HEAD

Human Expectations and Experiences of Autonomous Driving

Public report

Project within: Electronics, Software and Communication
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Content

Executive summary

Developing autonomous cars is technically challenging and so far research into autonomous driving (AD) generally has focused on technical development and operational safety. Little has been known about user expectations and experiences relating to AD. Now that technologically putting AD cars on the road is a reality this project has taken the timely step of addressing this gap in knowledge. The main objective of this project has been to: Apply a multidisciplinary research model that can identify user expectations and experiences of AD-cars. Two different research approaches have been combined in this project; design ethnography and experimental methodology. The approaches have been developed in dialogue with each other and have been applied also in the on-going field operational testing in the overarching DriveMe project. Design ethnography brings together anthropological techniques of researching the present with design approaches to researching the future. In experimental methodology test participants are exposed to a system in a realistic, but often simulated, environment.

Within the project we undertook research with participants who were regarded as future AD car users in order to understand how they experienced commuting to work by car at present, and how they used existing autonomous features. We also performed an online ethnography study of a Swedish Tesla fans online forum in order to understand how user expectations and experiences of the ownership of a new high technology car with highly semi-AD functionality evolved. We also explored the families expectations of AD cars within the DriveMe project in order to understand how these expectations changed over time when they got the possibility to try autonomous driving functionality in their daily life. In the second phase of the DriveMe ethnographies we researched how the DriveMe AD cars was experienced and learned by the users, the new car's role in the family, the change in expectations and experience of autonomous features and the change in daily routines. In addition, customer needs regarding autonomous driving was explored on different markets (Stockholm, LA, Shanghai, London). The material above served as a base in the work with an 'impact map' (strategic planning of the project) and the design of low fidelity human-machine interaction (HMI) concepts. Experimental studies on test track were performed, in combination with an ethnographic approach. In these studies the Wizard of Oz (WOz) test cars that were developed within this project were used. These cars are based on Volvo XC90s and gives the ability to put test persons in a 'real' autonomous driving context by simulating all features of the AD car. One test track study was performed that compared different ways of initiating hand-over of control: steering wheel paddles, as a function in a menu, gear shifter and two-way steering wheel paddles, another one focused on if drivers trust a fully autonomous car and if they experience that in-vehicle tasks can be conveniently carried out when in full autonomous mode.

The project has brought together future-focused ethnographic research with experimental automotive testing. This has involved undertaking ethnographic research in both 'ordinary' everyday life and in testing and simulation conditions - using the Wizard of Oz-platform - in order to understand how people improvise with existing technologies and how they use and experience future technologies. These approaches have given new ways to get insights from users and has thus enhanced the design process of AD.

Background

About the project

Research into autonomous driving (AD) has generally focused on technical development and operational safety. Little has been known about user expectations and experiences relating to AD. Volvo Cars has high ambitions in the area of AD and test cars with autonomous functionality with actual users within the DriveMe project, which is a Swedish pilot project on public roads. To successfully introduce AD cars, where autonomous mode is extensively engaged, the cars need not only to demonstrate a commitment to safety, quality and environment, they need to also live up to the expectations of the user. In order to live up to Volvo Cars core vision of being *Designed Around You* the deployment of human-centred design is needed to achieve a uniquely integrated approach to the technological and social approaches to AD. There is a need to understand what makes people feel safe and in control, how the AD car shall behave in traffic so that the driver feels comfortable, and what makes people feel free and flexible. Now that technologically putting cars with automated functionality on the road is a reality this project has taken the timely step of addressing this gap in knowledge. Therefore, the main objective of this project has been to: Apply a multidisciplinary ethnographic and experimental research model that can identify user expectations and experiences of AD-cars.

HEAD has been undertaken in collaboration with DriveMe and has focused on what drivers' need, experience, understand, enact, believe and do as part of AD. To produce this much needed new in-depth knowledge the project has developed and made use of tailored innovative design ethnographic and experimental "Wizard of Oz" research techniques. The findings of this research have fed new research-based insights into the design, development and marketing/branding of the AD car. The combination of design ethnography and experimental testing in this project has given a unique opportunity to produce insights about how AD is experienced and perceived and has iterated these insights in experimental testing.

State of the art

In recent years the area of AD has gained rapidly growing interest and there is presently a global race in the area. Within the automotive industry several car manufacturers have made strong statements, but also non-automotive stakeholders have entered the scene and have revealed concepts that have attracted public attention. Contemporary cars can be driven both manually and partially automatically since they often have systems that can take over longitudinal and lateral control, and in the foreseeable future it will be possible to drive the usual car manually, partially automatically and fully automatically since driver involvement may need to differ between different traffic conditions. On the other hand, the autonomous cars designed by for example Waymo are aimed to be fully self-driving.

