

# 2016 CCMTA ANNUAL MEETING

HALIFAX, NOVA SCOTIA

## CONCURRENT SESSIONS

TOPIC:

# UPDATE ON THE CANADIAN NATURALISTIC DRIVING STUDY (CNDS)

PRESENTER:

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RESEARCH SCIENTIST AND LEADER, TEEN RISK AND INJURY PREVENTION GROUP,  
PRINCIPAL INVESTIGATOR AND PROJECT MANAGER, CANADA NATURALISTIC DRIVING STUDY,  
VIRGINIA TECH TRANSPORTATION INSTITUTE



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# Canada Naturalistic Driving Study: Transportation Research Possibilities

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CCMTA, Halifax, Nova Scotia

June 19, 2016



# Outline of Presentation

- Power of Naturalistic Driving Studies
- Description of Canada NDS
- Videos
- Reduction process
- Results
- Next steps-Canada Insight/InDepth
- Description of the Canada Truck NDS

# What are the advantages of Naturalistic Driving approach?

- More detailed driver behavior information in the seconds leading up to:
  - Incidents
  - Near crash
  - Crash
- Greater external validity
  - Information about driver behavior under normal day-to-day pressures
- Rich data set
  - Vehicle data
  - Driver data (demographic/questionnaire)
  - Video

# Teen Driving Research at VTTI

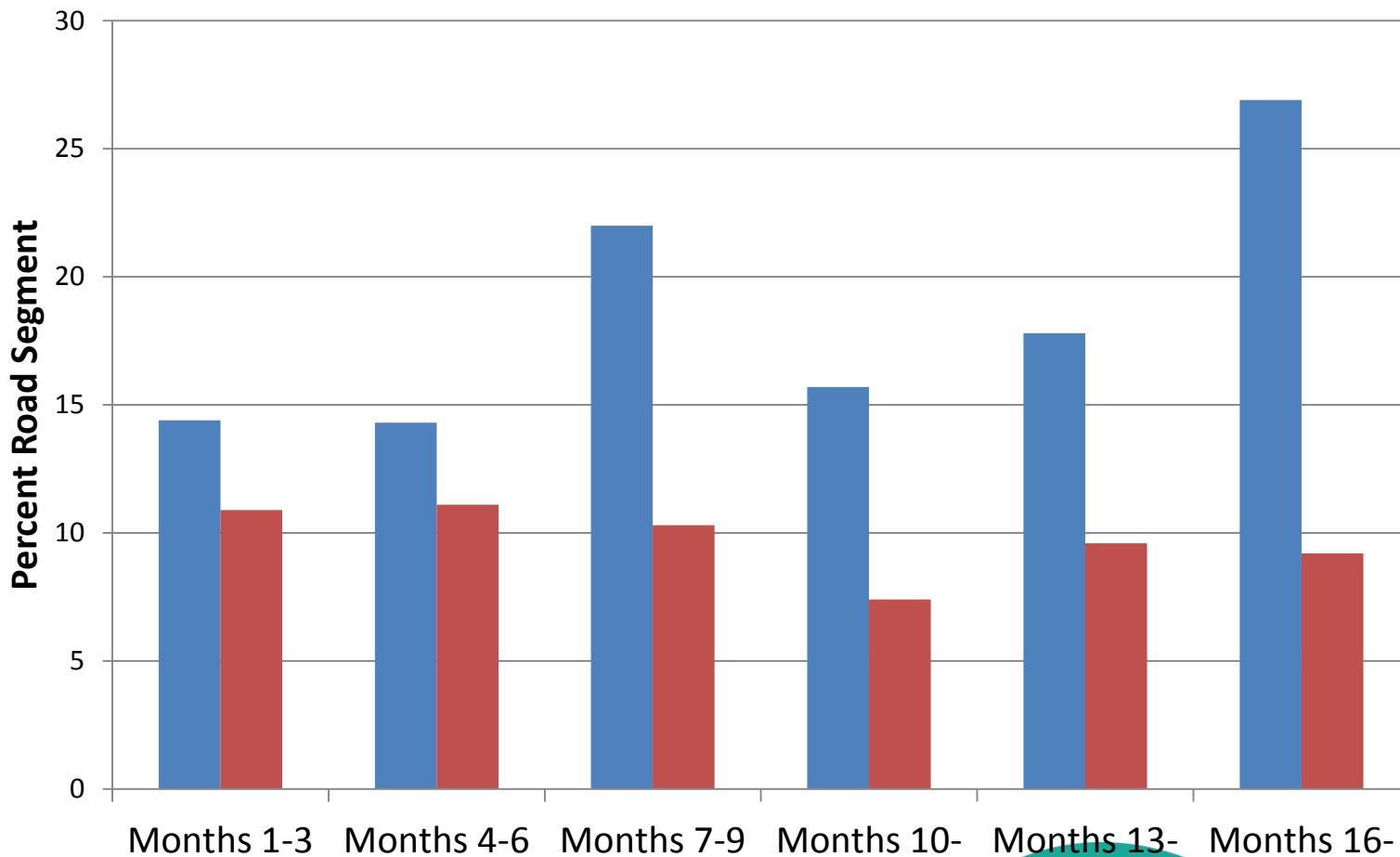
- **Naturalistic Teenage Driving Study** (Complete)
  - 42 Teens, from licensure through first 18 months of driving
- **Supervised Practice Driving Study** (In Process)
  - 90 Teens, from Learners Permit through first 6 months of independent driving
  - **Control Group**
- **Driver Coach Study** (2012)
  - 90 Teens, from Learners Permit through first 6 months of independent driving
  - **Feedback Group**

