

# Accessible Automated Automotive Workshop Series (A3WS): International Perspective on Inclusive External Human-Machine Interfaces

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## ABSTRACT

The fact that automated vehicles will be part of road traffic raises the question of how human road users, like bicyclists or pedestrians, would safely interact with them. Research has proposed external human-machine interfaces (eHMIs) for automated vehicles as a potential solution. Concept prototypes and evaluations so far have mainly focused on young, healthy adults and people without disabilities, such as visual impairments. For a “one-for-all” holistic, inclusive solution, however, further target groups like children, seniors, or people with (other) special needs will have to be considered. In this workshop, we bring together researchers, experts, and practitioners working on eHMIs to broaden our perspective on inclusiveness. We aim to identify aspects of inclusive eHMI design that can be universal and tailored to any culture and will focus on discussing methods, tools, and scenarios for inclusive communication.

## CCS CONCEPTS

• **Human-centered computing** → **Accessibility**; *Human computer interaction (HCI)*; • **Computer systems organization** → *External interfaces for robotics*.

## KEYWORDS

Workshop; vulnerable road users; automated vehicles; inclusiveness; human-machine interaction; external human-machine interfaces

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## 1 BACKGROUND

To be understandable and acceptable by other road users, automated vehicles (AVs) might need to communicate in a special way [12, 15]. This workshop will focus on the communication between AVs and vulnerable road users (VRUs), especially those who benefit most from inclusive design, like children, older adults or people with disabilities and reduced mobility, cognition, vision, or orientation. This part of the population is largely underrepresented in AV-VRU research [6, 10].

Previous works on the interaction between VRUs and AVs through external human-machine interfaces (eHMIs, see Figure 1) [6, 10, 15, 19] or by simulating social interactions via eye contact or gestures [33] focus primarily on visual stimuli (e.g., [14, 28]), and do not comply with the principles of Universal Design [7], as they exclude people with visual, cognitive, or motor impairments [6]. Our previous workshops focused on exploring eHMI designs [26], methods to evaluate them [9, 27], and also started the discussion on inclusive eHMIs [13, 18]. Building on these workshops, our goal is to continue the discussion on inclusive solutions for the AV-VRU interaction, specifically focusing on the international perspective and identifying the obstacles to consolidating the vast amount of eHMI concepts into a few inclusive ones.

Of particular interest in this workshop are **children, older adults, and people with accessibility needs**. Children between the ages of six and thirteen are the most vulnerable subgroup among cyclists due to their still developing motor and perceptual-motor

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**Figure 1: Example eHMIs from a VRU's perspective, as discussed in [16] and [19].**

skills [1, 11, 22–25], but are underrepresented in previous eHMI studies [8]. Research also shows that older adults are underrepresented in studies. At the same time, they have difficulties with regard to taking road-crossing decisions [31], and have different expectations for automated driving than younger adults [20], take longer to adapt to new technology [2], and have different requirements [17]. Further, people with auditory/visual impairments constitute a significant proportion of the VRU demographic [3, 29, 30], but are largely uncatered for, especially given the predominance of visual eHMI concepts [4–6, 21].

## 2 WORKSHOP GOALS

Building on our previous eHMI workshops [9, 13, 18, 26, 27], we aim to consolidate eHMI concepts with a focus on inclusion, rather than exploring further concepts. We intend to achieve the following:

- (1) Raise awareness of the (missing) inclusion in AVs' (external) communication with VRUs.
- (2) Give an overview of the current state of research on inclusive interactions between AVs and VRUs.
- (3) Identify research barriers that explain why research on inclusive communication has not increased recently, although this research gap is well known.
- (4) Establish and deepen connections between interdisciplinary researchers for future (international) cooperation.

## 3 PARTICIPATION

The workshop focuses on inclusion, which relates not only to accessibility but also to cultural differences and diversity. We invite researchers and practitioners from different cultures, backgrounds, and disciplines to explore inclusive interaction between AVs and

**Table 1: Preliminary workshop schedule. The start-time will depend on the allocated time slot at AutomotiveUI. Also, we may decide to change the schedule on the fly to make more room for important emerging discussions.**

### A3WS: International Perspective on Inclusive eHMIs

09:00	Welcome
09:10	Setting the stage
09:20	Mini Tutorial: eHMIs
	Mini Tutorial: Inclusive Design
09:50	World Café (rounds 1 & 2)
10:30	Lightning talks
11:00	Break
11:30	World Café (rounds 3 & 4)
12:10	Table summaries
12:30	Wrap-Up
13:00	End.

other road users. Their interests may involve inclusion or assistive devices for children, seniors, or people with disabilities, but also vehicular user interfaces. We prepare a website to inform about this workshop and reach the community through social media channels (e.g., Twitter, Facebook, or LinkedIn) and mailing lists (e.g., GI or ACM SIGCHI).

Participants are invited to submit position papers but are not required to do so. The papers should be two to four pages long (without references) in the single-column ACM SIGCHI template. They will be reviewed by at least two workshop organizers.

