Interacting with Autonomous Vehicles: Learning from other Domains

Alexander Meschtscherjakov
Center for HCI
University of Salzburg
Salzburg, Austria
alexander.meschtscherjakov@
sbg.ac.at

Manfred Tscheligi
AIT Austrian Institute of
Technology GmbH
Vienna, Austria
manfred.tscheligi@ait.ac.at

Bastian Pfleging
LMU Munich
Munich, Germany
bastian.pfleging@ifi.lmu.de

Shadan Sadeghian Borojeni
OFFIS Institute for Information
Technology
Oldenburg, Germany
shadan.sadeghianborojeni@
offis.de

Wendy Ju
Cornell Tech
New York City, NY, USA
wendyju@cornell.edu

Philippe Palanque
ICS-IRIT
University of Toulouse
Toulouse, France
palanque@irit.fr

Andreas Riener
Technische Hochschule Ingolstadt
(THI)
Ingolstadt, Germany
andreas.riener@thi.de

Bilge Mutlu
University of Wisconsin–Madison
Madison, WI, USA
bilge@cs.wisc.edu

Andrew L. Kun
University of New Hampshire
Durham, NH, USA
andrew.kun@unh.edu

Abstract

The rise of evermore autonomy in vehicles and the expected introduction of self-driving cars have led to a focus on human interactions with such systems from an HCI perspective over the last years. Automotive User Interface researchers have been investigating issues such as transition control procedures, shared control, (over)trust, and overall user experience in automated vehicles. Now, it is time to open the research field of automated driving to other CHI research fields, such as Human-Robot-Interaction (HRI), aeronautics and space, conversational agents, or smart devices. These communities have been dealing with the interplay between humans and automated systems for more than 30 years. In this workshop, we aim to provide a forum to discuss what can be learnt from other domains for the design of autonomous vehicles. Interaction design problems that occur in these domains, such as transition control procedures, how to build trust in the system, and ethics will be discussed.

Author Keywords

Aeronautics and Space; Automated Driving; Autonomous Systems; Conversational Agents; Human-machine Interplay; Human-Robot Interaction.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

Background
The potential introduction of autonomous vehicles on real streets has been shaping the public discussion over the last years. Examples range from Google's driverless car [25] to the announcement of Uber's use of self-driving cars to transport people.[1] The introduction of fully autonomous vehicles will have a significant impact not only on people's mobility behavior but also how people or other vehicles interact with automated vehicles. Issues, such as the design of user-friendly interfaces for the driver to communicate with the vehicle (e.g., giving directions) or how User Experience (UX) will change when driving in automated vehicles have been discussed from an HCI perspective in the Automotive UI community [e.g., 20, 27], mobile HCI [15], RO-MAN [21], as well as at CHI itself [4, 13, 14].

Issues that have been dealt with from an HCI perspective include control transition procedures from the vehicle to the human driver and vice versa [18, 28], timing of such procedures [7], conveying contextual information at takeover [24], shared situation awareness between driver and vehicle [11], naturalness of interaction with a vehicle [16], perceived loss of control [3], acceptance of autonomous vehicles [22, 29], ethical issues in decision making [5], side activities for automated rides [17], and the simulation of automated driving [1].

---

[1]   https://www.wired.com/2016/09/heres-like-ride-ubers-self-driving-car/

The problems surrounding automated vehicles are not unique. Other domains have been dealing with collaboration between humans and autonomous systems such as robots, aeronautics and space, conversational agents, or smart devices over the last years. Issues such as how to design a system for shared control or how to program a conversational agent have been studied. It has been even argued that an automated vehicle can be regarded as a special kind of robot, since it observes the environment (including humans), makes autonomous decisions based on sensed data and decision rules, and affects the physical environment [26]. In this workshop, we want to discuss what automated driving interaction research can learn from other domains.

It is inspired by a special interest group (SIG) at CHI 2016 that discussed multiple views on safety-critical automation, ranging from aircrafts and autonomous vehicles to air traffic management and satellite control [4]. The SIG targeted the general audience and covered multiple industries and multiple contexts of use with the aim of discussing experiences with interaction design in the context of autonomous systems.