# Method

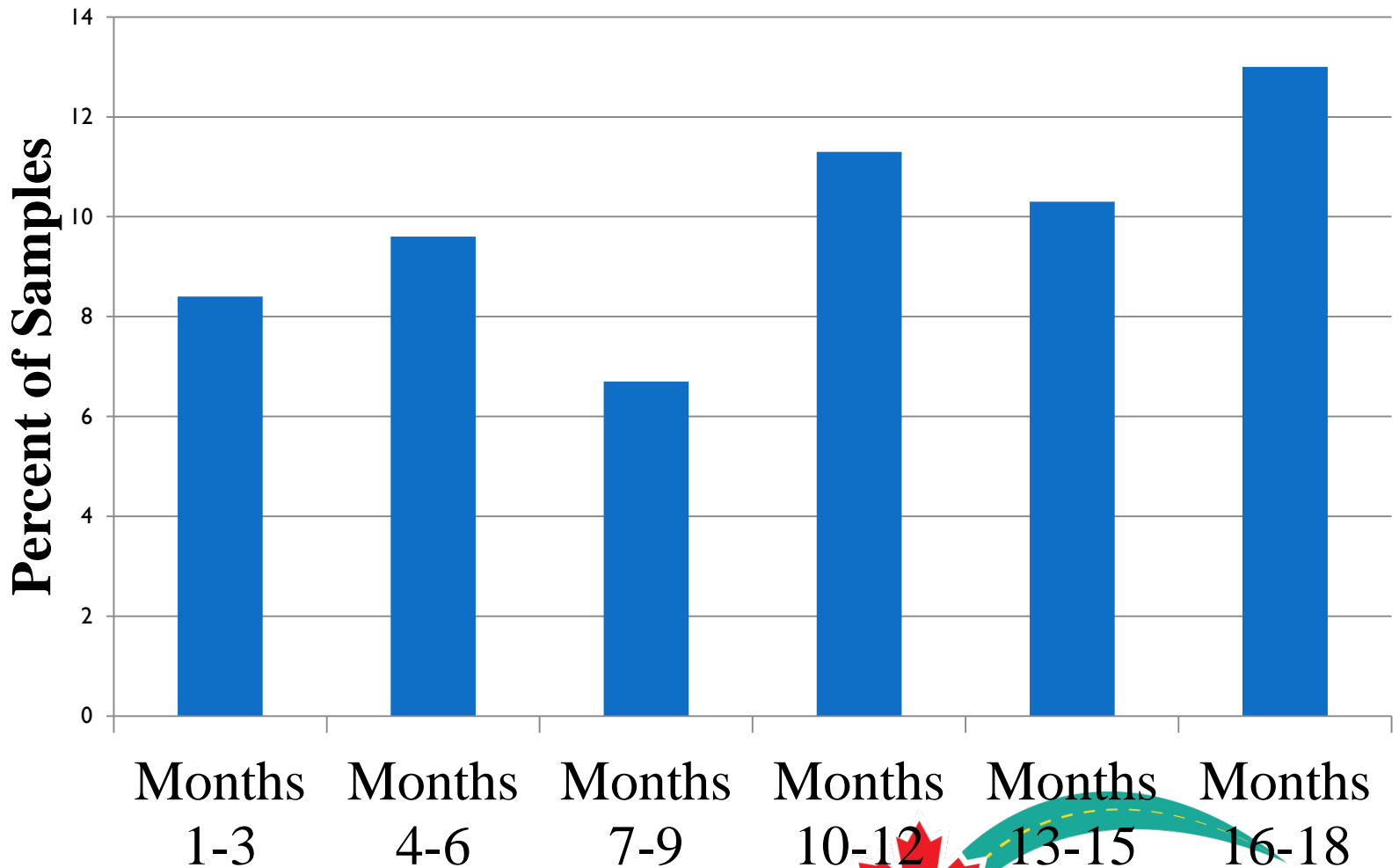
- Instrument 42 private vehicles with highly capable data collection systems
  - Collect continuous data beginning within 2 weeks of licensure and continuing for 18 months
    - 25 teens 'own' vehicle/17 teens share vehicle with parents
    - 50% male/50% female participants
  - Video, video snapshots, driving performance data, and questionnaire data

# The percent of road segments where teenage drivers were speeding greater than 10 mph.

■ Primary Vehicle Driver    ■ Shared Vehicle Driver



# Engaging in Secondary Tasks by Month Since Licensure





# Secondary Task Engagement and CNC (Random Effects Logistic Regression)

| Secondary Task                  | NTDS<br>(Novice Drivers) |          | 100-Car Study<br>(Experienced Drivers) |         |
|---------------------------------|--------------------------|----------|--|---------|
|                                 | OR                       | 95% CI   | OR                                     | 95% CI  |
| Phone -Texting                  | 4.3                      | 1.9/10.0 | n/a                                    | n/a     |
| Phone - Dialing                 | 7.8                      | 2.7/23.1 | 2.5                                    | 1.4/4.5 |
| Phone - Talking                 | 0.8                      | 0.4/1.5  | 0.7                                    | 0.5/1.1 |
| Phone - Reaching                | 4.7                      | 1.8/11.7 | 1.4                                    | 0.3/6.1 |
| Object (not phone) - reaching   | 7.8                      | 3.5/16.8 | 1.2                                    | 0.6/2.3 |
| Roadside Object - looking       | 3.7                      | 1.7/8.5  | 0.7                                    | 0.4-1.2 |
| Radio/HVAC – managing           | 1.4                      | 0.8/2.7  | 0.5                                    | 0.3/0.9 |
| Vehicle Operations - performing | 2.5                      | 0.9/7.3  | 0.6                                    | 0.2/2.7 |
| Eating                          | 3.3                      | 1.5/7.2  | 1.3                                    | 0.7/2.1 |
| Drinking (non-alcoholic)        | 1.3                      | 0.3/5.7  | 0.4                                    | 0.2/0.8 |