Research has established that the major benefits to be expected of AD cars are safety, fuel economy, lower emissions and driver convenience (Davila & Nombela, 2012; Rupp & King, 2010; Verberne, Ham, & Midden, 2012). These are benefits potentially to both the individual driver and to society at large. However, there has been a gap in knowledge about user

expectations and experiences of autonomous cars, what values customers attribute to them, and how they use them.

Understandings of user expectations are valuable because they have been claimed to have a crucial role in shaping the later experiences of a technology (Karapanos, et al, 2009; Wright, Wallace & McCarthy, 2008). Expectations of technologies are never neutral, they are influenced by social and cultural factors (Forlizzi & Ford 2000; Lindgren, 2009). Expectations can be both positive and negative and may be filled with hopes and worries (Wright, Wallace & McCarthy, 2008). An understanding of users' expectations can aid our development of and understanding of how users will experience, react to and behave in relation to AD cars. It will thus play an important role in informing AD car design for positive experiences. To be able to both ensure that AD is optimised in use and to reach market success globally, it is important to understand user expectations and prerequisites. Some interview studies on user expectations of AD cars have been conducted (e.g. Pettersson & Karlsson, 2015). These studies have given information about, for example, social implications, trust and every-day activities in autonomous cars.

Another gap in our knowledge about AD cars has been in the area of user experience. This is inevitable given that AD cars are not yet on the market. Simulator studies have been made, focusing on transitions between driver-vehicle in AD (e.g. Merat, Lai, Daly and Carsten, 2014). But few more realistic or long-term studies on user experience in the real AD-context has been conducted previously.

It has been revealed that trust plays a prominent role when it comes to using automation (Lee and Moray, 1994), given that full automation can be problematic because people can fail to rely upon it appropriately. To feel trust in the automated car people need to feel safe and in control in this new redefined driving situation. It is therefore vital to understand how to reach optimal reliance on automation and how trust will be experienced and generated for AD cars. Research has revealed that many factors potentially impact on the generation of trust, such as expectations, context, automation characteristics, cognitive processes and brand promise (Lee and See, 2004). In addition, trust in a car's abilities is related to normative perceptions of such things as appropriate distances between vehicles and specific speeds, how aggressive one should be when passing another vehicle, etc. These perceptions themselves can change from one cultural context to another, or based on such factors as the age, gender, or driving experience of the AD uses.

In the US, Europe and also parts of Asia people spend a large amount of time every day commuting by car, the commute comprises more than any other category in vehicle kilometres travelled (e.g. NHTS, 2009). Studies in the US have indicated that people like their commute if the trip is relatively easy, but this is proven to be less true for people commuting in urban areas (Langer, 2005). The commute situation for these drivers can most certainly be improved if there is a possibility to have the freedom to focus on more meaningful activities than driving. To be able to provide this freedom the time gained needs to be perceived as valuable, i.e. the AD driving would not require constant monitoring.

Sociological and anthropological studies of what people do in cars reveal two key findings relating to how people know their car and how they associate particular forms of behaviour. These works suggest that drivers experience cars and driving in ways that the car feels as though it becomes an 'extension' of the body (Jordan, Wasson and Roth-Lobo https://www.epicpeople.org/ethnographic-study-lifts-the-hood/), and that driving can be understood as a social activity, through which drivers continually define other drivers as

particular types (Laurier and Dant, 2012) according to their cars and the ways they act/drive. Indeed, an important part of the driving experience that is not sufficiently recognized concerns the degree to which the driving experience is framed as adventurous, and may press the boundaries of what is perceived to be safe and trustworthy (O'Dell, 2001). Notions of freedom, and being able to brazenly explore the open road can come in conflict with attributes of driving such as trust, and safety, which are otherwise positively valued. These types of tensions between perceptions of freedom, safety and trust can have a direct effect on the manner in which the potentials of AD are perceived, understood and deemed appealingly desirable (or not). These studies together suggest two questions: what should it feel like to drive an AD car and in what ways can the design of AD cars take into account the manner in which the AD car/driver interface can be understood as part of the larger social activity of driving.

Research methodologies

In this section we outline the two different research approaches that have been combined in this project; design ethnography and experimental methodology.

Design ethnography

Design ethnography combines methods from the social sciences and design to undertake in depth analysis of the real everyday contexts of product and service use. These methods have been successfully developed in the field of design anthropology (e.g. Gunn et al 2013) and by Sarah Pink in applied research in other technology fields in UK and Australia (e.g. Pink et al 2013, 2014, Pink 2015 Lingard et al 2015). This project has taken the innovative step of engaging these methods in the development and implementation of research focused on automated driving. The approach engaged in this project has used immersive participant observation and interviewing methods, innovative video and digital techniques to investigate aspects of AD use and experience that are not accessible through standard interviewing and observation. The strength of ethnographic methods lies in their ability to illuminate and bring understanding about people's real behaviour and attitudes as they unfold as an aspect of their daily lives.

