039	1,004,442
	Sea	attle ^d			State C	College		Tampa ^r			
SHRP 2 Age Group	Male	Female	Total	SHRP 2 Age Group	SHRP 2	Female	Total	FL DHSMV Age Group	Male	Female	Total
16–17	16,157	16,740	32,897	16–17	3,247	2,880	6,127	16–17	14,479	14,182	28,661
18–20	52,770	48,763	101,533	18–20	11,015	10,138	21,153	18–20	30,671	30,137	60,808
21–25	117,988	108,550	226,538	21–25	20,207	19,010	39,217	21–30	117,578	117,668	235,246
26–35	295,230	262,127	557,357	26–35	36,714	35,246	71,960	31–40	120,051	119,076	239,127
36–50	415,653	374,847	790,500	36–50	65,084	64,046	129,100	41–50	128,470	126,371	254,841
51–65	339,557	322,726	662,283	51–65	68,002	67,805	135,807	51–60	103,846	108,702	212,548
66–75	96,642	94,304	190,946	66–75	25,999	28,102	54,101	61–70	72,892	77,515	150,407
75+	53,531	58,537	112,068	75+	18,525	22,472	40,997	71–80	40,606	43,900	84,506
								81+	18,922	23,618	42,540
Total	1,387,528	1,286,594	2,674,122		248,793	249,699	498,462		647,515	661,169	1,308,684

^a Data provided for eight counties in primary study area (Brown, Greene, Lawrence, Martin, Monroe, Morgan, Orange, and Owen).

^b https://data.ny.gov/Transportation/Driver-License-Permit-and-Non-Driver-Identificatio/rsxa-xf6b. Accessed Nov. 8, 2013. (Passenger & Light Truck only. Does not include Commercial Drivers Licenses, Tow Truck/Farm Equipment Licenses, Taxi/Livery Licenses and Motorcycle licenses.)

Data entered are totals for Chatham, Wake, Orange, and Durham counties. Source: North Carolina DOT. Data for ages calculated on Jan. 1, 2010.

^d Seattle data provided via e-mail by Washington DOT; original source: Washington State DMV (2012 data). Note: Licensed Driver data are 2012 while Population data (Table 2.6) are 2010.

 $^{^{\}rm e}\,\textsc{Data}$ from Pennsylvania DOT for 10 counties in State College study area for year 2010.

Florida 2010 Department of Highway Safety and Motor Vehicles (DHSMV). http://www.flhsmv.gov/html/driverdemographics/CountySexAge2010.pdf. Accessed Oct. 10, 2013.

Table B.5. Vehicle Registrations by Vehicle Type for Counties in Study Areas

Vehicle Type	Bloomington	Buffalo ^b	Durham	Seattle ^d	State Collegee	Tampa ^r
Passenger car	291,489 ^g	557,434	833,691	2,223,547	415,183	1,149,645 ^h
Truck	3,645 [/]	54,233	162,746	587,708	149,297	62,159
Trailer	44,915 ^g	24,314	76,916	201,990	99,374	143,009
Motorcycle/moped	12,810	22,782	17,542	NA	32,566	44,900
Recreational vehicle	1,727	NA	1,679	234,610	NA	95,964
Bus	690	1,668	1,862	NA	3,489	5,535
Farm vehicle	4,344	152	NA	NA	28	NA
Other/unknown	78	9,163 ^j	536 ^k	5,917′	179	79,927 ^g
Total	359,698	669,746	1,094,972	3,253,772	700,116	1,581,139

Note: NA = not available.

^a Totals for primary study area in Brown, Greene, Lawrence, Martin, Monroe, Morgan, Orange, and Owen counties.

^b Data for Erie County, NY, New York State DMV. http://www.dmv.ny.gov. Accessed Aug. 18, 2013.

^c Totals for Chatham, Wake, Orange, and Durham counties.

^d Data for King, Pierce, and Snohomish counties, State of Washington Office of Financial Management. 2012. 2011 Data Book. http://www.ofm.wa.gov/databook/pdf/databook.pdf. Accessed Nov. 7, 2013.

 $^{^{\}rm e}\,{\rm Data}$ include all 10 counties in State College area for year 2010.

^fData for Pasco and Hillsborough counties.

g Includes "vessels" and "travel trailers."

^h Includes automobiles and pick-up trucks.

ⁱIncludes heavy trucks.

¹ Includes "ambulances," "rental," and "taxis."

^k Includes mobile homes, special mobile equipment, wrecker, and others.

Includes "exempt" and "other."

APPENDIX C

Certificate of Confidentiality Applicable to All Study Centers

CERTIFICATE OF CONFIDENTIALITY

CC-MH-IO-182

Issued to

Virginia Polytechnic Institute

conducting research known as

The In-Vehicle Driving Behavior and Crash Risk Study (SHRP 2 Naturalistic Driving Study)

In accordance with the provisions of section 301(d) of the Public Health Service Act 42 U.S.C. 241(d), this Certificate is issued in response to the request of the Principal Investigator, Dr. Jonathan Antin, to protect the privacy of research subjects by withholding their identities from all persons not connected with this research. Dr. Antin is primarily responsible for the conduct of this research, which is supported by the Transportation Research Board of the National Academies.

Under the authority vested in the Secretary of Health and Human Services by section 301(d), all persons who:

- 1. are enrolled in, employed by, or associated with the Virginia Polytechnic Institute and their contractors or cooperating agencies and
- 2. have in the course of their employment or association access to information that would identify individuals who are the subjects of the research pertaining to the project known as The In-Vehicle Driving Behavior and Crash Risk Study (SHRP 2 Naturalistic Driving Study)

are hereby authorized to protect the privacy of the individuals who are the subjects of that research by withholding their names and other identifying characteristics from all persons not connected with the conduct of that research.

This research study examines driving behaviors such as cognitive awareness, substance usage, fatigue, impairment, and other behavioral and environmental factors associated with collisions. The research uses advanced technologies to collect a spectrum of data on subjects to examine driving and risky behaviors in different environmental conditions to determine their influence at increasing the risk of collisions.

A Certificate of Confidentiality is needed because sensitive information will be collected during the course of the study. The certificate will help researchers avoid involuntary disclosure that could expose subjects or their families to adverse economic, legal, psychological, and social consequences.

All subjects will be assigned a code number and identifying information and records will be kept in locked files at the Institution.

This research is currently underway and is expected to end on 09/30/2013.

CERTIFICATE OF CONFIDENTIALITY (continued)

As provided in section 301 (d) of the Public Health Service Act 42 U.S.C. 241(d):

'Persons so authorized to protect the privacy of such individuals may not be compelled in any Federal, State, or local civil, criminal, administrative, legislative, or other proceedings to identify such individuals.'

This Certificate does not protect you from being compelled to make disclosures that: (1) have been consented to in writing by the research subject or the subject's legally authorized representative; (2) are required by the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 301 et seq.) or regulations issued under that Act; or (3) have been requested from a research project funded by the National Institutes of Health (NIH) or the Department of Health and Human Services (DHHS) by authorized representatives of those agencies for the purpose of audit or program review.

This Certificate does not represent an endorsement of the research project by the DHHS. This Certificate is now in effect and will expire on 09/30/2013. The protection afforded by this Confidentiality Certificate is permanent with respect to subjects who participate in the research during the time the Certificate is in effect.

Date: 10/14/2010

Patrick Shirdon

Associate Director for Management National Institute of Mental Health

Willen Men

APPENDIX D

Examples of Recruiting Materials



Figure D.1. Durham SHRP 2 maintenance van.

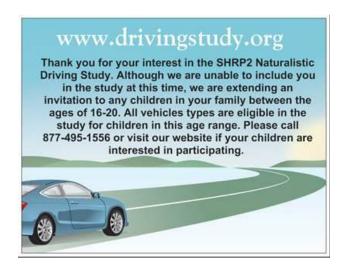


Figure D.2. Buffalo recruitment postcard.



Figure D.3. Seattle recruitment postcard.

APPENDIX E

Participants by Driver Type, Age, and Gender for Each Study Center

The tables which follow include participants with at least 1 day in the study as determined by VTTI in March 2014. Only secondary drivers with consent date and reference image are included in secondary driver total. Age and gender information are not available for all secondary drivers. Secondary drivers are not counted toward "participant" age group total.

