Introducing Advanced Driver Assistance Systems (ADAS) into drivers’ training and testing: The young learner drivers’ perspective

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Based on research by Anastasia Tsapi (Royal HaskoningDHV/TUDelft)

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• René Claesen, CBR
Introduction

Worldwide traffic Safety facts:

• 1.23 million road traffic deaths per year
• > 50 million injuries per year
• # 1 cause of death among those aged 15-29 years

Novice driver most related causes:

• Speed adaptation
• Hazard detection
• Road type recognition
• Giving right of way
Introduction

1. **ADAS:**
   Different levels of automation (warning-full control of vehicle) to:
   - **Mitigate human errors, reduce # of accidents**
   - Improve traffic flow
   - Protect the environment, but…
   - Different levels complexity
   - Limitations & Failures

2. **Training & Testing**
   - Needs of drivers
   - Technological developments
Problem Statement

What is the learner drivers’ perspective on the Blind Spot Detection (BSD) and Adaptive Cruise Control (ACC) systems and their introduction to drivers’ training and testing?
Methodology

Questionnaire development

- Driver Self-Image & Driver Stress Inventory
- ADAS related questionnaire

Data Analysis
(Descriptive Statistics, Factor Analysis, Statistical tests, like Pearson correlation, Friedman tests, MANOVA, etc.)

Focus on ADAS in T&T

In-depth personal Interviews

Literature review

Novice drivers' behaviour

Current T&T methods

BSD & ACC systems
# Methodology

## Literature findings

<table>
<thead>
<tr>
<th>Risk increasing factors</th>
<th>Novice drivers’ behaviour</th>
<th>Drivers’ training</th>
<th>ADAS (ACC, BSD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Visual information collection</td>
<td>□ Inability in higher order tasks (hazard recognition, impulse control)</td>
<td>□ Basic – 3 level task</td>
<td></td>
</tr>
<tr>
<td>□ Speed and headway adaptation</td>
<td>□ Willingness to take risks</td>
<td>□ GDE matrix – 4th level: “Goals for life and skills for living”</td>
<td></td>
</tr>
<tr>
<td>□ Hazard monitoring</td>
<td>□ Underestimation of risks-passengers’ influence</td>
<td>□ Advances in:</td>
<td></td>
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<tr>
<td></td>
<td>□ Slow eye scanning movements</td>
<td>• Pre –test practice structure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Fragmentary perception of events</td>
<td>• Quality in training</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Driving test</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Probationary periods</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>□ ACC &amp; BSD: radar systems preferred</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ ACC &amp; BSD: reduction fatalities up to 7%</td>
<td></td>
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</tbody>
</table>
| | | □ Concerns:
| | | • Overreliance |
| | | • Wrong expectations |
| | | □ Introduction to Training & Testing - GDE matrix |

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*How best to prepare young people to be safe and responsible drivers for now and for the future*

[www.ciecacongress2016.eu](http://www.ciecacongress2016.eu)  info@ciecacongress2016.eu
Methodology

Questionnaire Development-

Adaptive Cruise Control: https://www.youtube.com/watch?v=RDSZWFV7qFk

Blind Spot Detection System: https://www.youtube.com/watch?v=NfK9Rm2ShRw
Methodology
Questionnaire Development-Inventories

Participants: 40 learner & 48 experienced drivers

6. Please answer the following questions on the basis of your usual or typical feelings about driving. Indicate how strongly you agree or disagree with each of the following statements.

Does it worry you to drive in bad weather?

Blind Spot Detection (BSD) system VIDEO
At this point you are kindly asked to watch the following video which describes the Blind Spot Detection system.

26. Indicate how willing you are to use the Adaptive Cruise Control system in the following situations:

I am willing to use the system...

<table>
<thead>
<tr>
<th></th>
<th>strongly disagree</th>
<th>disagree</th>
<th>neither agree or disagree</th>
<th>agree</th>
<th>strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>...in urban...</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>...in rural...</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>...in highway...</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>highly congested...</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

27. Answer the following questions on the training and testing of the system.

It is important to learn about the system before using it

<table>
<thead>
<tr>
<th></th>
<th>strongly disagree</th>
<th>disagree</th>
<th>neither agree or disagree</th>
<th>agree</th>
<th>strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please explain why you agree or disagree.</td>
<td></td>
<td></td>
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<td></td>
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</tbody>
</table>
Methodology

In-depth Interviews

• Participants: 4 learner drivers (2 TU Delft students & 2 students from driving schools)
• Content: Introduction of BSD and ACC in training and testing (based on results of questionnaire analysis)
• Location: TU Delft, Skype