Ethnographic interviewing (Pink 2015), video recorded re-enactments (Pink and Leder Mackley 2014), and go-along accompanied use of WOz and DriveMe cars have been used to gain deep insights into the usually not spoken about, hidden and mundane, but important, aspects of the experience of AD car use. Observational and participatory ethnographic methods have enabled researchers to identify how users' needs emerge in real life contexts as they use AD cars. Speculative and interviewing methods has uncovered how expectations about AD are formed and articulated in relation to people's previous experiences as well as the experiences they derive from actually using AD cars. The speculative aspects of these research techniques focus upon how people imagine future uses and engagements with AD technologies, through interviewing and enactment methods.

Experimental methodology

For an iterative UX design process there is a need to be able to put people in the right context when conducting evaluations. In the area of AD, evaluations need to be made in a realistic environment before fully functional AD cars are available. For this car simulators can be used, but to get a more realistic and ecologically valid test setup the Wizard of Oz (WOz) methodology is

more promising. WOz is a research approach in which participants interact with a system that they believe to be autonomous, but which is actually being operated or partially operated by an unseen human being (Bella & Hanington, 2012).

In this project Volvo Cars has developed a Wizard of Oz test platform and new experimental methodology for studying the interface between the autonomous car and users. In WOz studies, participants are told to act as if they are interacting with a computer system through an interface, when in fact their interactions are mediated by a human operator – the wizard. The use of "the wizard in the loop" experimental setup allows experiments to be both less constrained – through use of improvisation or the wizard's expressiveness - and more systematically constrained – by cutting out the limitations of an automated system. It does this in a way that is not reliant upon the development of new software and algorithms to control the vehicle, as is the case in real computer-operated system (Dahlbäck, 1993). WOz can provide an inexpensive and flexible simulation due to the use of a human operator. As indicated in Hoffman et al. (2014), WOz experiments early in the design process can be used to explore a wide range of possibilities and can help identify key features and functions of a system. Given its versatility, WOz is a good platform to examine interactions between humans and automated cars. The WOz technique has been used in the automotive research community for the design and study of automotive user interfaces (e.g. Geutner, 2002; Schuller, 2006; Alpern, 2003; Tsimhoni, 2004; Lathrop 2004). As these cars give a very realistic autonomous experience that allows the driver to be fully out of the driving loop they have complemented the DriveMe project in terms of test scenarios that would not be possible to evaluate in the DriveMe cars.

Objective

The central objective of this project was to – **Apply a multidisciplinary ethnographic and experimental research model that can identify user expectations and experiences of AD-cars**. This illuminated the following research questions:

1. How can ethnographic and experimental ("Wizard of Oz") methods be used to enhance the design process of AD? How can the organisation (Volvo Cars) be provided with insights from users' expectations and experiences of AD?
2. What are the recruited DriveMe users' *expectations* of AD cars before use?
3. How are the DriveMe AD cars *experienced and learned* by the users? What do people do during AD-time? What do they want to be able to do?
4. How are different HMI-concepts for AD *experienced* (using the "Wizard of Oz" methodology)?

Project realization

Two different research approaches have been combined in this project; design ethnography and experimental methodology. The approaches have been developed in dialogue with each other and have been applied also in the on-going field operational testing in the overarching DriveMe project. As described above, design ethnography brings together anthropological techniques of researching the present with design approaches to researching the future. Ethnography is an

approach that enables us to go under the surface of people's experiences to investigate what happens in everyday life, how they feel about it and the hopes, and anxieties, they might have for the future. It involves face to face encounters with research participants in the actual circumstances of their everyday lives. Experimental methodology relies more on a controlled environment and manipulation of variables to test a hypothesis. We used ethnography and experimental methodology across several studies within this project:

In-car ethnographies: We undertook research with 15 participants who were regarded as future AD car users in order to understand how they experienced commuting to work by car at present, and how they used existing autonomous features, such as autobrake. We studied how they prepared for their commute at home, how they experienced the commute itself and their arrival at work. This was achieved by visiting them at their homes, and travelling with them along their usual commute routes into the city. We used innovative video-based research methods to investigate with participants how they organised and experienced their commutes and how they used automated and connected digital technologies as part of their driving and commuting experience. We also used future-focused methods that involved using the experience of the present as a basis upon which to imagine more automated future driving experiences. We found that: in the present the relationship between the car and the smartphone is pivotal in the commuting experience, and that participants used the smartphone in relation to and to augment automated and connected features of their cars; most of our participants valued their smartphones more than they valued their cars and would chose to relinquish the car if they had to choose; and that participants were able to imagine future automated features based on their existing experience and needs.