# NTDS Study Publications

- Klauer, S. G., Guo, F., Simons-Morton, B. G., Ouimet, M-C., Lee, S. E., and Dingus, T.A. (2014). Distracted Driving and Risk of Road Crashes among Novice and Experienced Drivers. ***The New England Journal of Medicine***, 370: 54-59.
- Guo, F., Simons-Morton, B. G., Klauer, S.G., Ouimet, M-C., Dingus, T.A., and Lee, S. E. (2013). Variability in Crash and Near-Crash Risk among Novice Teenage Drivers: A Naturalistic Study. ***The Journal of Pediatrics***, 163(6): 1670-1676.
- Ouimet, M-C., Brown, T. G., Guo, F., Klauer, S. G., Simons-Morton, B. G., Fang, Y., Lee, S. E., Gianoulakis, C., and Dingus, T.A. (2014, in press). Higher crash and near-crash rates in teenage drivers with lower cortisol reactivity: An 18-month longitudinal, naturalistic study. ***Journal of the American Medical Association, Pediatrics***. In Press.
- Klauer, Simons-Morton, Lee, Ouimet, Howard, & Dingus, (2011). Novice drivers' exposure to known risk factors during the first 18 months of licensure: The effect of vehicle ownership. ***Traffic Injury Prevention***.
- Lee, S. E., Simons-Morton, B. G., Klauer, S. G., Ouimet, M. C., and Dingus, T.A. (2011). Naturalistic Assessment of Novice Teenage Crash Experience. ***Accident Analysis and Prevention***.
- Simons-Morton, Ouimet, Klauer, Lee, Dingus, (2011) The Effect of Passengers and Risk-Taking Friends on Risky Driving and Crashes/Near Crashes Among Novice Teenagers. ***Journal of Adolescent Health***.
- Simons-Morton, Ouimet, Zhang, Klauer, Lee, & Dingus (2011). Risky Driving Among Novice Teenagers and Their Parents. ***American Journal of Public Health***.



# Canada Naturalistic Driving Study

Data collection site:  
Saskatoon, Saskatchewan

# CNDS Primary Research Questions

- What is the distribution of causal/contributing factors to crashes and near-crashes in Saskatchewan, Canada?
  - Rural highways
  - Winter conditions
- What is the prevalence of risky behaviors?
  - Of primary interest is speeding (per speed limit but also per roadway conditions), secondary task engagement, drowsiness, and impairment.

# CNDS Study Data collection

- 140 vehicles were instrumented
- Targeted 125 participants/Replaced some participants.
  - Participants were recruited for 24 months, 18 months, or 12 months
  - Data collection occurred from 6/2013-10/2015
- Recruited participants through SGI
  - SGI sent letters to target the population of interest
  - Participants were paid \$450 per year

# Light Vehicle Recruitment

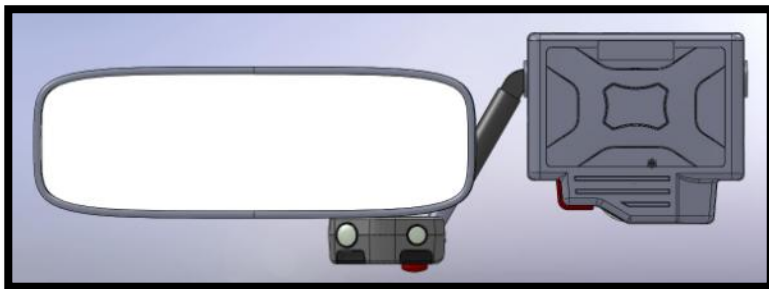
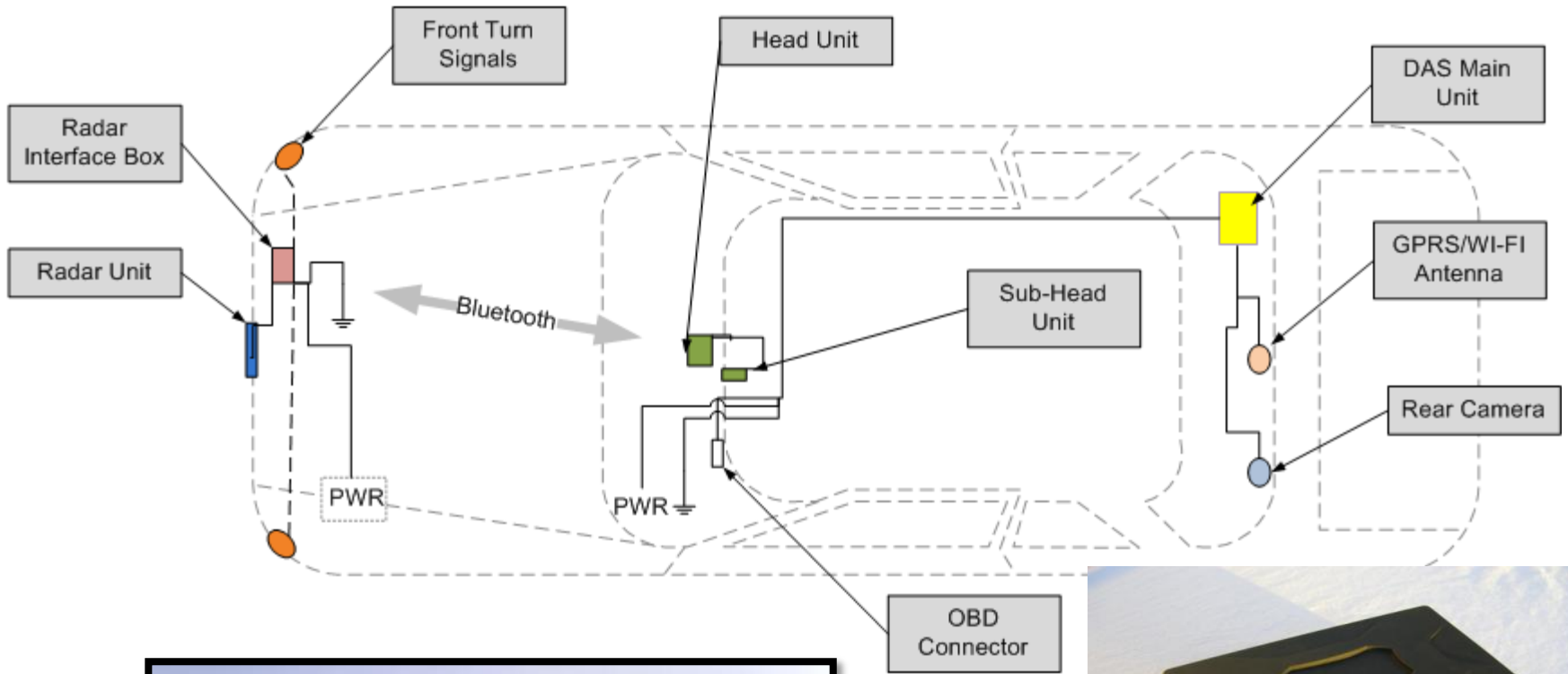
| Target Participant Numbers |           |        |           |        |         |        |
|----------------------------|-----------|--------|-----------|--------|---------|--------|
|                            | Age 18-25 |        | Age 26-65 |        | Age 66+ |        |
|                            | Male      | Female | Male      | Female | Male    | Female |
| High Mileage Commuter      | 9-10      | 9-10   | 12-16     | 12-16  | 9-10    | 9-10   |
| Low Mileage Commuter       | 7-9       | 6-9    | 12-15     | 12-15  | 7-9     | 6-9    |

| Study Participant Numbers |           |        |           |        |         |        |
|---------------------------|-----------|--------|-----------|--------|---------|--------|
|                           | Age 18-25 |        | Age 26-65 |        | Age 66+ |        |
|                           | Male      | Female | Male      | Female | Male    | Female |
| High Mileage Commuter     | 3         | 8      | 17        | 15     | 7       | 2      |
| Low Mileage Commuter      | 21        | 18     | 15        | 13     | 10      | 11     |