Workshop goals
The workshop has multiple goals in order to inform HCI research and practice within automated driving.

- Provide a forum for researchers and designers of human interaction with autonomous systems with a focus on automated driving
- Discuss potential for transferring knowledge from other domains such as HRI and aeronautics and space to the design and evaluation of automated vehicles

- Present research on how the design of human-automated system communication can inform the design of automated vehicles (e.g., chatbots or virtual assistants such as Amazon's Alexa, Apple's Siri, or Google Assistant)
- Discuss best practices and patterns for the design of autonomous systems and how they can be applied for the design of automated vehicles
- Envision new interaction paradigms for the driver to communicate with the automated vehicle
- Explore new designs for (shared) control situations including authority sharing
- Explore engineering issues related to safety, reliability, and security properties as well as certification
- Consider UX factors relevant to the design of interactions with autonomous systems such as acceptance and trust (including complacency)
- Discuss ethical questions and assess their relevance in the context of critical systems

Participation
The workshop is intended for HCI researchers, practitioners, designers and developers that deal with the interaction of humans with autonomous systems (e.g., HRI, aeronautics and space, conversational agents). Workshop candidates have to submit a position paper (four pages in the CHI extended abstract format).

Organizers
We have experience in the organization of conferences and workshops in the area of automated driving and human-robot-interaction. This includes events at conferences such as CHI, AutomotiveUI, and HRI.

More precisely, starting in 2013, we have been involved in the organization of a series of workshops on UX in automated driving at the ACM International Conference on Automotive User Interfaces and Interactive Vehicular Applications [e.g., 12, 13, 14, 15, 20, 27]. In 2015, we organized a CHI workshop on "Experiencing Autonomous Vehicles: Crossing the Boundaries between a Drive and a Ride" [13]. In 2016, we held a CHI workshop on "Autonomous Vehicles: Contextual Experience Informs Design" [14] and organized a SIG on "Multiple Views on Safety-Critical Automation: Aircrafts, Autonomous Vehicles, Air Traffic Management and Satellite Ground Segments Perspectives" [4]. In 2015, organizers were involved in the organization of the ATACCS[2] (Application and Theory of Automation for Command and Control Systems). Also, some of the organizers were and are involved in organizing AutomotiveUI 2017 and HRI 2017.

Alexander Meschtscherjakov will be the main contact person. He is an Assistant Professor at the Center for HCI of the University of Salzburg. In his research, he deals with automotive user interface design, user experience with autonomous vehicles [22], and deskilling of drivers in automated vehicles [12]. He was co-organizing conferences such as AutomotiveUI'11, Persuasive'15 and organizer of different workshops (e.g., AutomotiveUI'13-16, CHI'15-16).

Manfred Tscheligi is professor for HCI & Usability at the University of Salzburg and is heading the Center for Technology Experience at AIT (Vienna). He is involved in driving experience activities and has been active already in the discussion on automated driving and HRI

---

[2] http://www.ataccs.org/

[26]. He has been involved in several conferences (e.g., co-chairing CHI'04 and AutomotiveUI'11) and co-organizing workshops and SIGs (e.g., CHI'16, AutomotiveUI'15, and Interact'15). He was also conference co-chair of HRI 2017.

Bastian Pfleging is a postdoc researcher at LMU Munich, Germany. Previously, he was researcher at the University of Stuttgart and the BMW Technology Office in California. His special research interests are automotive user interfaces, now with a focus on non-driving-related activities and the transition towards automated driving. He was involved in co-organizing various workshops (e.g., AutoNUI'13, CHI'16) and conferences in this domain (e.g., program chair of AutomotiveUI'17, and WIP chair in 2015 and 2016).

Shadan Sadeghian Borojeni is a researcher at the Interactive Systems group at OFFIS Institute for Information Technology in Oldenburg, Germany. Her research investigates interaction techniques to support task switching and takeover situations in highly automated driving using multi-modal cues evaluated in driving simulator experiments (e.g., [24]).

