

# The Canada Naturalistic Driving Study

The primary goals of the Canada Naturalistic Driving Study (CNDS) are to gain a greater understanding of the driver behaviour associated with crash occurrence, as well as how drivers interact with and adapt to the vehicle, roadway, traffic environment, weather, etc. Additionally, the data collected during the CNDS can be used to better understand the impact of roadway design and infrastructure on driver behaviour and crash/near-crash occurrence.

The CNDS was conducted at a Canadian site comparable to the U.S. sites that were part of the Second Strategic Highway Research Program's Naturalistic Driving Study (SHRP 2 NDS). The SHRP 2 NDS had six data collection sites across the U.S.—Buffalo, NY; State College, PA; Raleigh, NC; Tampa, FL; Bloomington, IN; and Seattle, WA. The CNDS and SHRP 2 NDS data collection protocols were similar in that consented participants in each completed similar questionnaires at the beginning of the study, had similar data acquisition systems (DASs) installed in their personal vehicles, and completed similar questionnaires at the end of the study. Data were collected for between 12 and 24 months for both studies. For a summary of the SHRP 2 NDS, please use the following link: [https://insight.shrp2nds.us/documents/shrp2\\_background.pdf](https://insight.shrp2nds.us/documents/shrp2_background.pdf).

The power of naturalistic driving studies lies within the data made available by the continuous video collected during real-world driving situations. During the CNDS, in-car cameras recorded views of the driver's face, over the driver's shoulder, and both the forward and rear roadways in order to understand how driver behaviour may contribute to or neutralize the impact of a conflict both before and during a safety critical event (e.g., crash). A broader understanding of driver behaviour during these events will improve the ability to design vehicle safety systems that provide the most effective crash countermeasures.

## Participant Recruitment

All 149 participants were recruited from the city of Saskatoon in the Canadian province of Saskatchewan. Data were collected between June 2013 and October 2015. The majority of participants were recruited via letters sent by Saskatchewan Government Insurance (SGI) to drivers who owned vehicles newer than model year 2000 and who lived in postal codes in and around the Saskatoon area. Traditional recruitment methods (i.e., fliers, posters, and social media) were also used, primarily to target older or younger participants.

For all recruitment methods, any interested persons were asked to contact the CNDS office via a phone number provided in the recruitment material or to visit the CNDS website for further information about the study and to complete the initial screening forms. Eligible participants were then contacted by trained researchers to schedule a time at the CNDS office for completion of study participation consent forms, initial questionnaires, and to have their personal vehicle instrumented with the DAS.

## Data Collection Procedures

The length of data collection was staggered for this study—earlier participants were recruited to participate for 24 months; mid-recruitment participants were recruited to participate for 18 months; and later participants were recruited to participate for 12 months. Participants were compensated for their time C\$450 per 12-month period of data collection. This staggered approach allowed researchers to maximize the number of hours travelled for the duration of the study. At the end of the study,

researchers had recruited and collected data on 149 participants and collected over 53,000 vehicle hours travelled.

#### Consent procedure:

All eligible participants who were of appropriate age, held a valid driver’s licence, and had a suitable vehicle were accepted as study participants. Each participant signed an informed consent to participate in the study, per both Canadian Research Ethics Board and U.S. Institutional Review Board standards. All participants also agreed to have a DAS installed in their vehicle for the duration of the study.

#### Surveys, questionnaires and interviews:

Each participant also completed a battery of questionnaires and surveys that assessed risk perception, driving knowledge and habits, health and sleep hygiene, and personality factors. Standard vision, grip strength, and rapid walking tasks were also completed. Many of these questionnaires and surveys were available on-line, and could have been completed either at the participant’s home or at the CNDS study office. Completion of all assessments took approximately 2 to 3 hours.

#### Data Acquisition System (DAS)

The DAS that was used for the CNDS was similar to the system that was used for the SHRP 2 NDS. This system was designed and developed by the Virginia Tech Transportation Institute (VTTI). The DAS includes four continuous video channels, including a colour forward view camera, driver’s face, over-the-shoulder, and rear-view camera. The DAS also includes forward radar, multi-axis accelerometers, a machine vision-based lane tracker, global positioning system data (GPS) and a connection to the OBD2 port to collect vehicle speed, brake (on/off), and throttle position. The complete list of sensors is shown in Figure 1. A schematic of the DAS as it is installed in a vehicle is shown in Figure 2. The driver’s face camera and forward view cameras are located in the head unit, which is installed directly behind and slightly below the rear-view mirror (Figure 3). The accelerometers and passive alcohol sensor are also located in the head unit.

