Human Factors: The Necessity of a User-Centred Approach for Automated Vehicles

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Overview

1. Canadian guidance documents to support Testing & Safety Assessments
2. HF Expert Assessment L2 testing program
3. Low Speed Automated Shuttles: Scenario Development & Standardization Initiatives
4. Low Speed Automated Shuttles: Human Factors Assessment
5. Final remarks
Guidance for the Safe Testing and Deployment for ADS

Documents available at: www.canada.ca/automatedvehicles
Human Factors Concerns

Usability
- Inattention, overload
- Training

Mode Confusion
- Human Fallback
- Miscalibrated trust

Driver Monitoring
- External HMI
- Remote operation

Assessment Procedures

Design Process Requirements

Expert Audit

Lab Testing

On Road Trials

Assessment Procedures
Human Factors Assessment of Interaction & Safety of L2 Vehicles

Transport Canada has been testing components of ADAS systems for ~ 20 years (Forward Collision Warning, ACC, AEB etc) conducted on test tracks.

Human Factors Assessments

- Driver interactions with currently available L2 systems
- In a single drive, a driver may experience several different driving experiences from home to work
- Must consider driver/vehicle/environment for each of these
- How is this experienced from the user’s perspective?
Human Factors L2 Assessments

Goal: Support the development of assessment & testing methods

Areas of Assessment:

- HMI
- Driver understanding & use of system functions
- Transitions: driver & system initiated
- Potential for misuse/mischief

On road assessments with HF experts

Multi-methods approach:

- Video & audio recordings for additional analyses, coding procedures
- Error analyses, check lists….

Work is ongoing
Low Speed Automated Driving Systems (LSAD) Testing in Ottawa

Develop and assess test procedures to evaluate the safe operation of LSAD around pedestrians and cyclists.

Build on ADAS test procedures and targets.

Capitalize on partners that have a vehicle and city-like test bed.

**PROCEDURES**
- Share results with LSAD standard ISO 22737
- Euro NCAP – AEB VRU Systems
- Low speed urban interaction between vehicles and cyclists/pedestrians

**SCENARIOS**
- 7 Collision path
- 2 False positive

**TARGETS**
- 50th percentile male dummy – 5 km/h
- 50th percentile male cyclist – 15 km/h
- 7 year old child dummy – 5 km/h
- Shuttle on a straight line – 7.2 km/h
- Shuttle turning manoeuver – 3.2 km/h
Test Environment Intersection Set Up
Equipment

The test vehicles where instrumented with **RT4002 Inertial GPS Navigation Systems and RT-Range from OxTS** to measure the vehicle:

- position and heading,
- vehicle speed and angular velocities (yaw, roll, and pitch rate),
- linear acceleration (longitudinal, lateral and vertical),
- distance to target and relative velocity.

- The accuracy of the GPS was augmented through the use of a portable GPS Base Station.

- Child
- Adult
- Cyclist

- Euro NCAP Pedestrian Targets paired with the Soft PedestrianTarget (SPT-20) system from ABD
**Example Dynamic Scenarios**

