Stakeholder-Centred Taxonomy Design for Automated Vehicles

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ABSTRACT

As the adoption of automated vehicles becomes more prevalent, there is a need for systematic approaches to understanding, communicating, and analyzing the design aspects of the technology. Designing a taxonomy—a hierarchical framework that classifies and organizes design elements and features—is a critical tool in this pursuit. A well-defined taxonomy provides an effective communication tool and enables stakeholders to understand, discuss, and compare system designs. However, current taxonomies often fail to consider technological advancements and the needs of stakeholders. This gap limits the understanding of vehicle automation and hinders addressing critical aspects such as safety and social impact. This workshop aims to propose a stakeholder-centered taxonomy for automated vehicles, taking into consideration the perspectives and requirements of different stakeholder groups, such as technology professionals, policymakers, and end-users. The workshop aims to identify relevant considerations for taxonomy design that cater to different stakeholders, incorporate diverse perspectives, and highlight opportunities and challenges for effective communication and decision-making in vehicle automation.

CCS CONCEPTS

• **Human-centered computing**; • **Interaction design**; • **User centered design**;

KEYWORDS

Vehicle automation, Taxonomy, Design

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1 INTRODUCTION

Automated vehicle technology is rapidly developing, promising increased safety and comfort to drivers [1]. As the deployment of automated vehicles becomes increasingly prevalent, developing systematic approaches for understanding, communicating and analysing the design aspects are needed. One critical tool in this pursuit is designing a taxonomy, which is a hierarchical framework that classifies and organises various design elements and features [2]. Taxonomy enhances decision-making processes and collaboration across various domains. Therefore, well-defined taxonomy provides an effective communication tool and enables stakeholders to discuss and understand system designs.

Among several vehicle automation taxonomies suggested by automated vehicle experts as shown in Table 1, the Society of Automotive Engineers (SAE) International's taxonomy J3016 [3] has gained widespread recognition and adoption in the automotive industry and academia, classifies vehicles based on their level of automation, ranging from Level 0 (no automation) to Level 5 (full automation). One of the concerns with SAE taxonomy is focusing on the functional aspects of automated vehicles, so it lacks consideration of emerging technologies and stakeholder perspectives. Furthermore, SAE Standard J3016 focuses on sustained driving automation only. Even though definitions of other functions enabling or extending sustained driving automation have been increasingly incorporated, they remain less visible compared to sustained driving automation. To place J3016's scope in the broader context of driving automation functions, it refers to the Principles of Operation Framework [4]. This taxonomy has been designed to provide a full picture of automated driving functions that influence vehicle guidance. Therefore, it considers sustained driving automation as one of three Principles of Operation: (A) information/warning functions that realize their effect on vehicle guidance mediated by the driver, (B) sustained driving automation as further differentiated in J3016, and (C) interventions in accident-prone situations considering both abstract and concrete hazards.

Table 1: Taxonomy of vehicle automation

Source	Taxonomy					
SAE [3]	Level 0 (No Driving Automation)	Level 1 (Driver Assistance)	Level 2 (Partial Driving Automation)	Level 3 (Conditional Driving Automation)	Level 4 (High Driving Automation)	Level 5 (Full Driving Automation)
Euro NCAP [5]		Assisted driving mode		Automated driving mode		Autonomous driving mode
MEDIATOR H2020 project [6]		Continuous Mediation		Driver Standby	Time to Sleep	

The widespread adoption of automated vehicles has sparked significant interest and engagement from various stakeholders, including researchers, engineers, policymakers, regulators, industry professionals, and end-users. Each stakeholder brings their perspective and set of requirements to the design and development of automated vehicles. However, to accomplish their respective aims and purposes, stakeholders frequently create their own taxonomy which they consider more suitable for their respective purpose. This approach leads to many individual taxonomies that may hinder communication across stakeholders. This gap limits the drivers' understanding of vehicle automation and hinders the ability to address critical aspects such as safety and social impact.

In this workshop, our focus is on addressing the diverse needs of various stakeholders in designing a taxonomy, including technology professionals, end-users, and policymakers. End-users, such as passengers, pedestrians, and other road users, play a crucial role in automated vehicle design. However, their understanding and perception of different levels of automation can vary, making it challenging to develop a taxonomy that accurately represents their perspectives. On the other hand, technology professionals, including designers, engineers, and researchers, benefit from taxonomies that help identify technological advancements and gaps in manufacturing. Existing taxonomies often fall short when it comes to incorporating user perspectives and meeting regulatory requirements set by governments and regulatory bodies [7]. This technology-centric approach can lead to confusion among researchers, industry experts, and policymakers, which in turn misrepresents the capabilities of automated vehicles [8, 9]. As the field of automated vehicles rapidly evolves, it becomes crucial to design a taxonomy that promotes clarity and understanding among stakeholders. This workshop aims to propose a stakeholder-centered taxonomy design that considers the perspectives and requirements of different stakeholder groups. Our objective is to develop a structured framework that classifies and organizes design elements and features based on the specific needs and perspectives of each stakeholder.