Table E.1. Participants by Driver Type, Age Group, and Gender for Bloomington Study Center

			Bloomingtor	n Participan	ts	
Age Group	Gender	Primary Driver	Additional Primary Driver	Total by Gender	Total AVTs for Each Age Group	Secondary Driver
16–17	Male	9	3	12	27	0
	Female	15	0	15		0
18–20	Male	19	0	19	36	0
	Female	14	3	17		0
21–25	Male	17	1	18	43	0
	Female	25	0	25		0
26–35	Male	11	0	11	22	0
	Female	11	0	11		0
36–50	Male	10	0	10	26	3
	Female	15	1	16		2
51–65	Male	16	0	16	32	3
	Female	16	0	16		1
66–75	Male	11	0	11	22	4
	Female	11	0	11		1
76+	Male	18	0	18	35	1
	Female	17	0	17		1
Subtotal (age/gender)		235	8	243	243	16
AVT (no age/gender)		11	0		11	0
Secondary Driver (no age/gender)						1
Total		246	8		254	17

Table E.2. Participants by Driver Type, Age Group, and Gender for Buffalo Study Center

Age Group	Gender	Primary Driver	Additional Primary Driver	Total by Gender	Total AVTs for Each Age Group	Secondary Driver
16–17	Male	12	2	14	28	0
	Female	12	2	14		0
18–20	Male	42	2	44	120	0
	Female	75	1	76		1
21–25	Male	56	1	57	155	0
	Female	97	1	98		1
26–35	Male	35	0	35	72	0
	Female	37	0	37		1
36–50	Male	37	0	37	76	2
	Female	37	2	39		0
51–65	Male	30	3	33	75	1
	Female	41	1	42		3
66–75	Male	45	0	45	84	2
	Female	39	0	39		2
76+	Male	46	0	46	90	0
	Female	44	0	44		0
Subtotal (age/gender)		685	15	700	700	13
AVT (no age/gender)		40	0		40	0
Secondary Driver (no age/gender)						0
Total		725	15		740	13

Table E.3. Participants by Driver Type, Age Group, and Gender for Durham Study Center

			Durham P	articipants		
Age Group	Gender	Primary Driver	Additional Primary Driver	Total by Gender	Total AVTs for Each Age Group	Secondary Driver
16–17	Male	26	0	26	58	0
	Female	32	0	32		0
18–20	Male	21	0	21	53	1
	Female	32	0	32		1
21–25	Male	26	0	26	71	2
	Female	45	0	45		2
26–35	Male	35	0	35	62	2
	Female	26	1	27		1
36–50	Male	36	0	36	67	2
	Female	31	0	31		1
51–65	Male	29	0	29	58	4
	Female	29	0	29		3
66–75	Male	29	0	29	49	4
	Female	20	0	20		2
76+	Male	55	0	55	85	1
	Female	30	0	30		1
Subtotal (age/gender)		502	1	503	503	27
AVT (no age/gender)		26	0		26	0
Secondary Driver (no age/gender)						9
Total		528	1		529	36

Table E.4. Participants by Driver Type, Age Group, and Gender for Seattle Study Center

			Seattle Pa	articipants		
Age Group	Gender	Primary Driver	Additional Primary Driver	Total by Gender	Total AVTs for Each Age Group	Secondary Driver
16–17	Male	39	3	42	90	0
	Female	47	1	48		0
18–20	Male	39	1	40	94	3
	Female	54	0	54		2
21–25	Male	62	1	63	136	5
	Female	72	1	73		3
26–35	Male	30	0	30	62	9
	Female	31	1	32		14
36–50	Male	29	0	29	58	9
	Female	29	0	29		11
51–65	Male	28	0	28	59	10
	Female	31	0	31		15
66–75	Male	29	0	29	58	9
	Female	29	0	29		5
76+	Male	69	1	70	126	2
	Female	54	2	56		3
Unspecified		1	0	1	1	0
Subtotal (age/gender)		673	11	684	684	100
AVT (no age/gender)		31	0		31	0
Secondary Driver (no age/gender)						21
Total		704	11		715	121

Table E.5. Participants by Driver Type, Age Group, and Gender for State College Study Center

			State College	e Participar	nts	
Age Group	Gender	Primary Driver	Additional Primary Driver	Total by Gender	Total AVTs for Each Age Group	Secondary Driver
16–17	Male	7	1	8	17	0
	Female	9	0	9		0
18–20	Male	17	0	17	39	0
	Female	21	1	22		0
21–25	Male	28	0	28	60	0
	Female	32	0	32		0
26–35	Male	21	1	22	35	0
	Female	12	1	13		0
36–50	Male	12	1	13	28	0
	Female	14	1	15		0
51–65	Male	15	0	15	40	0
	Female	25	0	25		0
66–75	Male	12	0	12	24	0
	Female	12	0	12		0
76+	Male	18	0	18	31	0
	Female	13	0	13		0
Subtotal (age/gender)		268	6	274	274	0
AVT (no age/gender)		1	0		1	0
Secondary Driver (no age/gender)						11
Total		269	6		275	11

Table E.6. Participants by Driver Type, Age Group, and Gender for Tampa Study Center

Age Group	Gender	Primary Driver	Additional Primary Driver	Total by Gender	Total AVTs for Each Age Group	Secondary Driver
16–17	Male	16	1	17	42	0
	Female	25	0	25		0
18–20	Male	95	1	96	184	0
	Female	88	0	88		0
21–25	Male	52	1	53	128	1
	Female	74	1	75		2
26–35	Male	24	0	24	55	1
	Female	31	0	31		1
36–50	Male	29	2	31	66	0
	Female	35	0	35		1
51–65	Male	36	0	36	75	1
	Female	39	0	39		1
66–75	Male	40	0	40	77	0
	Female	37	0	37		0
76+	Male	42	0	42	81	0
	Female	39	0	39		1
Subtotal (age/gender)		702	6	708	708	0
AVT (no age/gender)		26	0		26	0
Secondary Driver (no age/gender)						2
Total		728	6		734	11

APPENDIX F

Naturalistic Driving Study Consent Form

PARTICIPANT CONSENT FORM FOR TWO-YEAR PRIMARY DRIVER

IN-VEHICLE DRIVING BEHAVIOR AND CRASH RISK STUDY

("The SHRP 2 Naturalistic Driving Study")

SPONSORS: National Academies of Science, Transportation Research Board, SHRP 2 Program

The United States Department of Transportation

INVESTIGATORS: Tom Dingus, Jon Hankey, Jon Antin, Suzie Lee, and Lisa Eichelberger: Virginia Tech

Transportation Institute

John Pierowicz, Alan Blatt, and Marie Flanigan:

Calspan University of Buffalo Research Center (CUBRC)

Ann Brach and Ken Campbell: National Academies, Transportation

Research Board, SHRP 2 Program

WHAT IS THE PURPOSE OF THIS RESEARCH?

The Naturalistic Driving Study is a large research effort directed at improving Highway Safety in the United States where more than 30,000 people are killed and 2 million are injured every year in highway-related accidents. The study will help researchers gain a deeper understanding of the interaction between the driver, vehicle and roadway and lead to safer roadways, vehicles, and driver training programs. The SHRP 2 Naturalistic Driving Study will look at how people normally drive by installing cameras and sensors in people's own vehicles. The study is being conducted at six locations across the United States with up to 3,100 participants. About three-fourths of participants will be in the study for one year, and the rest for two years.

WHAT SHOULD I KNOW BEFORE DECIDING TO PARTICIPATE?

- 1. You are providing permission for us to collect data (including video) whenever your vehicle is used or whenever you happen to drive another vehicle that is part of the study (for example, a vehicle owned by a friend who also happens to be in the study). If there are drivers of your vehicle who have not signed consent forms, we will delete their data from every trip in which they drove your vehicle.
- 2. There will be video of your face and portions of your body and the roadway. Audio will not be recorded unless you press a red incident button. The video, audio, and other data that personally identifies you, or could be used to personally identify you, will be held under a high level of security at one or more data repositories. Your data will be identified with a code rather than your name. Finally, only qualified researchers will be authorized to have access to data that personally identifies you, or can be used to personally identify you, and the level to which they have access will be based on their level of authorization.

- 3. No identifying information will be collected on passengers.
- 4. For the duration of the project you will be responsible for your insurance coverage. If you are in a crash, please contact emergency services as you normally would. We will then ask for more information, as detailed below.
- 5. You may withdraw from the study at any time. If you do withdraw from the study before your scheduled end date, you must agree to allow us to retrieve the data collection system from your vehicle as soon as is feasible.

WHAT DO I HAVE TO DO IF I CHOOSE TO PARTICIPATE?