We plan for 35 participants. The interactive parts will be done in small groups so that we can respond to different numbers of participants by adjusting the number of groups without compromising the interactivity. Thus, the workshop can be conducted with 15 to 49 people.

## 4 WORKSHOP ORGANIZATION

The workshop schedule is outlined in Table 1. We begin with a brief introduction (*Welcome*). We then *set the stage* and ask participants to identify three main reasons that make it difficult to explore or develop inclusive interactions between AVs and VRUs, using an online tool like Mentimeter<sup>1</sup>. The results will be displayed throughout the workshop to stimulate discussions.

The main part starts with *mini tutorials*: two speakers will each give a presentation on eHMIs and inclusive design. This part will give a general overview of these topics to ensure that all participants are familiar with them. We will then split into four to six groups (depending on attendance) to discuss selected topics in a *World Café* format [34]. The groups discuss a topic at one table for twenty minutes before moving on to the next topic. In this way, ideas are disseminated across tables. The topics of the World Café can be changed to better reflect the interests of the participants and the adopted position papers. Currently, we plan the following topics:

- (1) “Why are we not seeing more studies on inclusive eHMIs (and what can we do about it)?”

<sup>1</sup><https://www.mentimeter.com/>

- (2) “Which (novel) methods are needed to research, design, and develop inclusive eHMIs?”
- (3) “How can we better include people with cognitive, motor, or other kinds of disabilities in the design process?”
- (4) “What are the major characteristics of an inclusive eHMI? Pick any of the existing eHMI concepts and suggest how it could be re-designed to ensure inclusiveness”
- (5) “What cultural aspects should be taken into account when designing eHMIs?”
- (6) “What are the future research opportunities when it comes to inclusive eHMI? Describe your “dream” study!”

After the first two World Café rounds, participants present their accepted position papers as *lightning talks*. The time per presentation depends on the number of accepted papers. We will then have a *break* where participants will have the opportunity to socialize, deepen discussions, watch the South Korean traffic for inspiration or simply regain some energy. Inspired by the lightning rounds and discussions during the break, the World Café will continue. In the last round, participants have the additional task of summarizing the most important points of their current table.

After the last World Café session, participants will summarize the main takeaways per table (*Table summaries*). This already prepares the *wrap-up* of the workshop, where we will discuss where to publish the results and how we can collaborate in the future.

## 5 NEEDED SUPPORT

We will need a projector, six groups of tables for eight people each (or less, depending on participant numbers), flipchart paper (or similar) placed on the tables to write ideas on, colorful pens, and post-its.

## 6 EXPECTED OUTCOMES

This workshop brings together people from different fields to discuss how to develop inclusive communication concepts for AVs that need to interact with VRUs (cf. eHMIs). To share the results with a broader community, the accepted position papers will be published on the workshop website if the authors agree, and we will summarize the discussions and results in an article.

We also stimulate future collaboration on this topic in a dedicated session of the workshop, as we believe that international collaboration among interdisciplinary research groups is necessary to incorporate ideas from different perspectives and cultures (cf. [32]) to develop inclusive solutions for traffic participants.

## 7 ORGANIZERS

**Andreas Löcken** is a postdoctoral HCI researcher at the Technische Hochschule Ingolstadt (THI) and the CARISMA Institute of Automated Driving (C-IAD). His current research focuses on the interaction between AVs and humans, including passenger and VRU perspectives.

**Andrii Matviienko** is a postdoctoral researcher at the Technical University of Darmstadt. His research focuses on assisting technology in urban environments. He investigates how to make evaluation environments for micro-mobility safe and realistic and what future micro-mobility.

**Mark Colley** is a PhD candidate at the University of Ulm in the Institute of Media Informatics. His research looks into communication possibilities between AVs and VRUs like pedestrians and cyclists, focusing on accessibility. Colley already co-organized workshops at AutomotiveUI and MobileHCI.

**Debargha Dey** is a postdoctoral researcher at Eindhoven University of Technology, Netherlands. He has a background in Human-Computer Interaction and his research interest lies in automotive human factors. His current research focuses on Human-Machine Interfaces for automated driving, and he has been working in the space of traffic safety and interaction between AVs and other road users for 7+ years.

**Azra Habibovic** (PhD) is Technology Leader for Human Factors at Scania CV AB where she is responsible for defining and driving forward Scania’s roadmap for early-stage research in this field. Her research focuses on traffic safety and user experience, with emphasis on the design and evaluation of interactions in and around AVs.

**Yee Mun Lee** is a senior research fellow at the Institute for Transport Studies, University of Leeds. Yee Mun has been involved in multiple EU-projects in leading roles and is active in the International Organisation for Standardisation (ISO). Her research interests include the interaction between AVs and other road users in urban scenarios.

**Andreas Riemer** is a professor for Human Machine Interface and Virtual Reality at Technische Hochschule Ingolstadt (THI) with co-appointment at the CARISMA Institute for Automated Driving (C-IAD). His research interests include driving ergonomics, driver state assessment from physiological measures and trust, acceptance, and ethics in automated driving.

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