2 WORKSHOP GOAL AND OBJECTIVES

The overall goal of this workshop is to design a taxonomy of vehicle automation for different stakeholders (end-users, technology professionals, and policymakers) following the above-mentioned classification scheme. This workshop contributes to providing an opportunity to explore and develop a stakeholder-centered taxonomy framework for automated vehicles. To reach this goal, our workshop will address the following objectives:

- Identify taxonomy design considerations and elements relevant to different stakeholders.
- Incorporate diverse perspectives to ensure the taxonomy considers technological advancements, user needs, and policy considerations.
- Discuss opportunities and challenges in designing the taxonomy for effective communication and decision-making regarding vehicle automation.

3 WORKSHOP OVERVIEW

3.1 Schedule

The workshop will be a half-day program and will cover the following agenda points:

1) Introduction (15 min)

The workshop begins with a short introduction by the organizers and participants. We briefly introduce the objective and schedule of the workshop.

2) Ignition Talk (20 minutes)

We will talk to set the stage for a general overview of the current taxonomy of vehicle automation and challenges for design taxonomy. An expert will deliver a design sprint to highlight the importance of taxonomy design and its impact on automated vehicles adoption and safety.

3) Taxonomy Framework Development – part 1 (40 minutes + 15 minutes break time)

This session will focus on identifying the needs and purpose of taxonomy. Participants arrange group, and each group represent the different stakeholders: end-users, technology professionals, and policymakers. Then, participants discuss the requirement to design a taxonomy for each stakeholder. For example, the capability of automation is an important criterion for adopting taxonomy for car manufacturers.

4) Taxonomy Framework Development – part 2 (60 minutes + 15 minutes break time)

Based on the previous activity, participants determine the critical factors that differentiate each level of automation. These factors can include the extent of human involvement, the vehicle's capability to perform specific tasks, the need for driver attention, and the ability to handle complex driving situations. The discussion will be conducted in groups. The expected outputs from group work are clear boundaries (and distinct levels of automation: if possible) for designing taxonomy for each stakeholder. Based on the identified differentiators, discuss how to align with the taxonomy of

different stakeholders. In addition, participants discuss what level of taxonomy other stakeholders (i.e., insurance company, journalist, marketing) should use.

5) Discussion (30 min)

Each group will present their findings. All participants facilitate discussion and collaboration to define and align different taxonomy of stakeholders. Further, we will discuss how to impact stakeholders to adopt the taxonomies.

3.2 Expected Outcome

After the workshop, we will have developed a stakeholder-centered taxonomy framework for the stakeholders of automated vehicles that incorporates the perspectives and requirements of end-users, technology professionals, and policymakers. We will integrate the workshop outcomes and make them available on the workshop website in the short term. Our long-term goal is to extend the outcomes through further in-depth studies, present them in an open-access paper to enhance visibility and accessibility and initiate additional projects such as special interest groups or future workshops.

3.3 Participants

The workshop targets researchers and practitioners positioned who are interested in vehicle automation taxonomy and stakeholder-centered design. This multi-disciplinary framing of the workshop will ensure that our participants can mutually inspire each other. Given the hands-on nature of the workshop, we would ideally host somewhere between 15 and 20 participants.

4 SHORT BIOGRAPHY OF THE ORGANIZERS

Soyeon Kim is a Ph.D. candidate at the Department of Human-Centered Design at TU Delft. She brings several years of experience in UI/UX design from Hyundai/Kia Motors in South Korea before joining the academy. Her research mainly focuses on designing Human-Machine Interaction for Trustworthy Collaboration.

Elisabeth Shi is a researcher at the German Federal Highway Research Institute's (BASt) Section F4 Automated Driving, and a Ph.D. candidate at the Chair of Ergonomics at TU Munich. She brings several years of experience in the standardization of SAE J3016. Her research mainly focuses on user-centered communication of automated driving and the effects of non-driving related activities in Level 3 automated driving.

Fjollë Novakazi is an industrial Ph.D. candidate at Volvo Cars, affiliated with the Division of Design & Human Factors at Chalmers University of Technology. Her research concerns how drivers perceive and understand driving automation systems. She approaches her studies through empirical mixed-methods research, facilitating surveys, in-depth interviews, naturalistic studies, and on-road observations.

Oscar Oviedo-Trespalacios is an Ass. Professor in Responsible Risk Management at Delft University of Technology. His areas of expertise include human-systems integration, misuse of technology, and transport safety and security. He is an expert in safety policy and has published numerous studies about the adoption of connected and automated vehicles.

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