# Data Acquisition System

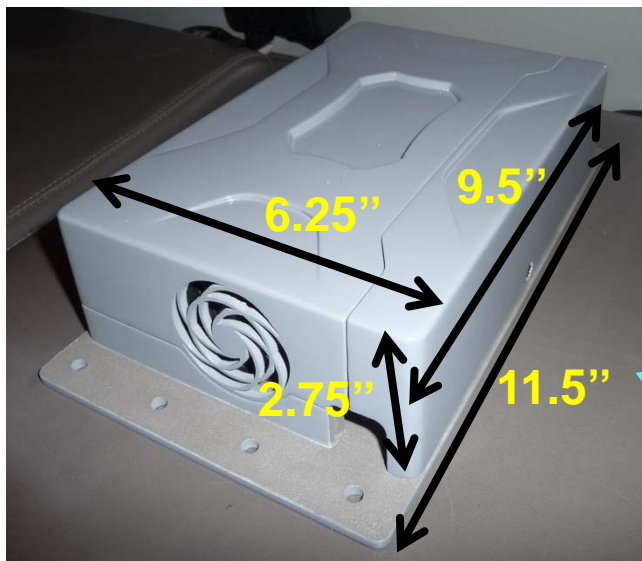
- Multiple Videos
  - Machine Vision Eyes Forward Monitor
  - Machine Vision Lane Tracker
- Accelerometer Data (3 axis)
- Rate Sensors (3 axis)
- GPS
  - Latitude, Longitude, Elevation, Time, Velocity
- Forward Radar
  - X and Y positions
  - Xdot and Ydot Velocities
- Cell Phone
  - ACN, health checks, location notification
  - Health checks, remote upgrades
- Illuminance sensor
- Passive alcohol sensor
- Incident push button
- Video
- Audio (only on incident push button)
- Turn signals
- Vehicle network data
  - Accelerator
  - Brake pedal activation
  - ABS
  - Gear position
  - Steering wheel angle
  - Speed
  - Seat Belt Information
  - Airbag deployment
  - etc

# NextGen Data Acquisition System





# DAS Photos



Head Unit



Main Unit

Front Radar Assembly



# Camera Image Samples

**Forward View - color**

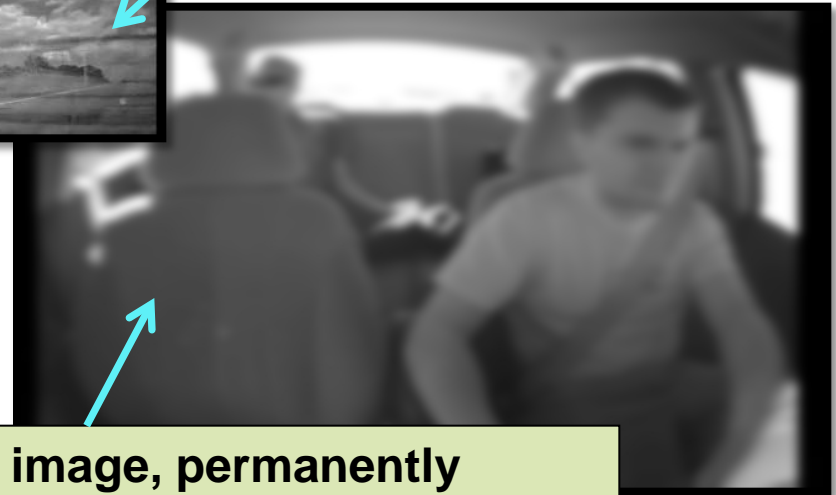
- 15 Hz continuous video
- 640x320 pixels

**Driver Face –  
Rotated for max  
pixel efficiency**



**Right-Rear View**

**Center stack –  
Pedal Interactions**



**Periodic still cabin image, permanently  
blurred for passenger anonymity**

# Canada NDS Study Status

- Data collection is complete
- Crash/near-crash and Baseline control segments have been coded
  - Eyeglance coding complete on CNC
  - Eyeglance coding is in process for Baseline control segments
- Working on preparing data for data sharing website

# General Study Stats: *Preliminary Results*

- 83 crashes and 301 near-crashes
- 1,904,813 vehicle kilometers traveled
- 53,718 vehicle hours traveled

# CNDS Data Reduction Effort

# Data Reduction (similar to SHRP 2 NDS)

- Driver ID by trip
- Crash/Near-Crash identification
- Crash/Near-Crash coding
  - Eyeglance
- Baseline coding
  - Eyeglance

# Driver ID by Trip

- In-house developed software
- Takes snapshots from face video at beginning and end of trip.
- Trained coder records driver id.
- SHRP2 NDS could code up to 800 trips per hour
- Non-consented drivers excluded from database

# CNC Process: Development of CNDS “Event” Database

- Events are identified based on “trigger” signatures from the electronic data that are indicative of the presence of a crash, near crash or conflict/incident event.
- Triggers include:
  - Radar-based time-to-collision
  - High lateral acceleration or yaw-rate change
  - Unplanned lane deviation
  - High longitudinal decelerations
  - High longitudinal decelerations with short time to collisions
  - Driver reported crashes