Wendy Ju is an assistant professor of Information Science at Cornell Tech in New York City. Her research focuses on interaction with automation, particularly human-robot interactions and autonomous vehicle interfaces (e.g., [26]), as well as novel research methods to understand interaction with autonomy (e.g. [1], [23]).

Philippe Palanque is Professor in Computer Science at the University Toulouse 3. He is working on formal methods for engineering interactive systems and the

application of such techniques to Higher Automation Levels in the field of Air Traffic Management, Interactive Cockpits of Large Civil Aircrafts [2] and Satellite Ground Segments [10]. He was chair of (Application and Theories of Automation in Command and Control Systems) ATACCS 2015 conference.

Andreas Riener is a professor for HMI and VR at THI with co-appointment at CARISSMA (Center of Automotive Research on Integrated Safety Systems and Measurement Area). His research interests include driving ergonomics, driver state estimation from physiological measures, human factors in driver-vehicle interfaces (e.g., [21]), as well as topics related to (over)trust, acceptance [29], and ethical issues [5, 20] in automated driving.

Bilge Mutlu is an associate professor of computer science and industrial engineering at the University of Wisconsin–Madison where he directs a research program on building human-centered principles and methods for designing robotic and autonomous technologies, including autonomous and collaborative driving systems (e.g., [6, 19]). He has co-organized several workshops, tutorials, and panels at CHI and HRI conferences and served on program, organizing, and steering committees, including serving as general co-chair of HRI 2017 with Manfred Tscheligi.

Andrew L. Kun is associate professor of Electrical and Computer Engineering at the University of New Hampshire. His research focus is human-computer interaction in vehicles [8], primarily in speech interaction, as well as the use of visual behavior and pupil diameter measures to assess and improve the

Time	Phases
09:00 – 09:10	Welcome and introduction to workshop goals and organization
09:10- 10:30	Position Paper Presentations I (presentations 10 min each: Pecha Kucha style + Q&A)
10:30 – 10:50	Coffee break
10:50 – 12:10	Position Paper Presentations II (presentations 10 min each: Pecha Kucha style + Q&A)
12:10 – 13:30	Lunch
13:30 – 15:10	World-Café-style group discussions on 4 tables (25 minutes slots for each participant on every table)
15:10 – 15:30	Coffee break
15:30 – 16:30	Presentation of results from each table (15 min each)
16:30 – 17:00	Exploration of future work (e.g., joint publication) and wrap-up
later	Joint workshop dinner (optional)

Table 1: Workshop schedule.

design of user interfaces. He served as the General Chair of the 2012 AutomotiveUI conference [9].

Website
The workshop website will contain the call for participation including dates and author instructions. It includes the background of each organizer and a detailed schedule of the workshop. Accepted position papers will be available for download.

https://hci.sbg.ac.at/sites/autonomous-vehicles-chi2018

Pre-Workshop Plans
The call for participation (CFP) will be distributed via HCI-, HRI- and AutomotiveUI-related mailing lists (e.g., chi-announcements), as well as personal distribution lists based on workshops and conferences we have held. Accepted workshop position papers will be made available to all participants via the workshop website.

Workshop Structure
This will be a one-day workshop consisting of approx. 16 participants plus organizers. Table 1 provides an overview of the proposed workshop schedule.

Participants will be welcomed and introduced into workshop goals. The first half of the workshop-day will be dedicated to oral position and reflection presentations of each participant. Participants will be provided with a 10-minute presentation slot including Q&A. Presentations should be short and thought provoking. We encourage Pecha Kucha style presentations (i.e., 20 slides, 20 seconds for each slide, overall duration 6:40 min).

The second half of the workshop will be dedicated to participant discussions and collaborations. In world-café-style sessions, participants will discuss challenges of human-automated system interaction from various perspectives. There will be four tables each hosting a specific topic (e.g., shared control, anthropomorphism, mode and situation awareness, trust, ethics, etc.). Topics will be finalized based on position paper submissions. Each table will have a host (one of the organizers). After 25 minutes, every participant will move to another table to ensure that by the end of the workshop each participant has discussed each topic. Finally, a group session will be held, in which topic hosts will present results. In a wrap up phase potentials for a joint publication and/or a special issue on the topic will be discussed.

