

# 8th Workshop Automotive HMIs: User Interface Research in the Age of New Digital Realities

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## ABSTRACT

Even though many aspects of automated driving have not yet become reality, many human factors issues have already been investigated. However, recent discussions revealed common misconceptions in both research and society about vehicle automation and the levels of automation levels. This might be due to the fact that automated driving functions are misnamed (cf. Autopilot) and that vehicles integrate functions at different automation levels (L1 lane keeping assistant, L2/L3 traffic jam assist, L4 valet parking). The user interface is one of the most critical issues in the interaction between humans and vehicles – and diverging mental models might be a major challenge here. Today’s (manual) vehicles are ill-suited for appropriate HMI testing for automated vehicles. Instead, virtual or mixed reality might be a much better playground to test new interaction concepts in an automated driving setting. In this workshop – motivated by the conference theme – we will look into the potential of new digital realities for concepts, visualizations, and experiments in the car, e. g., by replacing all the windows with displays or transferring the entire environment into a VR world. We are further interested in discussing novel forms of interaction (speech, gestures, gaze-based interaction) and information displays to support the driver/passenger.

## CCS CONCEPTS

• **Human-centered computing** → *Interaction paradigms; HCI theory, concepts and models.*

## KEYWORDS

User interfaces, Automotive HMIs, AR/VR/MR, Automated driving, Interaction concepts, Content abstraction.

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## 1 PROBLEM STATEMENT & WORKSHOP AIM

Just recently, several proposers of this workshop co-organized and participated in a Dagstuhl seminar<sup>1</sup>: 30+ experts met and discussed issues related to driver-vehicle interaction with tomorrow’s vehicles. Interestingly, it turned out that problems discussed and solutions suggested did not significantly differ from those debated in a similar seminar back in 2016.

Our reasoning for this is, that the research methods have not changed since then and the researchers stuck in a stalled process, which, in turns, means that there is no chance for radical innovation to come through. With broad availability of Augmented / Virtual Reality (AR/VR) technology, we have new opportunities to explore and evaluate automotive user interface research in virtual (mixed) reality and build novel interfaces for automated cars. For example, with VR it will be easily possible to explore the potential of windshield displays – even in a more radical form by augmenting every window in the car including the rear window. Also, the replacement of the real world view out of the windows with abstracted representations of only safety-relevant road and infrastructure objects could easily be investigated. Concepts of virtual or augmented 3D avatars in the passenger compartment can also be implemented as easy as context-dependent dashboards, “interior skins”, and even morphing interior design. Additionally, also novel forms of interaction in / with the car (e. g., speech, gesture control, gaze-based interaction) and context-dependent information displays (attentive interfaces) to support the driver/passenger can easily be investigated.

In this workshop, we would like to bring together researchers and developers from academia and industry on innovative HMI research ideas to foster knowledge transfer and facilitate networking. Group work to come-up with (radical) new ideas and interactive sessions are an important part of this workshop and shall serve as a basis for future work, ideally as a nucleus for new cooperative projects.

## 2 TARGET AUDIENCE

This workshop is intended for researchers and practitioners as well for designers, developers, and (PhD) students interested in human factors, interaction design, human-computer interface development, amongst others, with particular focus on applications in automated driving. Its goal is to serve as a platform for knowledge exchange

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<sup>1</sup><https://www.dagstuhl.de/19132>

between academia and industry (automotive manufacturers, third-party suppliers) regarding novel approaches for HMI research (e. g., virtual/mixed reality) in the transition to automated driving.

### 3 TOPICS OF INTEREST

The main goal of the workshop is to discuss challenges and opportunities in automotive user interface research, such as mental models, misuse of terms, intransparency, etc. that might hinder or support the application on a broader basis. In particular, we are interested in **radical innovative ideas for future HMI research in virtual (mixed) reality**. Topics of interest include, but are not limited to:

- User interface concepts to foster trust and acceptance (e. g., transparency displays) for the different levels of automation [5]
- Futuristic (mixed reality) concepts of shared control, vehicle interior, and in-vehicle non-driving-related tasks [4]
- User experience design for automated vehicles [2]
- Personalization of vehicle behavior and interfaces
- Approaches that support situation awareness through design

We welcome contributions from both academia and industry!