The study involves a two year data collection effort in which a data collection system containing sensors and cameras will be installed in your vehicle to record a variety of driving measures. As a participant, you will complete the following activities:

- 1. Have your vehicle equipped (see the section below: "What will I have to do to get my vehicle equipped for the study?").
- 2. Drive as you normally would.
- 3. Provide us with contact information for all other adult drivers (over the age of 18) who drive your vehicle at least once a week. We would like to contact them to get permission to use data collected any time they happen to be driving your vehicle. We will also ask them to fill out two brief questionnaires.
- 4. Make an appointment for us to collect the driving data from your vehicle about once every 3 to 6 months. Each appointment could take up to one hour and will be scheduled to take place at a location that is convenient for you such as your home, work, school, or at a local shopping mall. You will not need to do anything at these appointments apart from providing access to the trunk or interior of the vehicle; a trained technician will handle everything else.
- 5. While you are in the study, we ask that you not drive your vehicle into any areas where cameras are not allowed, including any international border crossings, military bases, or similar facilities.
- 6. Advise other drivers of the video and audio equipment installed in your vehicle and ask them not to drive into areas where cameras are not allowed. Let these other drivers know that data will be collected when they drive the vehicle but will only be retained and analyzed if they sign a consent form. If they do not sign a consent form, then the data will be deleted for every trip in which they drove your vehicle.

What Will I Have To Do To Get My Vehicle Equipped For The Study?

- 1. Bring your vehicle to CUBRC at the scheduled day and time to have the data collection system installed. The technicians will strive to complete each vehicle in less than four (4) hours, but it may take longer in rare cases. The system will require a connection to the vehicle power and your vehicle network box. These connections will provide additional data as well as power for the system; by agreeing to participate, you are providing us permission to get information from your vehicle network as well as to install new sensors. Before we begin installation, we will show you where we will place the system and also show you pictures of what the completed installation will look like. The installation process will not change your vehicle's driving, handling, or safety characteristics, and your vehicle will be returned to its original state when your participation is concluded.
- 2. While the system is being installed on your vehicle, you will be provided a comfortable area in which to complete the consent process and testing at CUBRC, which should take about 2–3 hours. Specifically, you will be asked to:
 - a. Provide us with proof of a valid U.S. driver's license, proof of vehicle insurance, and proof of ownership (vehicle registration showing you as an owner or co-owner of the vehicle).
 - b. Review and sign this informed consent form.
 - c. Undergo about 20 minutes of non-invasive vision tests, performed on a computer monitor and a machine that you will look into but that will not touch or blow air into your eyes.

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- d. Take about 30 minutes of computer tests that will assess your memory, decision making, and attention skills, none of which require previous computer skill or knowledge.
- e. Take a 2 minute memory and attention test using pencil and paper and the following two tests of your body movements and strength.
 - i. You will be asked to walk as fast as you can without falling or tripping to a point 10 feet away, and then to return to the starting point. This should take about one minute.
 - ii. You will be asked to sit down and squeeze a device that measures grip strength. This should also take about two minutes.
- f. Fill out nine (9) questionnaires on a computer (some may be completed online from home later, if you prefer). The questionnaires vary in length and take between 5 and 15 minutes each to complete. They contain questions about: your health history and health status; driving behavior, history and knowledge. You will be asked to fill out one or more final questionnaires after completing your participation in the study.
- g. Take home and give copies of an Informed Consent form and questionnaires to any other adult drivers who drive your vehicle at least once a week.
- 3. Allow our technicians to drive your vehicle as needed during the installation and testing process.
- 4. When your vehicle is ready, we will show you the data collection system and provide you with information about who to contact if you have any vehicle problems that could be related to your data collection system, or if you notice any maintenance issues with the system (for example, a camera or device that comes loose).
- 5. We will take some reference pictures of you in your vehicle so that software can be used to identify you as the driver. To simulate driving at night, we will take some of these pictures with a blanket of material draped over your vehicle while you are sitting in the driver's seat.

What Do I Do After My Vehicle Is Equipped for the Study?

- 1. After you return home, you will be asked to complete any questionnaires you did not have time to complete during installation of the data collection system into your vehicle. Once you have completed all of the online questionnaires, you will receive your first payment of \$100 via check or direct deposit.
- 2. Drive as you normally would for two years.
- 3. If you are in a crash while in the study, we ask that you do five things (in the following order):
 - a. Seek emergency help the way that you normally would.
 - b. If possible, press an incident button that is located near the rear view mirror to describe the incident. The system will then record your brief description. You will know the button is working if the red light comes on when you press it.
 - c. Call us at (716) 204-5138 or (716) 204-5177 to notify us as soon as it is safe to do so.
 - d. Allow a member of the research team to interview you about the crash if we decide that your crash should be investigated in more detail. This interview would ideally take place soon after the crash, but only when you are comfortable and able to do so.
 - e. Allow us to have access to the police accident report, if any, which results from the crash.
- 4. We will make an appointment with you to collect the driving data from your vehicle about once every 3 to 6 months. These appointments will typically take about 15 minutes, but could take up to one hour depending on what needs to be done. They will be scheduled to take place at a location that is convenient for you such as your home, work, school, or at a local shopping mall. You will not need to be in the vehicle when the data are collected, but you will need to provide us with access to the trunk or interior of your vehicle. As mentioned above, we also will collect data from the vehicle after a crash, either at a place of your choosing or where the vehicle was towed.

- 5. While you are in the study, do not drive your vehicle into any areas where cameras are not allowed, including any international border crossings.
- 6. If we notice a new person driving your vehicle, we may contact you to find out if you have already asked them about participating in the study.

What Happens When The Study Is Over?

- 1. After two years, you will be asked to return to CUBRC so that we may remove the system from your vehicle. While your vehicle is being worked on, we will ask you to fill out some final questionnaires. This process is expected to take about two hours. After this session is complete, you will receive your final payment of \$200 via check or direct deposit.
- 2. When you leave the study, we may ask you whether we can keep your contact information to contact you for participation in future follow-on studies. This will be optional, and if you do not agree, we will delete your contact information one year after data collection is complete at CUBRC.
- 3. Once we have all the data, we will begin data analysis and reporting. It is likely that you will see references to the results of the study in the news or elsewhere. However, these reports will not identify participants by name, nor will personally identifying video be shown.

WHAT ARE THE RISKS OF PARTICIPATING IN THIS STUDY?

The operation or drivability of the vehicle will not be affected by the instrumentation, and thus carries a similar risk as when you operate the vehicle normally. However, if you violate state or local driving laws (such as driving under the influence, exceeding posted speed limits, or driving while distracted), the instrumentation could record evidence of these violations. This has the potential to pose greater than minimal risk of legal harm. A variety of strategies and procedures have been developed to reduce the potential for legal or economic harms. These strategies include encrypting the data obtained by sensors and cameras, using a code number to identify you with the code key maintained in a secure location, and obtaining a Certificate of Confidentiality. More details on these strategies are provided below.

All data collection equipment is mounted such that, to the greatest extent possible, it does not pose a hazard or problem for you when you drive. None of the data collection equipment should get in the way of your normal field of view. Placing the data collection system in your vehicle will not affect the operating or handling characteristics of the vehicle. You are not being asked to change the way you drive or where you drive, except for your visits to CUBRC at the beginning and end of the study.

You may opt out of the "blanket" process to record simulated nighttime images if you are claustrophobic or if the process otherwise makes you uncomfortable. There are non-driving risks resulting from participation. Five cameras will be placed in your vehicle. If you drive into an area where cameras are not allowed, including international border crossings, certain military and intelligence locations, and certain manufacturing plants, there is a risk that you may be detained or arrested or that your vehicle may be impounded. For this reason, by signing this Informed Consent and thereby agreeing to participate in the study, you also are agreeing not to drive into any such areas while you are in this study. We have provided a letter for the glove box which can be used to explain your vehicle's role in the study while still maintaining your privacy and keeping confidential your role in the study.

Throughout the study, we will take all possible steps to protect your privacy and keep confidential your role in the study and the confidentiality of your personally identifying information. To help us protect your privacy, we have obtained a Certificate of Confidentiality from the U.S. Department of Health and Human Services National Institutes of Health. With this Certificate, the researchers and study sponsors cannot be forced to disclose information that may identify you, even by a court subpoena, in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings. However, the Certificate of Confidentiality does not prevent the researchers from disclosing voluntarily matters such as child abuse, or a participant's threatened or actual harm to self or others. In terms of a vehicle, this could also include items such as driving under the influence of drugs or alcohol, allowing an unlicensed minor to drive the vehicle, or habitually running red lights at high speed. Such behaviors may result in your removal from the study and reporting of the behavior to the appropriate

authorities. In the event of a crash, it may not be possible to prevent the equipment and the data from falling into the hands of the police or an insurance company; if this happens, however, the data are still encrypted and inaccessible and unreadable to these individuals.

