

Building Blocks of Responsibility

A CONCEPTUAL MODEL ILLUSTRATING THE FACTORS INFLUENCING PERCEIVED RESPONSIBILITY OVER THE DRIVING TASK WHEN INTERACTING WITH AUTOMATION SYSTEMS

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PROBLEM STATEMENT

Applied to the context of driving, there are many laws and regulations that define what responsibilities come with the privilege of driving and how drivers are supposed to act. These regulations are put in place to enhance safety for all road users, but also to be able to evaluate situations after an accident and hold actors accountable for unsafe behavior and actions. However, the 2017 Traffic Safety Culture Index [1] revealed that while most drivers desire a greater level of safety, their actual behavior often contradicts their attitude.

Novakazi and colleagues [7] investigated how perceived control influences the responsibility the driver perceives over the driving task; however, it suggested that control is not the only reason why drivers feel responsible over the driving task. Especially regarding the introduction of driving automation systems, which aim to relieve the driver partly or fully of the driving task, the question of who is responsible over the driving task at what time becomes highly critical.

Therefore, there is a need to understand the building blocks of the subjective responsibility drivers have over the driving task when engaging with driving automation systems. Hence, this work investigates the factors influencing the driver's perceived responsibility over the driving task and propose a conceptual model, which focuses on explaining the drivers subjective view of responsibility and how the interpretation of different information leads to the perception of with whom the responsibility lies - the driver or the vehicle.

METHOD

This paper is based on insights from an empirical on-road study, with a Wizard-of-Oz (Woz) car, which took place in the San Francisco Bay Area, in June 2019. In the study 20 participants experienced two different driving modes, a level 2 supervised driving automation and a level 4 unsupervised driving automation system [8].

To address the aim, the authors have decided to facilitate semi-structured in-depth interviews, to gain insights into the driver's perspectives and reflections, regarding how they perceive their responsibility over the driving task, which factors make them feel responsible and how this translates into the interaction with the two different driving modes.

Contextual information

4 Driving environment and information from the car

Contextual Information refers to information available to and interpreted by the driver the moment of use. It is used by the driver to assess the situation regarding responsibility and control.

The driving environment includes the environment inside the car, such as if there are passengers, as well as the external environment, such as other road users, traffic density, weather and road conditions.

Information can be either implicit or explicit.

Explicit information is direct feedback e.g., the system prompting "steer the car".

Implicit information leaves room for interpretations, e.g., resistance in the steering wheel.

General Responsibility

1 Motivators and Competence

Motivators are linked to the moral views of the driver, such as how important it is to follow the law and keep people safe on the road. **Competence** is the responsibility the driver feels to understand the system and to be able to use the system correctly.

Perceived Control

2 Driver and System

Perceived Control describes how much control of the driving situation is present at a specific moment. It is an assessment of both the control by both the driver and the system. A strong feeling of responsibility of the motivators and competence responsibilities can increase the minimum amount of perceived control that the driver is comfortable with.

Specific Responsibility

3 Tasks and Monitoring

The last two categories are Tasks and Monitoring. What differentiates them is how the responsibility takes shape. **Tasks** are limited to actions that demand physical interaction with the system, whereas **Monitoring** is a mental activity where you observe the behavior of the system and the driving environment to find situations which the system cannot handle.

Individual factors

5 Expectations, experience and trust

Individual Factors entailing previous experiences and expectations, as well as trust affect the feeling of responsibility.

Expectations towards the system are shaped by exchange with others and media input and affect subjective responsibility, e.g., thinking that an automated system will work flawlessly and take full control of the driving task, resulting in going into a situation feeling less responsible.

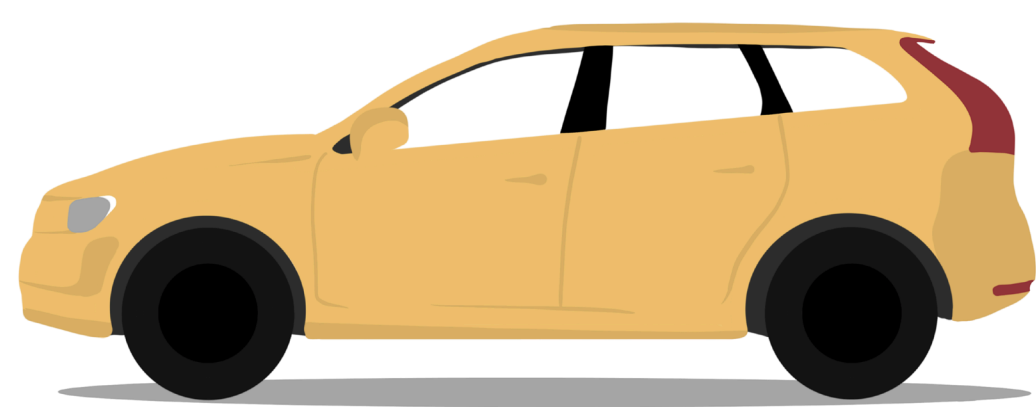
Experience with the system enables the driver to better evaluate what they feel responsible for.

Trust in the system enables the driver to hand over responsibility, which is build through experience. The users experience with and expectations towards a system can indirectly affect each other.

Engagement

6 Active, Aware or Disconnected

The result of all these leads to a level of Engagement from the driver, depending on how responsible the driver feels. The level of engagement ranges from a high level of engagement to a level where no engagement is present. Whereas one can distinguish between **active** (executing the driving task), **aware** (monitoring the driving task) and **disconnected** (out of the loop).



DISCUSSION AND IMPLICATIONS

The presented conceptual model aims to shed a light on the building blocks of responsibility during driving. This topic is especially relevant when considering nowadays technological development enabling semi- to highly automated driving systems in vehicles, where drivers find difficulties to distinguish who is in charge of the driving task [2]. This can happen for example when the actual ability of the driving automation is perceived higher than it is, and the driver falsely assumes that the vehicle is in control of the driving task. A mismatch in assessing the responsibility can have hazardous consequences, especially when this affects the driver's mode awareness [4].

One reason for confusion over the who is in charge of the driving task may be that the relationship and the allocation of responsibility between human and automation system are not clearly defined [9] [5] [10].

Hence, a key factor for a successful development of driving automation is that the drivers understand their own responsibility over the driving task, no matter the level of automation. The conceptual model "Building Blocks of Responsibility" highlights that perceived control affects the drivers perceived responsibility and how that is connected to and influenced by other types of responsibility, such as contextual and individual factors and can therefore aid a transparent system design, which supports the drivers' mental models and their understanding of their responsibility over the driving task at all times.

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