# Event Variables

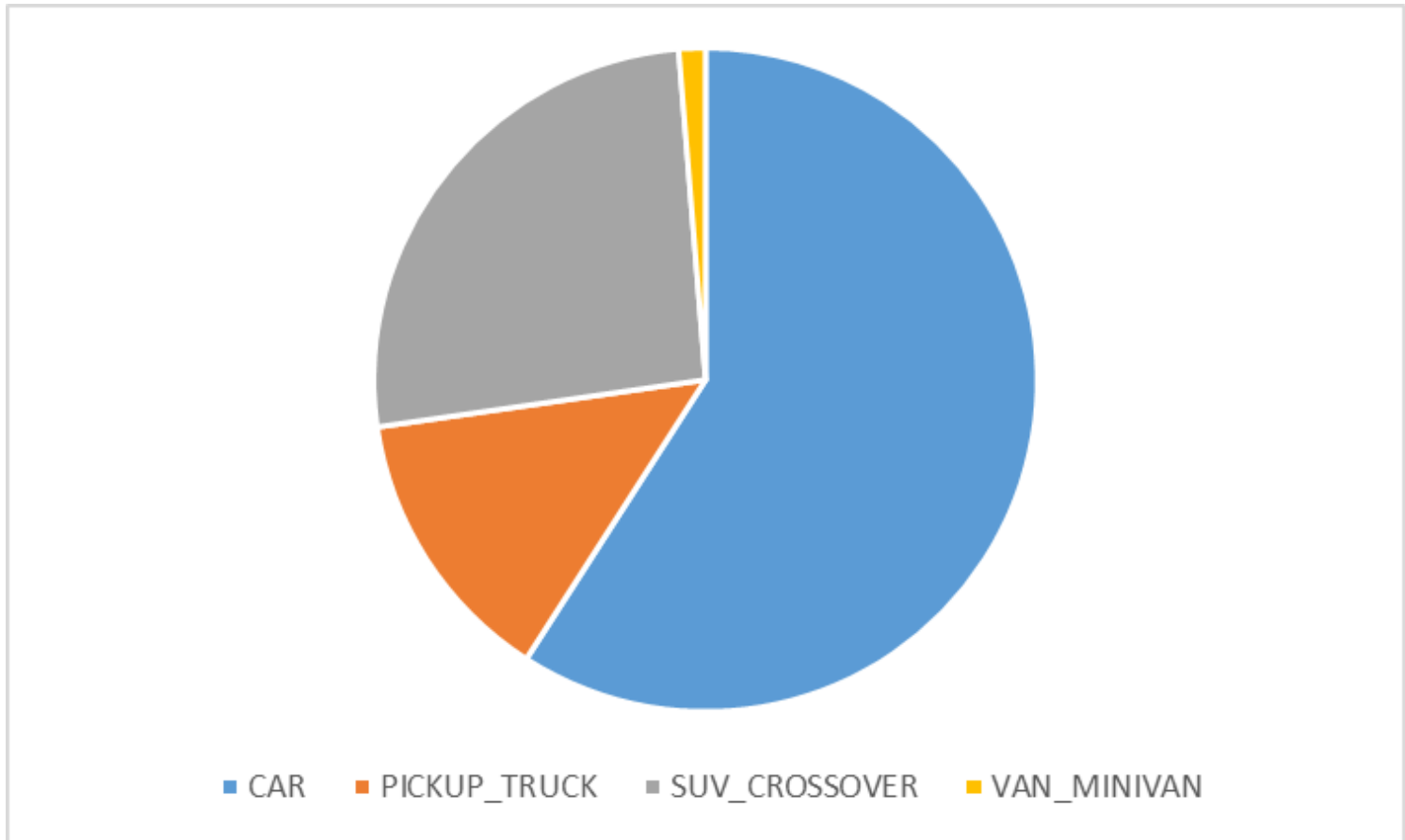
- Pre-Incident maneuver
- Crash/Incident type
- Precipitating factor
- Contributing factor(s)
- Evasive maneuver
- Roadway/Traffic variables
- Weather/Lighting
- Driver's state
  - Eye glance location
  - **Observer rating of drowsiness**
- Fault assignment
- Crash reconstruction
- Manual eyeglance for 20 seconds plus 10 s

# Baseline Variables

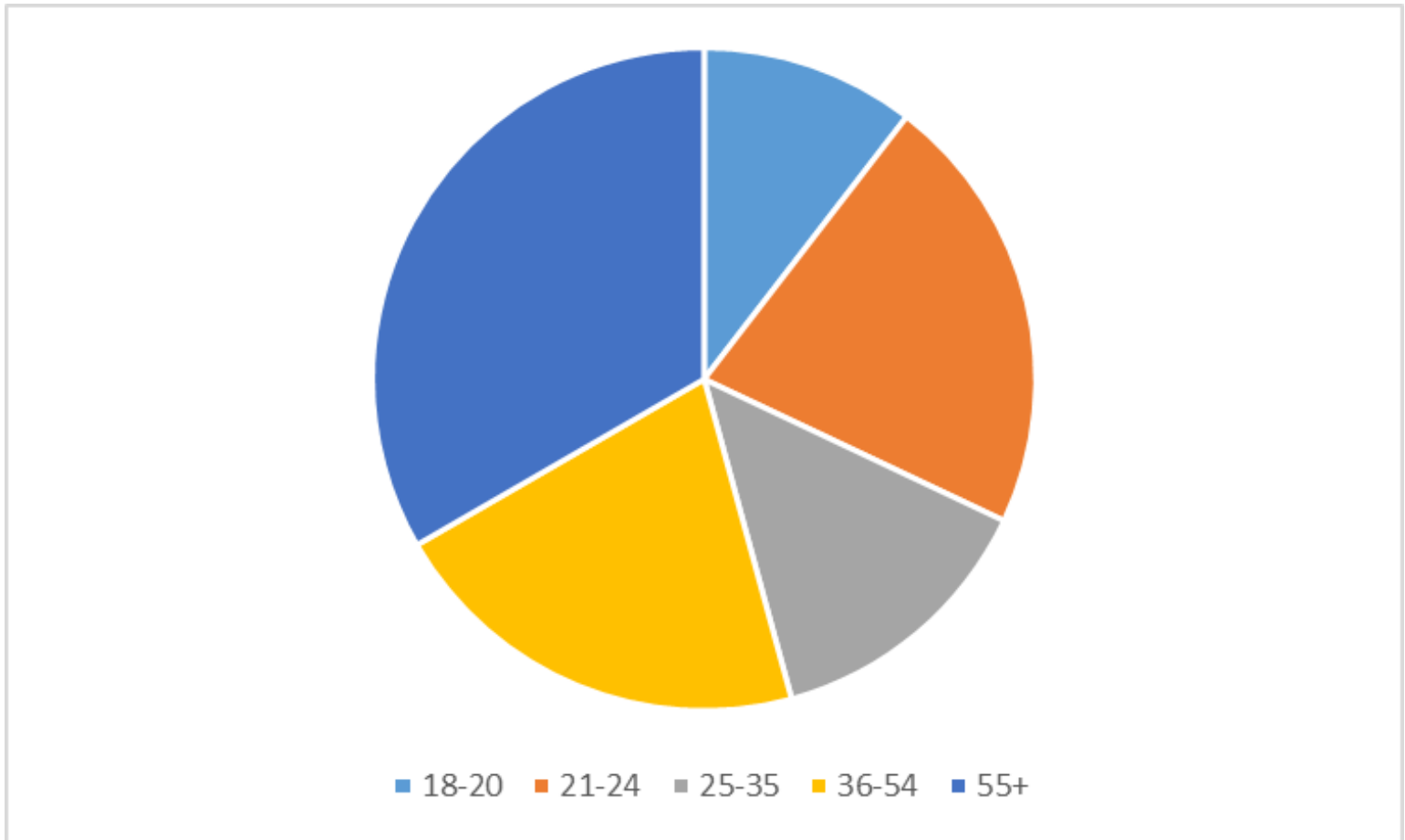
- Roadway/Traffic variables
- Weather/Lighting
- Driver's state
  - Eye glance location
  - Observer rating of drowsiness
- Manual eyeglance for 20 seconds