### 4 WORKSHOP SUMMARY

The workshop will be held on Sunday, September 8, 2019 (prior to the main conference) from 9 AM to ca. 6 PM and is organized in several sessions. It includes discussions, interactive hands-on sessions, and presentations, amongst others. We allow interested parties to jump in for single sessions only, but encourage everybody, in particular authors of contributed papers, to participate in the workshop throughout the whole day. The number of workshop participants will be limited to 30, excluding the organizers.

In the beginning of the workshop, participants will be welcomed by the organizers and **introduced to the workshop's goals** (9.00-9.15). A **speed-dating session** will follow to allow for quick and effective introduction to each other. This format was identified as very beneficial in many of our previously organized workshops (9.15-9.45). The remaining time until the coffee break (10.30-11.00) will be dedicated to **presentations of accepted position papers**, most likely in 20x20s **Pecha Kucha talks**. Participants will be encouraged to provide provoking presentations that tackle questions in line with the workshop goals (10 min. each, including time for Q&A). During the presentations, the audience is expected to note down questions, problems, challenges they identify in the presentations to paper cards. After the coffee break, a **brainstorming session** will be followed. Therefore, cards will be collected, discussed, and posted on a pin board. New PostIts with individual opportunities and pain points can be added as well. Together with participants, the workshop co-organizers will then cluster the PostIts/cards on a **brainstorming wall** and compile questions for the interactive part in the afternoon.

After the lunch break, participants will **split into groups and work on a specific topic** (assigned based on the result of the brainstorming wall). Each group will nominate a moderator and a note taker. The group will perform a dive into the current problems and is tasked with producing a solution (proposal). We might use **collaborative sketching** for this task. Groups will get a chance to

present the result of the discussions to the rest of the attendees. Presentation and discussion of group work results will further foster the exchange between participants (14.00-15.30). After the coffee break, the second half of the afternoon is organized as **(interactive) World Cafe** with about 5 discussion tables. Each table will have a host from the workshop organizers who will finalize the discussion topics of the table based on the accepted position papers or discussion outcome. Participants will be asked to change tables each ca. 15 minutes, to ensure that by the end of the session each participant had a chance to discuss on every table. The results of each table will be presented in a short **summary presentation** afterwards and made accessible via the workshop website. At the end of the workshop, both participants and organizers will discuss future plans, e. g., to continue with this workshop series at Mensch and Computer (MuC'20), AutoUI'20, CHI'20 and related conferences. The workshop will be closed at around 17.30 with a wrap-up (the detailed schedule is available on the workshop website at <http://www.andreasriener.com/MuC2019WS/>).

### 5 SUMMARY OF CONTRIBUTIONS

All papers submitted to this workshop were individually reviewed by 2 to 3 reviewers. Based on the review scores, 4 papers could be finally accepted for and invited to the workshop. Accepted contributions span various topics within the area of the workshop, ranging from concrete design studies of virtual windshields ("darkmode", navigation cues) to reflective perspectives on automated driving including design for well-being and feasible elicitation methods for future mobility scenarios. One of the accepted papers were submitted in German language, however, for consistency reason, the summaries are subsequently provided in English.

The first paper "**Autonomous Vehicles: From Acceptance to Well-Being**" (original title: "Autonome Fahrzeuge: Von Akzeptanz zu Wohlbefinden") by Stefan Geisler discusses the future of automated driving beyond acceptance. It introduces relevant Positive Computing theories (PERMA model, Six spheres of experience) and theories of acceptance (TAM, UTAUT, AVAM). The author points out the gap between acceptance and well-being (e. g., time-orientation: middle- vs. long-term) and concludes that for automotive development, the Positive Computing paradigm can help to implement well-being in individual and mass-transportation. It is expected that this paper will be a trigger for the discussion in the workshop on today's research perspective and on how to investigate future mobility scenarios or "new digital realities".