However, you, too, are responsible for taking steps to protect your privacy and for keeping confidential your role in this study. Do not post this information on public websites or tell people about your participation. Treat this information the same way that you protect other personal, sensitive information such as your bank account numbers or computer passwords. If you do not keep confidential your role in the study, there is a risk that some of the data collected during the study, including your personally identifying information, may be used against you in a court case or other legal proceeding.

The risk to you of completing the pre-collection questionnaires and tests while the data collection equipment is being installed in your vehicle is no more than when you are doing activities in your daily life like filling in forms, walking, squeezing your hand, and working at a computer. The assessment component involves filling in forms, standard vision tests, and standard computer-based tests. It is believed that there are no more than minimal risks involved with such activities. In addition, you will be asked to squeeze a grip strength tester and to rapidly walk 10 feet back and forth as fast as you can without running or falling. The risk with using the grip strength tester is brief hand soreness. The main risk with the Rapid Pace Walk is falling if you try to go too fast. Because the assessment process may take 2 or 3 hours, you may get tired, but you can also take breaks as needed.

WHAT ARE THE BENEFITS OF PARTICIPATING IN THIS STUDY?

While there are no direct benefits to you from this research, you may find this study interesting. No promise or guarantee of benefits is being made to encourage your participation. Participation will help to improve the body of knowledge regarding driving behavior and safety. Participation may also help us design safer vehicles and roadways in future years.

HOW WILL MY DATA BE KEPT CONFIDENTIAL AND SECURE AND WHO WILL HAVE ACCESS TO MY DATA?

Any data collected during this study that personally identifies you or that could be used to personally identify you will be treated with confidentiality. As soon as you begin participating in this study, your name and other identifying information will be separated from the raw data collected while you drive your vehicle and replaced with a number. That is, your raw data will not be attached to your name, but rather to a number (for example, Driver 0011). The raw data collected while you drive your vehicle will be encrypted (made unreadable) from the moment it is collected until it is transferred to one or more secure central storage locations. Your name also will be separated from any data about you, either provided by you in response to questionnaires or gathered by researchers during the study, including crash investigation data, and will be replaced by the same driver number (for example, Driver 0011).

Several types of information and data about you and your vehicle will be collected during the study:

- 1. **Contact information** includes your name, address, email address, phone numbers, and similar information used to contact you when needed. It will be stored securely in electronic form during the course of the study and destroyed after the study is complete (unless you grant permission for us to keep your contact information when the study is over). This information will not be linked to or mingled with your study data, and will not be used in any research or analysis.
- 2. **Auxiliary study information** includes your Social Security Number, license plate number, bank account information (for those using direct deposit) and similar information. This information is used to verify your identity and to make payments for your participation. This information will be stored at the site in electronic form (securely encrypted) destroyed after the study is complete. This information will not be linked to or mingled with your study data, and will not be used in any research or analysis.
- 3. **Driver data** includes your answers to questionnaires, vision test results, and the results of the brief physical tests described above. This data will not contain your name or any identifying information and will be used in analyses, both on its own and in combination with the driving data, vehicle data, and additional crash data. This data will be stored securely in electronic form throughout the lifetime of the data (defined below).

- 4. **Vehicle data** includes your vehicle make and model, its condition, and how it is equipped. This data will not contain your name or any identifying information and will be used in analyses, both on its own and in combination with the driver data, driving data, and additional crash data. This data will be stored securely in electronic form throughout the lifetime of the data (defined below).
- 5. **Driving data** includes the data we collect from your vehicle while you are driving, including video data and sensor data. This information will contain video of your face and GPS coordinates of your trips, both of which could be used to personally identify you. These data will be encrypted (stored in an unreadable format) from the moment of their creation until they are downloaded from your vehicle, transferred to a secure data storage facility, and verified. From this point on they will be decrypted (made readable) on as as-needed basis for each analysis. These data will be used for analysis, both on their own and in combination with the driver data, the vehicle data, and the additional crash data. This data will be stored securely in electronic form throughout the lifetime of the data (defined below).
- 6. Additional crash data includes items we may collect after a crash, including answers to an interview with one of our researchers and the police accident report resulting from the crash. This data will not contain your name or any identifying information and will be used in analyses, both on its own and in combination with the driver data, vehicle data, and driving data. This data will be stored securely in electronic form throughout the lifetime of the data (defined below).

It is possible that an authorized Institutional Review Board (IRB) may view this study's collected data for auditing purposes. An IRB is responsible for the oversight of the protection of human subjects involved in research.

It is also possible that the study sponsors or investigators may view this study's driver data and driving data for quality control or administrative purposes; in this case, the study sponsors or investigators will be required to maintain the security and confidentiality of any data that personally identifies study participants or that could be used to personally identify study participants.

While driving the vehicle, a camera will videotape your face with some added space around the head to handle any head movements. An example is shown below. Also, video cameras will capture views of the forward view, the rear view, an external view to the right, as well as a dashboard/lap-belt view. A camera will also periodically take a permanently blurred snapshot of the vehicle interior which will allow researchers to count the number of passengers and make rough estimates of age, gender, and seatbelt use. Passenger identification will not be possible from these blurred snapshots. All video will be captured and stored in digital format (no tape copies will exist).



There will also be an ambient atmospheric analyzer that is capable of detecting the presence of alcohol in the passenger compartment under certain conditions. It may not be able to distinguish whether the alcohol was imbibed or applied (as in hand sanitizer), and it will be unable to determine whether it is emanating from the driver or a passenger. However, this sensor will flag the data for possible indications of impaired driving.

If a safety-related incident or crash occurs, you are asked to press a button on the unit mounted near the rearview mirror. You will know this button is working if a red light appears when you press it. This will allow researchers to find the incident in the database after the data have been collected. Also, pressing the button starts a microphone for 30 seconds. During these 30-seconds, you can tell us what happened. No audio will be captured except when you press this incident button. Please note that pressing this button does NOT make a phone call, unlike OnStarTM. It simply records your voice in an audio file that remains in the vehicle until the data is collected.

During the data collection phase of this study, all data collected from your vehicle will be encrypted (made unreadable) from the time of its creation and then stored in a specific password-protected project folder on a secure server; the driving data will only be decrypted (made readable) once it has been stored in this folder. At the conclusion of the collection phase of this study, the driver data, driving data, and additional crash data will be permanently housed at one or more highly secure data storage facilities. One set of data will be permanently housed at Virginia Tech under the supervision of the Virginia Tech Transportation Institute, the organization overseeing the data collection for the entire study. It is possible that, after data collection is complete, one copy of study data will be transferred to the U.S. Department of Transportation (or other secure facilities as determined by the Transportation Research Board) for permanent storage and oversight.

Only authorized project personnel and authorized employees of the research sponsors will have access to study data that personally identifies you or that could be used to personally identify you. As explained below, other qualified research partners may be given limited access to your driver data, vehicle data, driving data, and additional crash data, solely for authorized research purposes and with the consent of an IRB. This limited access will be under the terms of a data sharing agreement or contract that, at a minimum, provides you with the same level of confidentiality and protection provided by this Consent Form. However, even these qualified researchers will not be permitted to copy raw study data that identifies you, or that could be used to identify you, or to remove it from the secure facilities in which it is stored without your consent.

Project personnel, the project sponsors and qualified, authorized research partners may show specific clips of video at research conferences. The project sponsors also may show specific clips of video to the media, driver's education teachers and students, and others involved in efforts to improve highway and road safety. The face portion of the video will be blurred, blacked out, or replaced with an animation for these purposes. Your name and other personally identifying information will never be associated with the showing of these video clips. Identifying location information will not be shown in association with these video clips.

It is expected that the data we capture throughout the course of the entire study, including that from all the approximately 3,100 primary participants, will be a valuable source of data on how drivers respond to certain situations and how the roadway and vehicle might be enhanced to improve driver safety. Researchers who study traffic congestion and traffic patterns may also find the data useful. Therefore, it is expected that there will be follow-on data analyses using all or part of the data for up to 30 years into the future. These follow-on analyses will be conducted by qualified researchers with IRB approval, as required by law, who may or may not be part of the original project team. In consenting to this study, you are consenting to future research uses of the information and videos we gather from you, consistent with the protections described above and elsewhere in this document.

If you are involved in a crash while participating in this study, the data collection equipment in your vehicle will likely capture the events leading up to the event. You are under NO LEGAL OBLIGATION to voluntarily mention the data collection equipment or your participation in this study at the time of a crash or traffic offense. We have provided a letter which you should keep in your glove box for these cases. The letter describes your vehicle's role in the study without identifying you as a participant in the study.