# Preliminary Results from Canada NDS

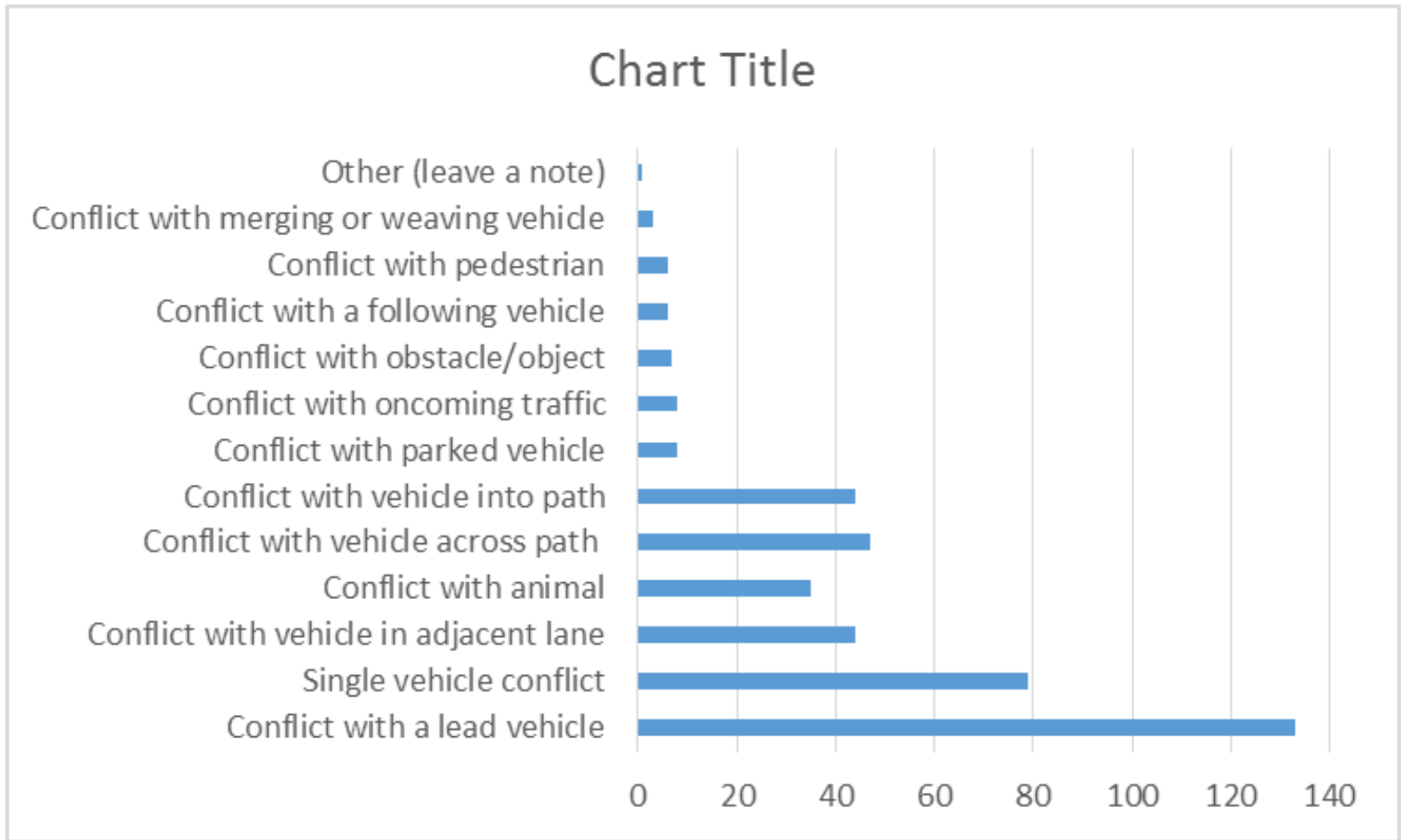
# Vehicle Description of Canada NDS



# Ages of Primary Participants

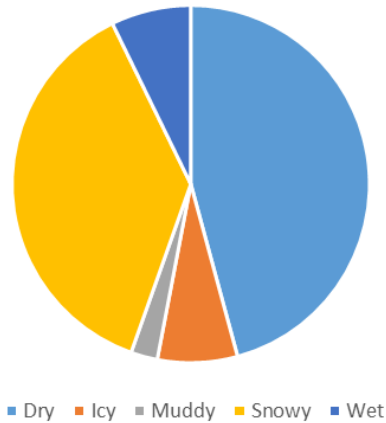


# Types of Crash/Near-Crash in Canada NDS

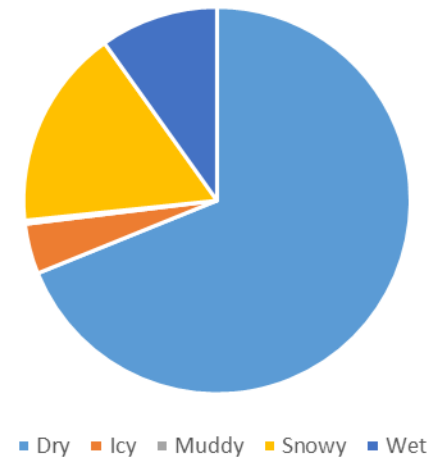


# Type of Road Surface Condition for Crashes and Near-Crashes

Road Surface Condition for Crashes Only



Road Surface Condition for Near-Crashes Only



# Next Steps

- Driver Behavior
  - Secondary task engagement
  - Drowsiness
  - Impairment
  - Other Risky Behavior
- Infrastructure
  - Many intersection crashes
  - Snowy/icy conditions
- **More NDS Data collection???**
  - 140 data acquisition systems are in storage in Canada





VTTI  
Driving Transportation with Technology

# Canada NDS Website

## Description of SHRP2 InSight Website

## Goals for the InSight Website

- Operate a public facing website to support data dissemination from the Canada naturalistic driving study (CNDS) project
  - Background information about the CNDS method and program
  - Interact with CNDS data and data administrators
  - Explore and query collected data based on research criteria
  - Interact with CNDS and SHPR2 NDS data...
  - Differentiate between InSight Data analysis or InDepth data analysis (data sharing agreement).

# What Can Users Do With the InSight Website?

- Review data collection procedures and project background  
How was this data collected?
- Explore data inventory, data dictionaries, and download sample data  
What variables are collected and how are they defined?
- Query for how many drivers, vehicles, or trips exist in the database that match various research criteria  
How much data is available that matches my research criteria?
- Review crash, near crash, and baseline events identified and classified during the study  
What were the details and context of the event?

# SHRP2 NDS InSight Website: <https://insight.shrp2nds.us/>

**InSight Data Access Website**  
SHRP2 Naturalistic Driving Study

[Learn More About SHRP2 NDS...](#)

**TRB** TRANSPORTATION RESEARCH BOARD  
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Password  
.....

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**What Is Available on This Website**

|   |   |
|---|---|
| Information describing the 3,400+ drivers and vehicles that participated in the naturalistic driving study. | 5,400,000+ Trip summary records that describe individual trips recorded during the study. |
| SHRP2 NDS status information including data collection and processing progress.                             | 36,000+ Crash, near crash, and baseline driving events. (More coming soon)                |
| Background information about the project and data being collected.  | Discussion forums for questions about the project and available data.                     |

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**What You Can Do on This Website**

- View Background information about the SHRP2 NDS.
- View detailed data collected from driver assessments, vehicles, trip summaries, and critical driving events.
- Query the database of detailed data, create cross tabulations, and assess NDS database content.

# Welcome to InSight

InSight provides access to data collected during the SHRP 2 Naturalistic Driving Study (NDS).