Examples of questions

1. Suppose that the BSD is part of the training and testing procedure. How would you like to be trained and tested on the BSD system?
2. If you could choose, with which sequence would you introduce the systems?
Methodology

Data Analysis
LEARNER DRIVERS' AWARENESS OF ACC SYSTEM

- **Before video**
  - Speed adaptation system: 20%
  - Speed + minimum headway adaptation system: 40%
  - Minimum headway adaptation system: 60%
  - No idea: 80%
  - Other: 100%

- **After video**
  - Speed adaptation system: 40%
  - Speed + minimum headway adaptation system: 60%
  - Minimum headway adaptation system: 80%
  - No idea: 100%
  - Other: 0%
## Results

### Questionnaire

**Usefulness & Willingness to use**

<table>
<thead>
<tr>
<th>BSD</th>
<th>Overtaking</th>
<th>Collision avoidance</th>
<th>Merging in highway</th>
<th>Driver Safety</th>
<th>Improvement of drivers’ performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACC</td>
<td>Adjustment to traffic conditions</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

| BSD       | Highways Rural | > | Urban                  |
| ACC       | Highways Rural | > | Urban Congestion |
| ACC       | Rural          | > | Urban                  |
Results

Questionnaire

Need in Training & Testing

Graph showing percentages for various training and testing needs, including:
- Learning before using
- Introduction to training
- Introduction to testing
- Video as teaching tool

Systems mentioned:
- Blind Spot Detection system
- Adaptive Cruise Control system
Results

Factor Analysis

Questionnaire

Driver Self-Image Inventory

- Confident

Driver Stress Inventory

- Courteous
- Impulsive
- Dislike of Driving
- Hazard Monitoring
- Thrill seeking
Results

Questionnaire: Driver Profiles & Need of the systems

Driver Self-Images and introduction to T&T

BSD: NO significant correlations!

Driver Stressors and introduction to T&T

ACC: NO significant correlations!

Introduction to T&T

Learners

Introduction to T&T

Experienced

Introduction to T&T
Results

Questionnaire

Differences between learners and experienced

* Ease of use: High for both systems (M_{BSD}=3.98, M_{ACC}=3.74)

“the BSD system is very straightforward”

“the ACC system is easy to use but more complex compared to the BSD system”.
# Results Interviews

<table>
<thead>
<tr>
<th></th>
<th>BSD</th>
<th>ACC</th>
</tr>
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</table>
| **Assisted driving tasks** | 1. **Multitasking** (alertness for blind spot)  
2. Reduction of mental workload | **Multitasking** (maintaining headway, slowing down in time) |
| **Advantages**          | Multiple ways of warnings provision                                  | Harmonious traffic flow                                               |
| **Disadvantages**       | 1. **Overreliance**                                                  | 1. **Overreliance**                                                  |
|                         | 2. Limitations of the system                                         | 2. More a luxury than a necessity                                      |
| **Preferred training method** | Practice                                                          | Practice                                                          |
| **Preferred testing method** | Theory                                                            | 1. **Theory**  
2. **Practice** (Driving exam) |
| **System’s introduction most important aspect** |                                                                       | Introduced as auxiliary system                                         |
| **Preferred sequence of introduction** | 1<sup>st</sup>                                                       | 2<sup>nd</sup>                                                       |
Conclusions

ACC

BSD

Poorer Understanding of the system

Low familiarity with the system

Wider range in areas of use

Higher Usefulness of the system

Acceptance from all driver profiles
Recommendations

Stage 1: Blind Spot Detection System

Training
- Theory
- Practice
  - System’s technical function
  - System’s Warnings
  - System’s Limitations
  - Driving scenarios development

Testing
- Theory
  - Questions
  - System’s Warnings
  - System’s Limitations
- Practice
  - Driving exam
  - System’s warnings
  - Different driving scenarios

Stage 2: Adaptive Cruise Control System

Training
- Theory
- Practice
  - System’s technical function
  - System’s set up
  - System’s Limitations
  - Areas of application

Testing
- Theory
  - Questions
  - System’s technical function
  - System’s activation-deactivation
  - System’s Limitations
- Practice
  - Driving exam
  - Different driving scenarios

Behavioral tests before and during classes
Recommendations (1)

• Practical
  – Used videos
  – Sample size

• For future research
  – Weights on factors affecting attitude to ADAS
  – Simulator and field experiments
  – Perception of other stakeholders
Recommendations (2)

• For future developments/projects
  – Organise a workshop: ADAS in training and testing
    with CIECA/EC stakeholders and other relevant stakeholders (e.g. from
    academics, automotive and road administrations)
  – Define a project group
    to define best practices leading to adequate training and testing protocol
  – Develop a best practice toolkit
    that meets individual countries needs and requirements
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