Because the vehicle camera system is storing continuous video, it may capture some incriminating evidence if an at-fault collision should occur. To help us protect your privacy, we have obtained a Certificate of Confidentiality from the U.S. Department of Health and Human Services National Institutes of Health. With this Certificate, neither the researchers nor study sponsors

can be forced to disclose information that may identify you, even by a court subpoena, in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings. Identifying information for the purposes of this study includes your contact information, your auxiliary study information, your driving data (including video of your face and GPS coordinates which may identify your home, work, or school locations), or any information in your driver data, vehicle data, or additional crash data that could be used to personally identify you. While your confidentiality is protected in most cases by the Certificate, you should know that in some rare instances involving alleged improper conduct by you or others, you may be prevented by a court from raising certain claims or defenses unless you agree to waive the confidentiality protection. The researchers and study sponsors will use the Certificate to resist any demands for information that would identify you, except as explained below.

The Certificate cannot be used to resist a demand for information from personnel of the United States Government that is used for auditing or evaluation of federally funded projects or for information that must be disclosed in order to meet the requirements of the federal Food and Drug Administration (FDA).

This Certificate of Confidentiality does not mean that the Federal government endorses this study. You should understand that a Certificate of Confidentiality does not prevent you or a member of your family from voluntarily releasing information about yourself or your involvement in this research. If an insurer, employer, or other person obtains your written consent to receive research information, then the researchers may not use the Certificate to withhold that information.

The Certificate of Confidentiality also does not prevent the researchers from disclosing voluntarily matters such as child abuse, or subject's threatened or actual harm to self or others. This could also include behaviors such as habitually driving under the influence of drugs or alcohol, allowing an unlicensed minor to drive the vehicle, or habitually running red lights at high speed. If this type of behavior is observed, we reserve the right to remove you from the study and inform the appropriate authorities of what we have observed. In most cases, we will notify you first of the behaviors we have observed prior to removing you from the study or informing others of our observations. If you are removed from the study, your compensation will be prorated based on the time you have already spent as a participant in the study.

The protections of the Certificate of Confidentiality described herein may not apply to passengers or drivers of your vehicle who have not consented to being in this study. For this reason, Informed Consent will be sought from all other adults who drive your vehicle, and these individuals will be protected by the Certificate of Confidentiality to the same degree as you are.

To summarize, your level of confidentiality in this study is as follows:

- 1. There will be video of your face and portions of your body. There will be audio recorded, but only for 30 seconds if you press the red incident button. The study also will collect health and driving data about you. The video, audio, and other data that personally identifies you, or could be used to personally identify you, will be held under a high level of security at one or more data storage facilities. Your data will be identified with a code rather than your name.
- 2. All data collected from other drivers who have not signed a consent form will be deleted. No identifying information will be collected on passengers.
- 3. For the purposes of this project, only authorized project personnel, authorized employees of the project sponsors, and qualified research partners will have access to study data containing personally identifying information, or that could be used to personally identify you. The data, including face video which has been blurred, blacked out, or replaced by animation, may be shown at research conferences and by the research sponsors for the highway and road safety purposes identified above. Under no circumstances will your name and other personally identifying information be associated with the video clips.
- 4. The personally identifying data collected in this study may be analyzed in the future for other research purposes by this project team or by other qualified researchers in a secure environment. Such efforts will require those researchers to sign a data sharing agreement which will continue to protect your confidentiality, and will also require additional IRB approval. The confidentiality protection provided to you by these data sharing agreements will be as great as or greater than the level provided and described in this document. Research partners will not be permitted to copy raw data that identifies you, or that could be used to identify you, or to remove it from the secure facility in which it is stored except with your consent.

5. A Certificate of Confidentiality has been obtained from the National Institutes of Health. With this Certificate, the researchers and study sponsors cannot be forced to disclose information that may identify you, even by a court subpoena, in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings. However, the Certificate of Confidentiality does not prevent the researchers from disclosing voluntarily matters such as child abuse, or a participant's threatened or actual harm to self or others. In terms of a vehicle, this could also include items such as driving under the influence of drugs or alcohol, allowing an unlicensed minor to drive the vehicle, or habitually running red lights at high speed. Such behaviors may result in your removal from the study and reporting of the behavior to the appropriate authorities. While your confidentiality is protected in most cases by the Certificate, you should know that in some rare instances involving alleged improper conduct by you or others, you may be prevented by a court from raising certain claims or defenses unless you agree to waive the confidentiality protection.

WILL I RECEIVE PAYMENT FOR PARTICIPATING IN THIS STUDY?

Total payment for your participation in this research will be \$300 per year, paid to you at five (5) times during the study. You are required to provide a valid social security number in order to receive your first payment. Payments will be scheduled as follows:

- 1. After you have been enrolled in the study, (your vehicle has been prepared for our study and you have completed the enrollment process, including the online questionnaires), you will receive \$100 via check or direct deposit. This initial payment covers months one through four of your participation in the study.
- 2. A second payment of \$100 via check or direct deposit will be received after the 6th month of participation. This payment covers months five through eight of your participation in the study.
- 3. A payment of \$100 after the 12th month of participation via check or direct deposit. This covers months 7 through 12 of your participation in the study.
- 4. A payment of \$100 after the 18th month of participation via check or direct deposit. This covers months 13 through 16 of your participation in the study.
- 5. During the 24th month, after you return to CUBRC to have the system removed from your vehicle and complete a few final questionnaires, you will receive a final payment of \$200 via check or direct deposit. This payment covers months 17 through 24 of your participation in the study. The overall maximum payment for those who complete all requirements will thus be \$600.

If you discontinue your participation early, by your own choice or because you are asked to leave by someone on the study team, you will be paid \$25 for every month of participation in the study (for payment purposes, a partial month at the conclusion would be considered a full month).

WHAT ABOUT INSURANCE?

Please note that since you are driving your own vehicle, neither study personnel nor their respective organizations are responsible for the expenses that are caused by a crash you may experience. In the event of a crash, you are **not** responsible for any damage to the data collection system that is installed into your vehicle.

Participants in a study are considered volunteers, regardless of whether they receive payment for their participation. Under New York state law, workers compensation does not apply to volunteers; therefore, the participants are responsible for their own medical insurance for bodily injury. Appropriate health insurance is strongly recommended to cover these types of expenses.

If you get hurt in a crash, whether in or out of an automobile, the medical treatment available to you would be that provided to any person by emergency medical services in the vicinity where the accident occurs. The participant agrees that this agreement shall be construed in accordance with the laws of the Commonwealth of Virginia, notwithstanding any conflicts of law provisions. Further, any and all claims and/or actions against Virginia Tech or the Commonwealth of Virginia shall be brought in a court of the Commonwealth of Virginia.

AM I FREE TO WITHDRAW FROM THIS STUDY AT ANY TIME?

As a participant in this research, you are free to withdraw at any time without penalty. If you choose to withdraw, you will receive partial payment as described in the Payment for Participation section of this form. You are free to choose not to answer any questions or respond to any tests that you choose without penalty. If you withdraw or are dismissed from the study, we will retain data collected before your withdrawal/dismissal, but delete any data collected in the interval between when we become aware of the withdrawal/dismissal and before we are able to remove the data collection equipment. If you choose to end your participation in the study earlier than originally planned, we will need to schedule a time to remove the data collection system from your vehicle. You will not receive your final payment due until we have removed the instrumentation from your vehicle.

HAS THIS RESEARCH BEEN APPROVED?

Before this experiment begins, the research must be approved by the Institutional Review Board for research involving human subjects at Virginia Tech. The research has also been approved by the IRB for the National Academies of Science. You should know that this approval has been obtained and is valid through the date listed at the bottom of this form.

HOW DO I PROVIDE MY CO	NSENT?		
stand what is being asked of me	rticipant) have read and understand this e. My questions have been answered. I fre t participation is voluntary and that I ma	ely agree to participate an	nd have not been coerced into
and sensors to be installed in th	co-owner of the vehicle that will be used the vehicle. I certify that I hold a valid Uni- the minimum amount of liability insura	ted States driver's license,	and that the vehicle that will
Participant (Pri	nt Name)	Signature	Date
Experimenter (Pr	int Name)	Signature	Date
======================================	out this research or its conduct, I may co	======================================	=========
Alan Blatt blatt@cubrc.org	CUBRC Site Principal Investigator	(716) 20	04-5138
Jon Antin jantin@vtti.vt.edu	Project Manager	(540) 2.	31-1579
David Moore moored@vt.edu	Chair, Virginia Tech Institutional Re Board for the Protection of Human Office of Research Compliance 2000 Kraft Drive, Suite 2000 (0497) Blacksburg, VA 24060	Subjects	31-4991

The Participant Must Be Provided With A Copy Of This Consent Form.