Post-Workshop Plans
Workshop results will be communicated both to communities and a general audience including a Poster at CHI. We plan to produce a report for publication in the ACM Interactions magazine and prepare a special issue in a selected journal (e.g. Springer Journal on Quality and User Experience[3]) following the conference. This will depend of the quality of the contributions and of the output of the workshop. In any case, workshop results will be made available through the workshop website and an email list to network with others will be created. Finally, the preparation of an informal Special Interest Group (SIG) at CHI 2019 will be considered.

---

[3] http://www.springer.com/engineering/signals/journal/41233

Call for Participation

"Interacting with Autonomous Vehicles: Learning from other Domains" is a one-day workshop at CHI 2018 in Montréal, Canada.

This workshop aims at research and designs that have been done in areas where humans interact with autonomous systems such as automated vehicles, Human-Robot-Interaction (HRI), aeronautics and space, conversational agents, and smart devices. We want to discuss what can be learnt from other domains for the design and evaluation of automated driving. To participate, a four-page long paper in the CHI extended abstract format has to be submitted via email to alexander.meschtscherjakov@sbg.ac.at. Position papers should cover one of the following or related topics:

- Interaction with autonomous systems
- HRI & autonomous vehicles
- Aeronautics and space & automated driving
- Shared control and authority
- Control transition (handover & takeover)
- Mode and situation awareness
- Acceptance, trust and complacency
- Conversational agents and chatbots
- Virtual assistants (e.g., Siri, Alexa)
- Anthropomorphism
- Theories and research methods
- Interaction design and modalities
- Best practices
- Ethics

The workshop is restricted to approximately 16 participants. Applications will be selected by workshop chairs, who will evaluate position papers based on their fit with the workshop theme, their originality, and their quality. The author of an accepted submission must attend the workshop, provide a short presentation, and register for both the workshop and for at least one day of the main conference.

Deadlines
- Position paper: February 2, 2018
- Notification: February 22, 2018
- Workshop at CHI2018: April 21/22, 2018

More Information:
https://hci.sbg.ac.at/sites/autonomous-vehicles-chi2018

References

1. Sonia Baltodano, Srinath Sibi, Nikolas Martelaro, Nikhil Gowda, and Wendy Ju. 2015. The RRADS platform: a real road autonomous driving simulator. In *Proc. AutomotiveUI '15*. ACM, New York, NY, USA, 281-288. DOI=http://dx.doi.org/10.1145/2799250.2799288

2. Regina Bernhaupt, Martin Cronel, François Manciet, Célia Martinie, Philippe A. Palanque: Transparent Automation for Assessing and Designing Better Interactions between Operators and Partly-Autonomous Interactive Systems. ATACCS 2015, ACM DL, 129-139

3. Kai Eckoldt, Martin Knobel, Marc Hassenzahl, and Josef Schumann. 2012. An Experiential Perspective on Advanced Driver Assistance Systems. *IT - Information Technology* 54, 4, 165–171.

4. Michael Feary, Célia Martinie, Philippe Palanque, and Manfred Tscheligi. 2016. Multiple Views on Safety-Critical Automation: Aircrafts, Autonomous Vehicles, Air Traffic Management and Satellite Ground Segments Perspectives. In *Proceedings of the 2016 CHI Conference Extended Abstracts on*

Human Factors in Computing Systems (CHI EA '16). ACM, New York, NY, USA, 1069-1072. DOI: http://dx.doi.org/10.1145/2851581.2886430

5. Anna-Katharina Frison, Philipp Wintersberger, and Andreas Riener. 2016. First Person Trolley Problems: Evaluation of Drivers' Ethical Decisions in a Driving Simulator. In Proc. *AutomotiveUI '16*. ACM, Ann Arbor, MI, USA.
DOI: http://dx.doi.org/10.1145/3004323.3004336

6. Madeleine Gibson, John Lee, Vindhya Venkatraman, Morgan Price, Jeffrey Lewis, Olivia Montgomery, Bilge Mutlu, Joshua Domeyer, James Foley. 2016. Situation Awareness, Scenarios, and Secondary Tasks: Measuring Driver Performance and Safety Margins in Highly Automated Vehicles. *SAE International Journal of Passenger Cars-Electronic and Electrical Systems*, 9(2016-01-0145), 237-242.