## What's Available on This Website

### [Driver Descriptions and Assessments](#)

Summary graphs and detailed records of driver assessments are provided addressing driver demographic background, physical, psychological, and medical condition.

### [Summary of Continuous Naturalistic Data Collected](#)

Graphs and detailed records describe data collection progress and characteristics of trips collected during the study.

### [Vehicle Descriptions](#)

Summary graphs and detailed records describe the types of vehicles involved in the study.

### [Custom Query Capability](#)

Build custom queries to search for records matching criteria that span multiple datasets.

### [Naturalistic Driving Study Background Information](#)

Access an overview of the SHRP 2 Naturalistic Driving Study project, data collection procedures, data dictionaries, and sample data.

### [Access to SHRP 2 NDS Forums](#)

Join a community of SHRP 2 NDS Forum members to discuss available data, website functionality, and related topics.

## What's New

9/10/2013 - New data released! New data include the Barkley's Quick Screen results and over 45,000 trip summaries.

7/8/2013 - SHRP 2 InSight forum website is now available for technical support and general discussion.

7/7/2013 - Query page expanded to include an initial crosstab table configuration tool.

[View More...](#)

## Build a Query or Select a Data Category to View

## Vehicles



View a collection of information about vehicles that were used to collect data in the SHRP 2 NDS.

- Vehicle types (car, truck, van, etc.)
- Vehicle ages and condition
- Amount of data collected per vehicle
- Quantities of vehicles installed
- Vehicle technologies and equipment

[View...](#)

## Trips



View a collection of information about trips collected and processed during the SHRP 2 NDS. Summary records can be used to screen for trips containing specific characteristics.

- Summary measures describing trips
- Trip length, duration, start time, stop time
- Min, Max, Mean for speed, acceleration
- Trip summary record table

[View...](#)

## Query Builder



Build and execute customized queries across multiple data tables, create cross tabulations, and view results.

- Select variables and conditions
- Submit query, assess results
- Build cross tabulations

[View...](#)

## Drivers



View a collection of information about drivers that participated in the SHRP 2 NDS.

- Quantities of drivers
- Amount of data collected per driver
- Driver demographics and driving history
- Driver physical and psychological state
- Driver participation experience

[View...](#)

## Crashes



View a collection of information about crash, near crash, and baseline events captured during SHRP 2 NDS.

- Crashes by severity
- Detailed crash assessment records
- Crash event viewer

[View...](#)

## Driver Data Selection

Click ▾ to show, or ▲ to hide, additional information about each data item.



Expand All Collapse All Reset

Search...



### ▲ How many drivers have participated in the study?

▾ Drivers by Age Group

View Graph

info

▾ Drivers by Age Group and Gender

View Graph

info

▾ Drivers Active and Completed

View Graph

info

▾ How much data has been collected from drivers, processed, and made available on this website?

▾ What are the demographic traits and driving history of participating drivers?

▾ What is the physical and psychological condition of participating drivers?