APPENDIX G

SHRP 2 Letter Provided for Participant Vehicle Glove Box

TRANSPORTATION RESEARCH BOARD

OF THE NATIONAL ACADEMIES

To whom it may concern,

This vehicle has been equipped with a variety of instruments as part of a driving study which is being conducted under the direction of the Transportation Research Board of the National Academies. The vehicle may be identified using the vehicle specific information shown below, including the state of registration and the last three characters of the license plate. The picture below shows the primary equipment that is located in the passenger compartment. The main goal of this study is to improve traffic safety for drivers, passengers, and all other road users in the United States. These instruments are not the property of the owner of this vehicle and should not be removed except by a trained, authorized technician. Any questions or concerns regarding the study or the role of the installed instruments should be directed to Mr. Alan Blatt (716-204-5215). Note that the individual reached will be able to confirm the study in general terms only.

Sincerely,

Alan Blatt

Program Manager CUBRC, Inc. 4455 Genesee St Buffalo, NY 14225 716-204-5215

Kenneth L Campbell, PhD, PE SHRP 2 Chief Program Officer Transportation Research Board

Make: Chevrolet Model: Aveo Year: 2011

State of Registration: NY

Last three digits/letters of license plate: 008



THE NATIONAL ACADEMIES Advisers to the Nation on Science, Engineering, and Medicine

500 Fifth Street, NW

Phone (202) 334-2934 Washington, DC 20001 Fax (202) 334-2003 www.TRB.org

APPENDIX H

Installation History at Each Study Center

The following tables present installation-related information for each of the six study centers by year and month of the program. It is important to note that there were no formal requirements for the collection of most of the data in the tables. With that in mind, each center established its own process for the collection of the data and not all of the data are available from all of the study centers. That said, each of the tables in the appendix contains columns with the following information:

Year and Month—Self explanatory

- Appointments Scheduled—The number of all installation-related appointments scheduled during the subject month. Ideally this number should include appointments in which participants arrived and had successful DAS equipment installations performed, appointments in which the participant was a no-show or cancelled, and appointments in which participants arrived and had their vehicle rejected for installation.
- # Installed—Number of installations performed. Ideally this should include DAS equipment installations into the vehicles of new participants as well as reinstallation of equipment into the vehicles of existing participants. The latter

- event occurred most often when an existing participant acquired a new car and wished to continue to be a part of the program.
- Number of Cancellations & No-Shows—Number of times a potential participant cancelled a previously established installation appointment or did not show up for an appointment.
- **Number of Vehicles Rejected at Site**—Number of times potential participants showed up for an installation appointment but had their vehicle rejected for installation.
- % of Cancellations & No-Shows (Month)—Percentage of all appointments made for installations during the subject month that resulted in cancellations or potential participant no-shows.
- % of Appointments with Vehicles Rejected—Percentage of all appointments made for installations during the subject month that resulted in the rejection of the potential vehicle.
- % of Cancellations & No-Shows (Program to Date)— Cumulative percentage of appointments made for installations that resulted in program-to-date cancellations or potential participant no-shows.

Table H.1. Installation Appointment Statistics for Bloomington (Indiana)

Year	Month	Bloomington Appointments Scheduled	# Installed	Number of Cancellations and No-Shows	Number of Vehicles Rejected at Site	% of Cancellations and No-Shows (By Month)	% of Appointments with Vehicles Rejected	% of Cancellations and No-Shows (Program to Date)
2010	October							
	November							
	December							
2011	January	7	1	3	3	42.86%	42.86%	42.86%
	February	21	8	12	1	57.14%	4.76%	53.57%
	March	30	11	17	2	56.67%	6.67%	55.17%
	April	28	14	13	1	46.43%	3.57%	52.33%
	May	25	14	11	0	44.00%	0.00%	50.45%
	June	29	12	16	1	55.17%	3.45%	51.43%
	July	21	15	5	1	23.81%	4.76%	47.83%
	August	30	17	11	2	36.67%	6.67%	46.07%
	September	24	19	4	1	16.67%	4.1%	42.79%
	October	29	14	10	0	34.48%	0.00%	41.80%
	November	30	15	13	2	43.33%	6.67%	41.97%
	December	16	10	5	1	31.25%	6.25%	41.38%
2012	January	6	4	1	1	16.67%	16.67%	4.88%
	February	9	8	0	1	0.00%	11.11%	39.67%
	March	20	14	6	0	30.00%	0.00%	39.08%
	April	8	4	4	0	50.00%	0.00%	39.34%
	May	12	8	4	0	33.33%	0.00%	39.13%
	June	8	5	1	2	12.50%	25.00%	38.53%
	July	10	6	4	0	40.00%	0.00%	38.57%
	August	14	3	9	2	64.29%	14.29%	39.52%
	September	19	8	6	5	31.58%	26.32%	39.14%
	October	9	3	3	3	33.33%	33.33%	39.01%
	November	14	6	5	3	35.71%	21.43%	38.90%
	December	6	4	1	0	16.67%	0.00%	38.59%
2013	January	4	3	1	0	25.00%	0.00%	38.46%
	February	3	2	1	0	33.33%	0.00%	38.43%
	March	1	1	0	0	0.00%	0.00%	38.34%
	April	7	5	2	0	28.57%	0.00%	38.18%
	May	12	9	0	3	0.00%	25.00%	37.17%
	June	0	0	0	0	0.00%	0.00%	37.17%
	July	6	5	0	1	0.00%	16.67%	36.68%
	August	0	0	0	0	0.00%	0.00%	36.68%
	September	0	0	0	0	0.00%	0.00%	36.68%
	Totals	458	248	168	36			

Table H.2. Installation Appointment Statistics for Buffalo (New York)

Year	Month	Buffalo Appointments Scheduled	# Installed	Number of Cancellations and No-Shows	Number of Vehicles Rejected at Site	% of Cancellations and No-Shows (By Month)	% of Appointments with Vehicles Rejected	% of Cancellations and No-Shows (Program to Date)
2010	October	7	4	2	1	33.3%	14.3%	33.3%
	November	17	11	4	3	23.5%	17.6%	26.1%
	December	21	14	2	6	9.5%	28.6%	18.2%
2011	January	21	13	2	6	9.5%	28.6%	15.4%
	February	12	7	5	0	41.7%	0.0%	19.5%
	March	20	16	4	0	20.0%	0.0%	19.6%
	April	32	27	4	1	12.5%	3.1%	17.8%
	May	17	14	2	1	11.8%	5.9%	17.1%
	June	10	10	0	0	0.0%	0.0%	16.0%
	July	23	20	1	2	4.3%	8.7%	14.5%
	August	37	30	7	1	18.9%	2.7%	15.3%
	September	54	47	6	1	11.1%	1.9%	14.4%
	October	51	35	16	0	31.4%	0.0%	17.1%
	November	46	39	7	0	15.2%	0.0%	16.9%
	December	62	47	16	0	25.8%	0.0%	18.2%
2012	January	64	34	26	4	40.6%	6.3%	21.1%
	February	55	24	28	4	50.9%	7.3%	24.1%
	March	88	67	20	1	22.7%	1.1%	23.9%
	April	16	15	2	2	12.5%	12.5%	23.6%
	May	20	14	6	1	30.0%	5.0%	23.8%
	June	21	16	7	2	33.3%	9.5%	24.1%
	July	31	17	14	1	45.2%	3.2%	25.0%
	August	32	27	4	2	12.5%	6.3%	24.5%
	September	29	21	8	1	27.6%	3.4%	24.6%
	October	35	26	6	2	17.1%	5.7%	24.3%
	November	56	32	10	3	17.9%	5.4%	23.9%
	December	35	26	8	2	22.9%	5.7%	23.8%
2013	January	55	51	8	0	14.5%	0.0%	23.3%
	February	21	24	2	2	9.5%	9.5%	23.0%
	March	12	16	1	0	8.3%	0.0%	22.8%
	April	2	6	2	0	100.0%	0.0%	23.0%
	May	12	13	1	0	8.3%	0.0%	22.8%
	June	10	15	1	0	10.0%	0.0%	22.7%
	July	4	4	2	0	50.0%	0.0%	22.8%
	August							
	September							
	Totals	1,028	782	234	49			

Table H.3. Installation Appointment Statistics for Durham (North Carolina)