7. Christian Gold and Klaus Bengler. 2014. Taking Over Control from Highly Automated Vehicles. Advances in Human Aspects of Transportation: Part II 8 (2014), 64.

8. Andrew L. Kun, S. Boll, and A. Schmidt. 2016. Shifting Gears: User Interfaces in the Age of Autonomous Driving. *IEEE Pervasive Computing* 15, 1 (Jan 2016), 32–38. DOI: http://dx.doi.org/10.1109/MPRV.2016.14

9. Andrew L. Kun, Linda Ng Boyle, Bryan Reimer, and Andreas Riener. 2013. AutomotiveUI: Interacting with Technology in Vehicles. *IEEE Pervasive Computing* 12, 2 (April 2013), 80-82. DOI: dx.doi.org/10.1109/MPRV.2013.27

10. Célia Martinie, Philippe A. Palanque, Eric Barboni, Martina Ragosta: Task-model based assessment of automation levels: Application to space ground segments. IEEE SMC 2011: 3267-3273

11. Roderick Mccall, Martin Baumann, Ioannis Politis, Shadan Sadeghian, Ignacio Alvarez, Alexander Mirnig, Alexander Meschtcherjakov, Manfred Tscheligi, Lewis Chuang and Jaques Terken. 2016. 1st Workshop on Situational Awareness in Semi-Automated Vehicles. In Adjunct *Proc. AutomotiveUI '16*. ACM, Ann Arbor, MI, USA.

12. Alexander Meschtscherjakov, Rod McCall, Nicolas Louveton, Thomas Engel, Manfred Tscheligi, and Vincent Koenig. 2015. MaDSAV: maintaining driving skills in semi-autonomous vehicles. In *Proc. AutomotiveUI '15*. ACM, New York, NY, USA, 136-139.
DOI=http://dx.doi.org/10.1145/2809730.2809732

13. Alexander Meschtscherjakov, Manfred Tscheligi, Dalila Szostak, Rabindra Ratan, Roderick McCall, Ioannis Politis, and Sven Krome. 2015. Experiencing Autonomous Vehicles: Crossing the Boundaries between a Drive and a Ride. In *Proc. CHI EA '15*. ACM, New York, NY, USA, 2413-2416.
DOI=http://dx.doi.org/10.1145/2702613.2702661

14. Alexander Meschtscherjakov, Manfred Tscheligi, Dalila Szostak, Sven Krome, Bastian Pfleging, Rabindra Ratan, Ioannis Politis, Sonia Baltodano, Dave Miller, and Wendy Ju. 2016. HCI and Autonomous Vehicles: Contextual Experience Informs Design. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems* (CHI EA '16). ACM, New York, NY, USA, 3542-3549. DOI: http://dx.doi.org/10.1145/2851581.2856489

15. Alexander Meschtscherjakov, Manfred Tscheligi, Peter Fröhlich, Rod McCall, Andreas Riener and Philippe Palanque. 2017. Mobile Interaction with and in Autonomous Vehicles. In *Proceedings of the 19th International Conference on Human-Computer Interaction with Mobile Devices and Services*, MobileHCI '17, ACM (New York, NY, USA, 2017), 78:1–78:6.

16. Bastian Pfleging, Ignacio Alvarez, Jennifer Healey, Nora Broy. 2013. AutoNUI: 3rd Workshop on Automotive Natural User Interfaces. In *Adjunct Proc. AutomotiveUI '13*, pp. 57-60, 2013.