The second paper "**Investigating Car Futures from Different Angles – An Overview of Methods Used to Study Human Factors of Autonomous Driving**" by Gunnar Stevens, Johanna Meurer, Christina Pakusch, and Paul Bossauer summarizes current research methods found in the literature (Research through Design, Wizard of Oz, Simulation, Survey, Interview, Observation). It discusses strengths and weaknesses of each method to generate knowledge on future mobility systems on individual level, social interaction level, or societal level. The authors conclude that there not one fitting method and researchers should adapt and mix methods for a particular research question. The paper, in line with the one before, is expected to start a vivid discussion on the communities research methods and tools.

The third paper “**Adaptive Dark Mode: Investigating Text and Transparency of Windshield Display Content for Automated Driving**” by Andreas Riegler, Andreas Riener, and Clemens Holzmann presents a driving simulator study on the design for text and text-background elements in virtual windshields using a chat. In a pre-study (n=10), contrast (black/white/transparent) and position (driver/passenger side) of GUI elements were evaluated. The display on the drivers side and a more transparent background was preferred, but an automatic adaption would be desired, if available. In the main study, the adaptive dark mode of the chat application was implemented, based on the environmental luminosity (rural/urban scene), and participants preferred it over a static dark mode version in terms readability and acceptance (TAM). Additionally, the adaptive version led to less side-task errors (counted pedestrians). In the workshop, this paper is likely to start a discussion on how to make use of a virtual windshield.

The last paper “**A real-world driving experiment to collect expert knowledge for the design of AR HUD navigation that covers less**” by Matthias Schneider, Tim Schluessener, Anna Bruder, Niels Henze, Marc Necker, and Christian Wolff presents a real world driving study (n=26) to explore navigational cues in augmented reality head-up displays (AR HUD). They develop two concepts (solid/dotted fishbone concept) that work with the drivers limited field of view and reduce occlusion of real world objects (masking). The concept variation did not influence the navigation task (errors), the workload (DALI), nor the user experience (UEQ). The authors argue, that both concepts or more general the usage of Gestalt Principles can help to reduce masking effects. The paper adds another perspective on virtual windshield applications and will therefore contribute to the workshops discussion.

## 6 OUTCOME AND CONCLUSIONS

The main aim of this workshop is to bring together researchers and practitioners from academia and industry, as well as PhD students, designers, and developers with particular interest in the workshop topic. The expected outcome is to identify the main opportunities and pain points in the application of Augmented / Virtual Reality (AR/VR) technology to support radical innovation in the field of human-machine (driver-vehicle) interfaces. The organizers commit to provide a platform for future exchange of problems, ideas, and results related to the workshop focus.

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## 7 ORGANIZERS

**Andreas Riener** is professor for Human-Machine Interaction and Virtual Reality at Technische Hochschule Ingolstadt and research professor at CARISSMA. His research interests include driver state estimation from physiological measures, human factors in driver-vehicle interaction, driving ergonomics, amongst others, with particular focus on automated driving. He is a member of the steering committee of ACM AutomotiveUI. He has co-organized several workshops at Mensch und Computer [3], CHI, and AutomotiveUI [1].

**Stefan Geisler** is professor for Applied Computer Science and Human-Machine Interaction at Hochschule Ruhr West. He worked for several years for Ford Werke GmbH in different automotive HMI projects. In his research, he continues working on automotive HMI, but also on usability and user experience of different kinds of technology in times of demographic change with user-centered design processes. He is head of the research institute Positive Computing.

**Bastian Pfleging** is assistant professor for Future Mobility Systems and Services at Eindhoven University of Technology. His research interests especially include novel concepts for non-driving-related activities in the car and the user experience of vehicles in the transition to full automation. He is a member of the steering committee of ACM AutomotiveUI and organized several workshops and conferences in various roles.

**Tamara von Sawitzky** is a research associate at Technische Hochschule Ingolstadt (THI) and doctoral candidate at JKU Linz, Austria. She received her masters degree in Applied Research in Engineering Sciences at THI, investigating the impact of driving aids utilizing AR technologies. Her current research focuses on UX factors for heads-up displays and influences depending on the level of reality (XR) during a HUD development.

**Henrik Detjen** is lecturer and researcher at the Hochschule Ruhr West and doctoral candidate at the University of Duisburg-Essen, where he studied Applied Cognitive and Media Sciences. His research deals with interaction in context of highly automated systems. His current focus is the application of natural user interfaces within autonomous vehicles.