Year	Month	Durham Appointments Scheduled	# Installed	Number of Cancellations and No-Shows	Number of Vehicles Rejected at Site	% of Cancellations and No-Shows (By Month)	% of Appointments with Vehicles Rejected	% of Cancellations and No-Shows (Program to Date)
2010	October							
	November	8	8	0	0	0.0%	0.0%	0.0%
	December	5	5	0	0	0.0%	0.0%	0.0%
2011	January	33	21	8	0	24.2%	0.0%	17.4%
	February	44	21	15	1	34.1%	2.3%	25.6%
	March	30	20	10	1	33.3%	3.3%	27.5%
	April	16	21	8	2	50.0%	12.5%	30.1%
	May	37	12	11	4	29.7%	10.8%	30.1%
	June	32	29	10	1	31.3%	3.1%	30.2%
	July	45	30	10	0	22.2%	0.0%	28.8%
	August	57	31	34	0	59.6%	0.0%	34.5%
	September	30	28	9	1	30.0%	3.3%	34.1%
	October	15	11	4	0	26.7%	0.0%	33.8%
	November	42	22	10	1	23.8%	2.4%	32.7%
	December	48	33	14	5	29.2%	10.4%	32.4%
2012	January	36	29	6	0	16.7%	0.0%	31.2%
	February	43	27	8	3	18.6%	7.0%	30.1%
	March	22	9	3	6	13.6%	27.3%	29.5%
	April	14	16	2	1	14.3%	7.1%	29.1%
	May	18	14	2	2	11.1%	11.1%	28.5%
	June	11	7	2	4	18.2%	36.4%	28.3%
	July	17	15	2	3	11.8%	17.6%	27.9%
	August	18	8	3	4	16.7%	22.2%	27.5%
	September	16	6	3	7	18.8%	43.8%	27.3%
	October	40	14	14	10	35.0%	25.0%	27.8%
	November	23	11	6	14	26.1%	60.9%	27.7%
	December	36	26	9	5	25.0%	13.9%	27.6%
2013	January	31	27	6	7	19.4%	22.6%	27.2%
	February	33	18	11	10	33.3%	30.3%	27.5%
	March	6	12	4	7	66.7%	116.7%	27.8%
	April	5	4	4	8	80.0%	160.0%	28.1%
	May	5	4	1	2	20.0%	40.0%	28.1%
	June	9	5	2	6	22.2%	66.7%	28.0%
	July	6	3	1	6	16.7%	100.0%	27.9%
	August							
	September							
	Totals	831	547	232	121			

Table H.4. Installation Appointment Statistics for Seattle (Washington)

Year	Month	Seattle Appointments Scheduled	# Installed	Number of Cancellations and No-Shows	Number of Vehicles Rejected at Site	% of Cancellations and No-Shows (By Month)	% of Appointments with Vehicles Rejected	% of Cancellations and No-Shows (Program to Date)
2010	October							
	November							
	December							
2011	January							
	February	3	3	0	0	0.0%	0.0%	0.0%
	March	16	10	5	1	31.3%	6.3%	26.3%
	April	38	24	12	2	31.6%	5.3%	29.8%
	May	36	22	12	2	33.3%	5.6%	31.2%
	June	56	39	17	0	30.4%	0.0%	30.9%
	July	73	46	27	0	37.0%	0.0%	32.9%
	August	48	36	11	1	22.9%	2.1%	31.1%
	September	45	32	13	0	28.9%	0.0%	30.8%
	October	36	28	8	0	22.2%	0.0%	29.9%
	November	34	27	7	0	20.6%	0.0%	29.1%
	December	36	24	10	2	27.8%	5.6%	29.0%
2012	January	65	44	20	1	30.8%	1.5%	29.2%
	February	47	35	11	1	23.4%	2.1%	28.7%
	March	35	22	12	1	34.3%	2.9%	29.0%
	April	57	34	18	5	31.6%	8.8%	29.3%
	May	48	29	18	1	37.5%	2.1%	29.9%
	June	43	30	13	0	30.2%	0.0%	29.9%
	July	56	29	24	3	42.9%	5.4%	30.8%
	August	45	27	16	2	35.6%	4.4%	31.1%
	September	43	32	9	2	20.9%	4.7%	30.6%
	October	62	37	23	2	37.1%	3.2%	31.0%
	November	42	21	19	2	45.2%	4.8%	31.6%
	December	15	12	3	0	20.0%	0.0%	31.5%
2013	January	37	21	12	4	32.4%	10.8%	31.5%
	February	36	21	12	3	33.3%	8.3%	31.6%
	March	32	17	13	2	40.6%	6.3%	31.8%
	April	11	7	4	0	36.4%	0.0%	31.9%
	May	11	6	4	1	36.4%	9.1%	31.9%
	June	15	13	2	0	13.3%	0.0%	31.7%
	July	19	10	7	2	36.8%	10.5%	31.8%
	August	1	1	0	0	0.0%	0.0%	31.7%
	September							
	Totals	1,141	739	362	40			

Table H.5. Installation Appointment Statistics for State College (Pennsylvania)

Year	Month	State College Appointments Scheduled	# Installed	Number of Cancellations and No-Shows	Number of Vehicles Rejected at Site	% of Cancellations and No-Shows (By Month)	% of Appointments with Vehicles Rejected	% of Cancellations and No-Shows (Program to Date)
2010	October							
	November							
	December							
2011	January							
	February	10	6	2	2	20.0%	20.0%	20.0%
	March	20	9	8	3	40.0%	15.0%	33.3%
	April	19	16	3	0	15.8%	0.0%	26.5%
	May	16	11	4	1	25.0%	6.3%	26.2%
	June	30	21	8	1	26.7%	3.3%	26.3%
	July	22	16	6	0	27.3%	0.0%	26.5%
	August	29	21	8	0	27.6%	0.0%	26.7%
	September	13	11	2	0	15.4%	0.0%	25.8%
	October	16	16	0	0	0.0%	0.0%	23.4%
	November	9	8	1	0	11.1%	0.0%	22.8%
	December	11	11	0	0	0.0%	0.0%	21.5%
2012	January	13	12	1	0	7.7%	0.0%	20.7%
	February	10	8	1	1	10.0%	10.0%	20.2%
	March	9	9	0	0	0.0%	0.0%	19.4%
	April	9	6	3	0	33.3%	0.0%	19.9%
	May	15	12	3	0	20.0%	0.0%	19.9%
	June	8	6	2	0	25.0%	0.0%	20.1%
	July	15	10	5	0	33.3%	0.0%	20.8%
	August	15	10	5	0	33.3%	0.0%	21.5%
	September	11	4	7	0	63.6%	0.0%	23.0%
	October	26	17	9	0	34.6%	0.0%	23.9%
	November	17	12	5	0	29.4%	0.0%	24.2%
	December	12	8	2	2	16.7%	16.7%	23.9%
2013	January	12	11	1	0	8.3%	0.0%	23.4%
	February	19	12	6	1	31.6%	5.3%	23.8%
	March	14	8	5	1	35.7%	7.1%	24.3%
	April	6	3	3	0	50.0%	0.0%	24.6%
	May	11	8	2	1	18.2%	9.1%	24.5%
	June	5	5	0	0	0.0%	0.0%	24.2%
	July	6	6	0	0	0.0%	0.0%	23.8%
	August	1	1	0	0	0.0%	0.0%	23.8%
	September							
	Totals	429	314	102	13			

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Table H.6. Installation Appointment Statistics for Tampa (Florida)

Year	Month	Tampa Appointments Scheduled	# Installed	Number of Cancellations and No-Shows	Number of Vehicles Rejected at Site	% of Cancellations and No-Shows (By Month)	% of Appointments with Vehicles Rejected	% of Cancellations and No-Shows (Program to Date)
2010	October							
	November	8	6	1	1	12.5%	12.5%	12.50%
	December	10	8	1	1	10.0%	10.0%	11.11%
2011	January	3	2	1	0	33.3%	0.0%	14.29%
	February	8	7	1	0	12.5%	0.0%	13.79%
	March	21	19	2	0	9.5%	0.0%	12.00%
	April	36	28	5	3	13.9%	8.3%	12.79%
	May	29	20	7	2	24.1%	6.9%	15.65%
	June	22	17	5	0	22.7%	0.0%	16.79%
	July	37	29	7	1	18.9%	2.7%	17.24%
	August	76	57	18	1	23.7%	1.3%	19.20%
	September	75	55	18	1	24.0%	1.3%	20.31%
	October	43	32	10	1	23.3%	2.3%	20.65%
	November	53	34	19	0	35.8%	0.0%	22.57%
	December	63	40	21	2	33.3%	3.2%	23.97%
2012	January	74	45	26	3	35.1%	4.1%	25.45%
	February	55	35	20	0	36.4%	0.0%	26.43%
	March	86	60	23	3	26.7%	3.5%	26.47%
	April	27	18	9	0	33.3%	0.0%	26.72%
	May	26	21	3	0	11.5%	0.0%	26.20%
	June	39	24	12	1	30.8%	2.6%	26.42%
	July	23	18	4	0	17.4%	0.0%	26.17%
	August	40	19	21	0	52.5%	0.0%	27.40%
	September	64	42	19	3	29.7%	4.7%	27.56%
	October	58	30	22	6	37.9%	10.3%	28.18%
	November	50	30	13	7	26.0%	14.0%	28.07%
	December	31	14	14	2	45.2%	6.5%	28.57%
2013	January	62	36	20	5	32.3%	8.1%	28.78%
	February	51	25	20	3	39.2%	5.9%	29.23%
	March	30	21	8	0	26.7%	0.0%	29.17%
	April	9	7	2	0	22.2%	0.0%	29.11%
	May	22	18	2	2	9.1%	9.1%	28.76%
	June	10	7	2	0	20.0%	0.0%	28.69%
	July	14	7	2	1	14.3%	7.1%	28.53%
	August							
	September							
	Totals	1,255	831	358	49			