17. Bastian Pfleging, Maurice Rang, Nora Broy. 2016. Investigating User Needs for Non-Driving-Related Activities During Automated Driving. In *Proc. MUM '16.* ACM, New York, NY, USA. DOI: http://dx.doi.org/10.1145/3012709.3012735

18. Ioannis Politis, Stephen Brewster, and Frank Pollick. 2015. Language-based multimodal displays for the handover of control in autonomous cars. In *Proc. AutomotiveUI '15*. ACM, New York, NY, USA, 3-10. DOI=http://dx.doi.org/10.1145/2799250.2799262

19. Morgan Price, Vindhya Venkatraman, Madeleine Gibson, John Lee, Bilge Mutlu. 2016. Psychophysics of Trust in Vehicle Control Algorithms (No. 2016-01-0144). SAE Technical Paper.

20. Andreas Riener, Myounghoon Jeon, Ignacio Alvarez, Bastian Pfleging, Alexander Mirning, Lewis Chuang. Manfred Tscheligi. 2016. 1st Workshop on Ethically Inspired User Interfaces for Automated Driving. In Proc. AutomotiveUI '16. ACM, Ann Arbor, MI, USA, pp. 4., DOI: http://dx.doi.org/10.1145/3004323.3005687

21. Andreas Riener, Alexander Meschtscherjakov, Alexander G. Mirnig, Manuel Giuliani, Manfred Tscheligi, Jeon Myounghoon, Zhi Zheng and Chung Hyuk Park. 2017. Workshop: CARobots: Automated Driving Systems as Robots on Four Wheels. In *26th IEEE International Symposium on Robot & Human Interactive Communication (RO-MAN 2017)*.

22. Christina Rödel, Susanne Stadler, Alexander Meschtscherjakov, and Manfred Tscheligi. 2014. Towards Autonomous Cars: The Effect of Autonomy Levels on Acceptance and User Experience. In *Proc. AutomotiveUI '14*. ACM, New York, NY, USA, Article 11, 8 pages. DOI=http://dx.doi.org/10.1145/2667317.2667330

23. Dirk Rothenbücher, Jamy Li, Brian Mok, David Sirkin, Wendy Ju. Ghost Driver: A Field Study Investigating the Interaction between Pedestrians and Driverless Vehicles. In Proc. 25th IEEE International Symposium on Robot and Human Interactive Communication, New York NY Aug 26-31, 2016.

24. Shadan Sadeghian Borojeni, Lewis Chuang, Wilko Heuten, and Susanne Boll. 2016. Assisting Drivers with Ambient Take-over Requests in Highly Automated Driving. In *Proc. AutomotiveUI '16*. ACM, Ann Arbor, MI, USA. DOI:http://dx.doi.org/10.1145/3003715.3005409

25. Sebastian Thrun. 2010. Toward robotic cars. *Commun. ACM* 53, 4 (April 2010), 99-106. DOI=http://dx.doi.org/10.1145/1721654.1721679

26. Manfred Tscheligi, Ulrich Bueker, Wendy Ju, Bernard Sendhoff. 2014. Panel "Toward 2020: Human Interaction with Autonomous Vehicles". In 9th ACM/IEEE International Conference on Human-Robot Interaction (2014).

27. Manfred Tscheligi, David Wilfinger, Alexander Meschtscherjakov, Carlos Montesinos, Roderick McCall, Dalila Szostak, Alexander Muir, Rabindra Ratan. 2013. Workshop: Exploring the User Experience of Autonomous Driving. In *Adjunct Proc. AutomotiveUI '13*.

28. Marcel Walch, Kristin Lange, Martin Baumann, and Michael Weber. 2015. Autonomous driving: investigating the feasibility of car-driver handover assistance. In Proc. *AutomotiveUI '15*. ACM, New York, NY, USA, 11-18. DOI=http://dx.doi.org/10.1145/2799250.2799268

29. Philipp Wintersberger, Andreas Riener, and Anna-Katharina Frison. 2016. Automated Driving System, Male, or Female Driver: Who'd You Prefer? Comparative Analysis of Passengers' Mental Conditions, Emotional States & Qualitative Feedback, In Proc. *AutomotiveUI '16*. ACM, Ann Arbor, MI, USA. DOI: http://dx.doi.org/10.1145/3003715.3005410