<table>
<thead>
<tr>
<th>VRU Scenario #1</th>
<th>VRU Scenario #2*</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{shuttle} = 3.6 \text{ km/h}$</td>
<td>$V_{shuttle} = 3.6 \text{ km/h}$</td>
</tr>
<tr>
<td>$V_{ped} = 5 \text{ km/h}$</td>
<td>$V_{ped} = 5 \text{ km/h}$</td>
</tr>
<tr>
<td>Impact zone = 50% front of shuttle</td>
<td>Impact zone = 75% front of shuttle (left corner)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VRU Scenario #3*</th>
<th>VRU Scenario #4**</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{shuttle} = 3.6 \text{ km/h}$</td>
<td>$V_{shuttle} = 7.2 \text{ km/h}$</td>
</tr>
<tr>
<td>$V_{ped} = 5 \text{ km/h}$</td>
<td>$V_{ped} = 5 \text{ km/h}$</td>
</tr>
<tr>
<td>Impact zone = 75% front of shuttle (right front)</td>
<td>Impact zone = 25% front of truck</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VRU Scenario #5a*** (obstructed) child</th>
<th>VRU Scenario #5b*** (unobstructed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{shuttle} = 7.2 \text{ km/h}$</td>
<td>$V_{shuttle} = 15 \text{ km/h}$</td>
</tr>
<tr>
<td>$V_{ped} = 5 \text{ km/h}$</td>
<td>$V_{ped} = 5 \text{ km/h}$</td>
</tr>
<tr>
<td>Impact zone = 75% front of truck, obstructed child</td>
<td>Impact zone = 75% front of truck</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VRU Scenario #5a &amp; 5b - cyclist</th>
<th>VRU Scenario 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{shuttle} = 7.2 \text{ km/h}$</td>
<td>$V_{shuttle} = 3.6 \text{ km/h}$</td>
</tr>
<tr>
<td>$V_{ped} = 5 \text{ km/h}$</td>
<td>$V_{ped} = 15 \text{ km/h}$</td>
</tr>
<tr>
<td>Impact zone = 50% front of truck, obstructed/unobstructed cyclist</td>
<td>Impact zone = Front right wheel</td>
</tr>
</tbody>
</table>

**Collision Data**

Based on vulnerable road user collision data (pedestrian and cyclists)

**EuroNCAP CPTA,**

turning walking adult. European New Car Assessment Program Test protocol AEB VRU system version 3.0.1

**ISO Low Speed Automated Driving 22737**

European New Car Assessment Program Test Protocol AEB VRU systems version 2.0.4 February 2019.

EuroNCAP CPLA-50 scenario, longitudinal walking adult.

EuroNCAP CPNC-50 scenario, running child from nearside from obstruction vehicles.

Non-occluded/occluded Hazardous situation (LSADr11.2).

This scenario can be scaled for the cyclist hazardous situation as well.
Preliminary Observations: LSAD work

• Variety of testing scenarios is valuable:
  • Important to use turning scenarios and occlusion of the pedestrians (behind a vehicle) to provide realistic challenges.

  ▪ Technical Challenges:
    ▪ Sensors (LIDAR) had issues during rain, which emphasizes the need to test under different weather conditions.
    ▪ Front of vehicle may need added protection to avoid damaging sensors (i.e., expect collisions).

NEXT STEPS:
  ▪ Analysis of test repeatability and stopping distances
Test Scenario Development Activities
Low Speed Automated Shuttles: Human Factors Considerations

- **User needs & expectations**
  - Comfort, **Safety**, Performance

- **Assistance/control in (un)expected situations**
  - Object in the road, operation failure…
  - Role of Remote Supervisor/operator

- **The larger traffic environment**
  - Interactions with other vehicles & humans

- 76 participants, closed route
Responses for Safety Items

What safety equipment did you notice on board?
- Seatbelts (.92; wanted 3 point)
  - Red emergency button (.30)
  - Door handles (.25)

What safety measures would you like to see on board?
- Obvious signage
- Emergency stop button, personal security alarm
- Emergency exit, windows that open
- Communication system during emergencies

Would it be acceptable to have passengers only?
- Yes, on a closed course (.80)
- But on Public roads wanted Remote or On-Board operator (.70)
Human Factors: Shuttle Evaluation

User needs & expectations:
- Safety is a primary concern
- Many needs previously met by the role of a bus driver; how will these needs be met on shuttles?
- Desire for assistance/ control possibly with a Remote Operator
  - Human Factors considerations for remote monitoring & operation
- User concerns impact trust, acceptance & willingness to use

Next Steps:
- Continue with analyses
- HF evaluations of other shuttles
Final Remarks…

- With automated vehicles, the focus is often on the new & exciting technologies.
- These new technologies and their functions are, of course, very important. They are changing the relationship between the human and the vehicle.
- But we must not neglect the human users in this new relationship.
  - Are these systems designed for human interaction?
  - Are they working as intended from a human user’s perspective?
  - Are they meeting users’ needs?
- These are essential requirements for safety and acceptance.
- There are tremendous benefits to be gained through coordinated efforts in research and the development of assessment methods to address these human factors needs.
Thank you for your attention

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