Data Acquisition System Channels		
<ul style="list-style-type: none"> <li>◆ Multiple videos</li> <li>◆ Machine vision               <ul style="list-style-type: none"> <li>– Eyes forward monitor</li> <li>– Lane tracker</li> </ul> </li> <li>◆ Accelerometer data (3 axis)</li> <li>◆ Rate sensors (3 axis)</li> <li>◆ GPS: latitude, longitude, elevation, time, velocity</li> <li>◆ Forward radar               <ul style="list-style-type: none"> <li>– X and Y positions</li> <li>– X and Y velocities</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>◆ Cell phone               <ul style="list-style-type: none"> <li>– Automatic collision notification, health checks, location notification</li> <li>– Health checks, remote upgrades</li> </ul> </li> <li>◆ Illuminance sensor</li> <li>◆ Infrared illumination</li> <li>◆ Passive alcohol sensor</li> <li>◆ Incident push button—audio (only on incident push button)</li> <li>◆ Turn signals</li> </ul>	<ul style="list-style-type: none"> <li>◆ Vehicle network data               <ul style="list-style-type: none"> <li>– Accelerator</li> <li>– Brake pedal activation</li> <li>– Automatic braking system</li> <li>– Gear position</li> <li>– Steering wheel angle</li> <li>– Speed</li> <li>– Horn</li> <li>– Seat belt information</li> <li>– Airbag deployment</li> <li>– Many more variables</li> </ul> </li> </ul>

Figure 1. Complete list of sensors in the DAS.

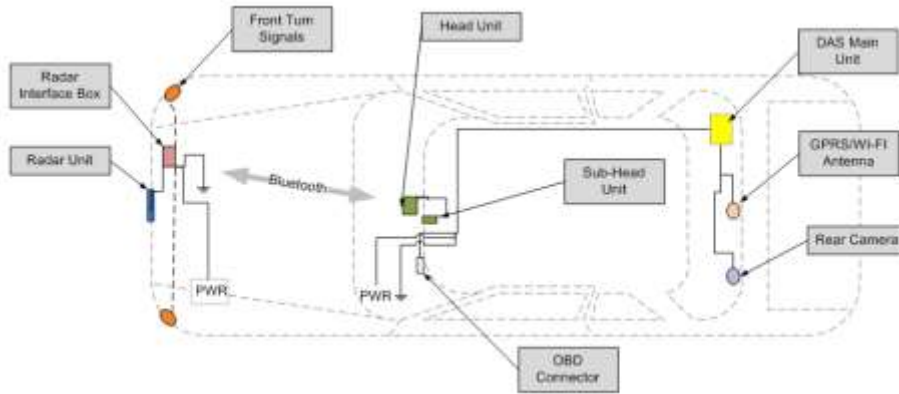


Figure 2. DAS Schematic view.



Figure 3. Picture of head unit installed behind rear-view mirror.



Figure 4. Picture of the main DAS unit, installed in the rear of the vehicle.

The hard drive is located in the DAS main unit (Figure 4). A rear-facing camera and Wi-Fi antenna are installed on the vehicle's back package shelf. The cellular capability is critical to controlling the quality of the data as it both provides "health checks" to VTTI and allows software updates to be broadly deployed to the instrumented vehicles.

The camera images are combined into a four-framed image as shown in Figure 5. The driver's face is in the upper left quadrant; the colour forward view is located in the upper right quadrant; the

over-the-shoulder view is in the lower left quadrant; and the rear view is in the lower right quadrant. A fifth camera was installed solely to save one or two frames of video every 10 minutes (Figure 6). This camera took a blurry picture of the entire interior cabin to allow for the assessment of passenger presence while, for privacy purposes, making it impossible to identify any passengers.



Figure 5. Quad image of driver (VTTI employee) face (upper left), colour forward view (upper right), over-the-shoulder (lower left), and rear view (lower right).



Figure 6. Blurred snapshot of the entire cabin.

For additional information regarding participants, vehicles, trips or events, the reader is encouraged to view the Data tab on [www.Insight.Canada-nds.net](http://www.Insight.Canada-nds.net).