APPENDIX I

Number of Instrumented Vehicles in the Field as a Function of Time at Each Study Center

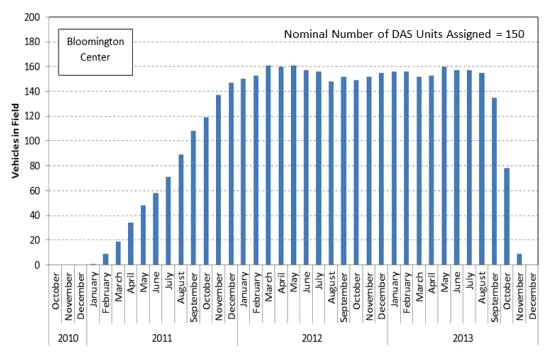


Figure I.1. Number of instrumented vehicles in the field as a function of time at the Bloomington center.

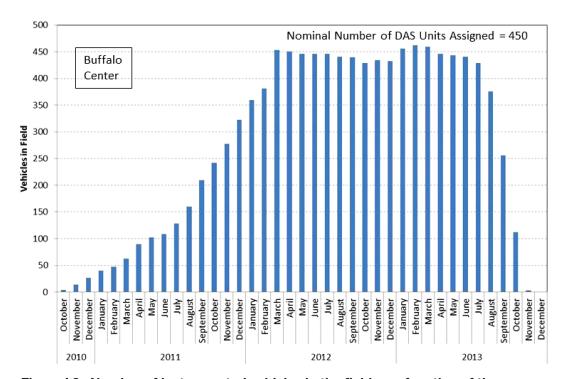


Figure I.2. Number of instrumented vehicles in the field as a function of time at the Buffalo center.

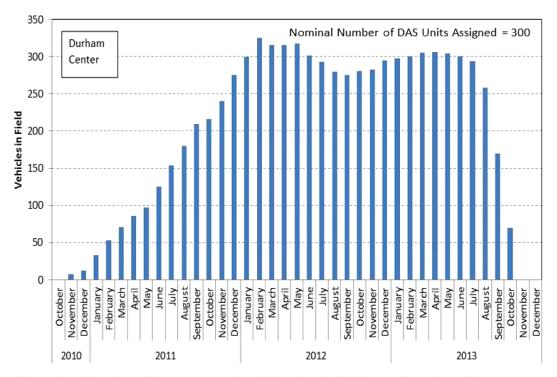


Figure I.3. Number of instrumented vehicles in the field as a function of time at the Durham center.

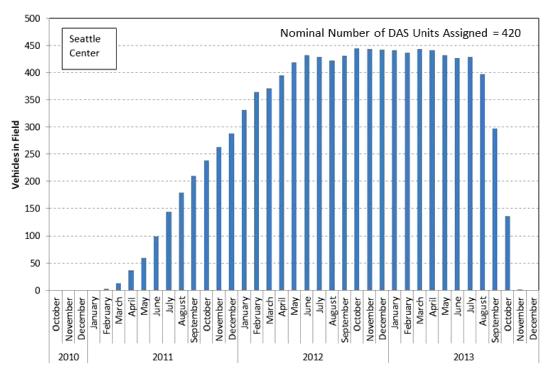


Figure I.4. Number of instrumented vehicles in the field as a function of time at the Seattle center.

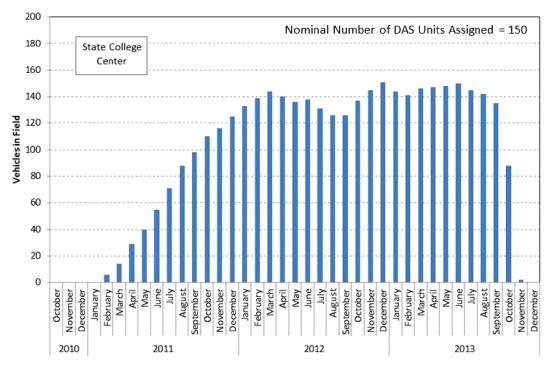


Figure I.5. Number of instrumented vehicles in the field as a function of time at the State College center.

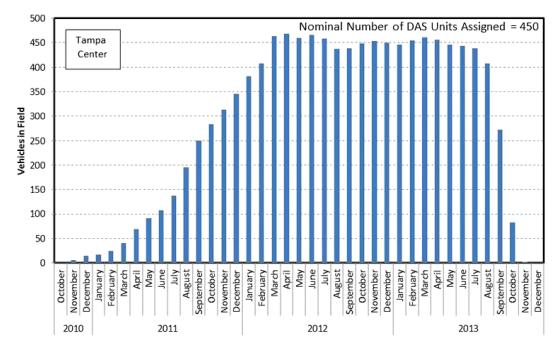


Figure I.6. Number of instrumented vehicles in the field as a function of time at the Tampa center.

APPENDIX J

Participant-Months in the Field for Six Study Centers

Table J.1. Distribution of Participant-Months in the Field by Study Center

Months in Study	Bloomington	Buffalo	Durham	Seattle	State College	Tampa	Total
>0	0	3	2	5	3	4	17
1	4	3	5	6	1	9	28
2	3	5	8	7	3	8	34
3	6	8	9	14	7	8	52
4	6	7	5	17	7	13	55
5	2	17	11	19	8	26	83
6	6	21	14	23	10	17	91
7	13	16	22	23	11	23	108
8	2	30	15	20	10	23	100
9	2	28	12	32	9	35	118
10	0	40	21	38	9	26	134
11	6	35	27	37	8	30	143
12	44	167	136	133	43	165	688
13	22	83	32	71	37	62	307
14	8	22	17	22	13	12	94
15	4	22	11	21	8	9	75
16	10	15	14	11	11	25	86
17	4	16	12	14	6	20	72
18	13	26	10	21	8	30	108
19	12	36	8	26	4	14	100
20	5	26	5	12	10	29	87
21	5	14	9	14	1	14	57
22	3	13	15	12	2	11	56
23	9	9	27	19	3	16	83
24	12	34	30	13	8	49	146
25	8	19	11	16	2	19	75
26	10	1	7	10	5	6	39

(continued on next page)

Table J.1. Distribution of Participant-Months in the Field by Study Center (continued)

Months in Study	Bloomington	Buffalo	Durham	Seattle	State College	Tampa	Total
27	4	1	7	16	6	1	35
28	10	7	1	18	4	10	50
29	7	3	2	18	7	5	42
30	5	2	6	7	1	4	25
31	6	6	12	0	6	6	36
32	1	0	3	0	2	4	10
33	2	4	0	0	2	0	8
34	0	0	0	0	0	0	0
35	0	0	3	0	0	1	4
36	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0
38	0	1	0	0	0	0	1
Total	254	740	529	715	275	734	3,247

Note: All participants with at least 1 day in study; total months in study = 46,866 months (3,905 participant-years).

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^{*} Membership as of January 2015.

^{*} Membership as of July 2014.

Related SHRP 2 Research

Naturalistic Driving Study: Development of the Roadway Information Database (S04A)

Design of the In-Vehicle Driving Behavior and Crash Risk Study (S05)

Naturalistic Driving Study: Technical Coordination and Quality Control (S06)

Analysis of Naturalistic Driving Study Data: Safer Glances, Driver Inattention, and Crash Risk (S08A)

Analysis of Naturalistic Driving Study Data: Offset Left-Turn Lanes (S08B)

Analysis of Naturalistic Driving Study Data: Roadway Departures on Rural Two-Lane Curves (S08D)

Naturalistic Driving Study: Descriptive Comparison of the Study Sample with National Data (S31)

Naturalistic Driving Study: Alcohol Sensor Performance (S31)

Naturalistic Driving Study: Linking the Study Data to the Roadway Information Database (S31)