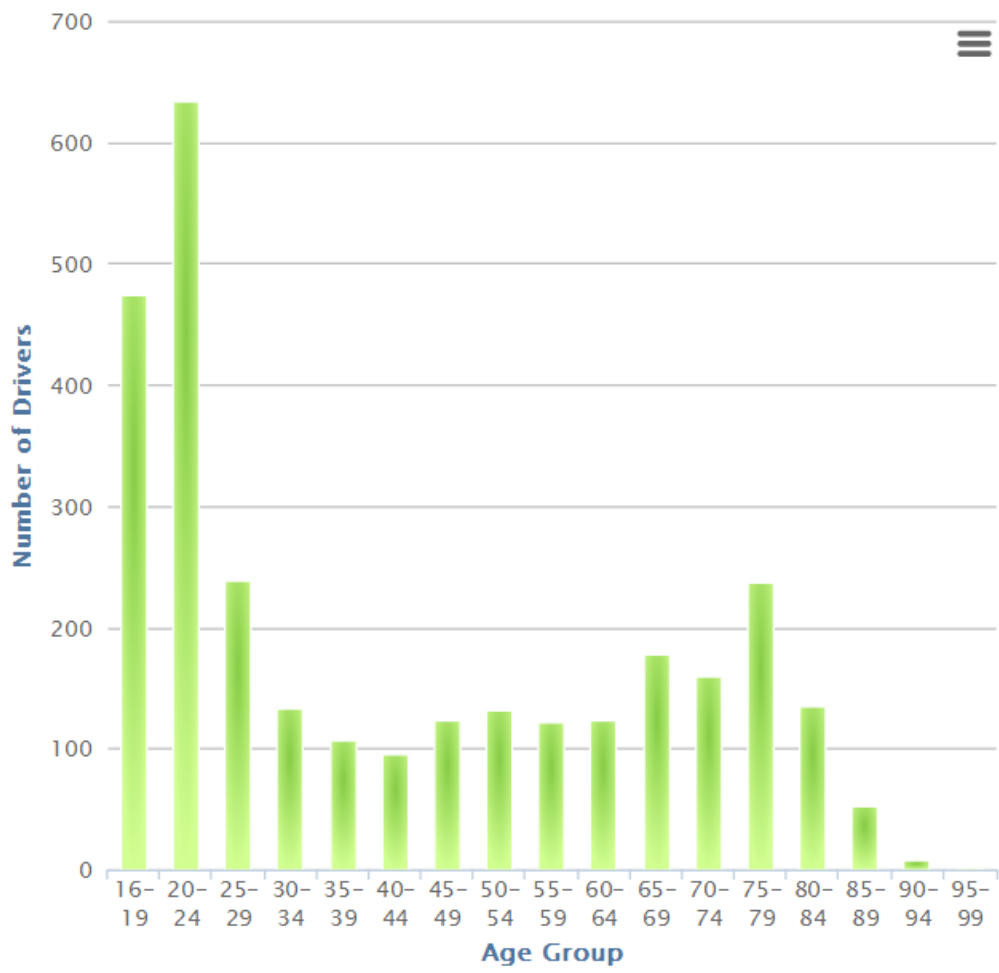
▾ What medical conditions and medications did driver report actually experiencing during the study?

▾ What was the driver's participation experience during the study?

# Drivers by Age Group

info

**Legend**  
(Click color to hide/show)  
■ All Sites



Data Collection Site Location

All Sites



# Accessing the NDS Data: Why we need Data Use Licensing

- Promises were made to participants and to the Research Ethics Board and Institutional Review Board overseeing the data collection
  - Additional use of data is subject to REB/IRB approval
  - Additional use of original data (whether identifying or not) requires a data use license
  - Identifying data (PII) can only be used in a secure data enclave
  - Only de-identified summary data can be readily shared
    - But this term is still not fully defined or vetted
- All original data must eventually be deleted so usage must be tracked

# Website Users

- Some original data can be viewed and queried from the website (cannot be downloaded because of tracking requirement)
- Need some minimal qualifications for users of original data on website
  - Proof of training in human subjects protection (REB training certificate, IRB training certificate)
- *Users* can only view background information about the study
- *Qualified researchers* can view and query all data available on the website
  - Have submitted a training certificate

# Other Data Users

- Those who want to hold a subset of the data locally or come to the secure data enclave to work with PII must submit a data use license application
  - Includes Purpose, Scope, and Data Specification (exactly which subset of the data do you need?)
  - Requires proof of REB/IRB approval (or proof of exemption)
  - Requires a data security plan (to ensure data will be held at the level of security promised to participants)
  - If there is a cost associated with extracting the data, the contract must be executed prior to the DUL (DUL is a license to use the data, does not mention money)

# Common Misunderstandings

- REB/IRB training certificate is proof of REB/IRB approval for a project
  - REB/IRB training certificates are issued to individuals upon completion of a course and do not confer approval for specific research projects
  - REB/IRB approval or proof of exemption is granted to a project (typically involving a group of researchers)
- Training certificate – issued to individual, used to become Qualified Researcher
- REB/IRB approval – issued to project, used to obtain data use license
- Data use license – agreement between institutions, not individuals (if a researcher moves to a new institution, they will need a new DUL to continue working with the data)

# Canada Naturalistic Truck Driving Study

Charlie Klauer, VTTI

# Project Status

- 25 trucks completed data collection
  - 25 participants (3 teams)
  - 2 females
  - 5 trucks with long routes (7-10 days on and 3-4 days off)
  - 2-3 double-trailer drivers
- Two minor crashes known to-date.

# Procedure

- Collect questionnaire/assessments on drivers
  - Based upon other commercial NDS studies
  - Driver logs
  - Driver abstracts
- Instrumented 25 trucks (with reinstrumentations)
  - Similar DAS as light vehicle study with cameras, radar, accelerometers, etc.
- Collect data for ~12 months = ~22 data years.



# Questions, Additions, or Concerns?



# CNDS Strengths

- Better view for distraction
  - Center stack
  - Driver
- Drowsiness coding
- Weather
- Cars and Heavy Trucks
- It is in Canada and Unique
- Roadway data???
- Possible enhancements to build strength
  - More detailed fatigue assessment could be added (obtain separate funding)
  - Canada specific baseline

*The Canada NDS was funded by the Council of Deputy Ministers Responsible for Transportation and Highway Safety and CCMTA*

Questions???