Online ethnography: We also performed an online ethnography study of a Swedish Tesla fans online forum in order to understand how user expectations and experiences of the ownership of a new high technology car with highly semi-AD functionality evolved. We followed the forum discussions for 10 months to discover how the user expectations and experiences of the car ownership of a new high technology car with semi-AD were expressed in the forum community. In the analysing process different themes emerged through coding and grouping of the content in the selected discussion threads. To narrow down the data amount, we selected three active Tesla owners from the forum and followed their online activities more than two years back in time, even before they became Tesla owners, and used their stories to exemplify the different ways how to become Tesla owners and how their anticipation of the car user experience and semi-AD technology were shared within the forum. To get an even deeper understanding of the different ways how to experience the car and become a Tesla owner, we made six phone interviews with some of the Tesla owners from the forum. We found out two things, first that the digitalisation of the car online blurred the border between a digital and a physical user experience (UX) of the car and enabled expectations of becoming a owner to continuously evolve through the online interactions. The expectations became a user experience in itself through the online discussions. Second, we identified how anticipation developed as a shared endeavour that evolved through five ways which forum members engaged and participated in their community of practice. Through their online interactions their UX evolved before using the actual car. Our findings provided deeper understandings of anticipatory UX, and insights for UX design.

Ethnography as part of the DriveMe project: We explored the family's expectations of AD cars within the DriveMe project in order to understand how these expectations would change over time when they got the possibility to try autonomous driving functionality in their daily life (research question 2). In the DriveMe project five families were recruited for a one and a half

year. During this time they got access to a DriveMe test car with autonomous drive capabilities to use as the main car for their everyday use. Although during the project, the legislation and technical limitations made it only possible for them to use the DriveMe cars in semi-autonomous drive, where they needed to have full responsibility and control of the car even if the car was able to keep speed, distance and between lanes in many situations. To explore the family's expectations of AD cars before use, we met the five families in the beginning of the DriveMe project before or just after they received their DriveMe car at their home for dinner or fika. The home visit activities involved two researchers visiting the participants' family homes where we undertook a series of group activities that included as many family members as possible. During the development of the methodology two external families from the DriveMe project were also interviewed and their empirical data also became part of the analysis. In this explorative approach we went through a number of different subjects in order to get to know the whole family, their different kind of travels, their everyday life struggles and highlights, how driving feels sensually/embodied and their expectations towards AD cars. This was done by using different visualisation techniques, were the families drew their everyday car routes on a map or drew how they organised the things and themselves inside the car and their reflections of how things might change when the AD functionality is available. We discovered a number of different themes that stood out from the interviews. Generally, they had quite high expectations about how AD would make their everyday life more simple and relaxed and solve some of their everyday car related routines, but they were also worried about thing like trust in the technology, the risk for losing the skill of driving, if shared AD cars would be flexible enough to solve their needs and practical things like were they could put all the stuff that they had in their car today. By this approach we made the families more relaxed and within their home context to easier relate AD functionality in their everyday life and together as a family.

In the second phase of the DriveMe ethnographies we researched how the DriveMe AD cars was experienced and learned by the users, the new car's role in the family, the change in expectations and experience of autonomous features and the change in daily routines (research question 3). We undertook drive-along interviews where we joined together with one or two of the family members in the car on their everyday way to work. These drive along interviews were done after a couple month after they received their car. All the families had become very familiar with the DriveMe car and the semi-autonomous driving functionality and it had become an integrated part of their everyday routines. The drive along interviews made the families to naturally reflect on their driving routines and they also instantly reflected on common traffic situations that occurred during the drive. From these interviews we found a number of themes like how learning of the cars AD functionality was a two-way communication challenge between the car and the driver, expectation of what the car would do next and tricks how they for e.g. used the control for distance to vehicle ahead as the control for managing the traffic flow to make room or not for other vehicles trying to merge into the lane in front.

International studies: Customer needs regarding autonomous driving was explored on different markets (Stockholm, Los Angeles, Shanghai, London). In Stockholm an approach called "Participatory innovation" was used where both users and stakeholders are involved in the innovation process. In Los Angeles, Shanghai and London focus groups were conducted with Volvo owners as well as non-Volvo owners to understand users' behaviours and needs on these markets. The material served as a base in the work with an 'impact map' (strategic planning of the project and future products) and the design of low/high fidelity HMI concepts.

Experimental study on test track: A Wizard of Oz test car based on an XC90 has was developed and evolved. The car was used as test platform for autonomous driving in experimental studies on test tracks. The car gives the ability to put test persons in a 'real' autonomous driving context by simulating all features of the AD car. A test track study was performed that compared different ways of initiating hand-over of control: steering wheel paddles, as a function in a menu, gear shifter and two-way steering wheel paddles (research question 4).

Experimental study on test track, with before and after in-car ethnographies: The aim of the study was to explore if drivers trust a fully autonomous car and if they experience that in-vehicle tasks can be conveniently carried out when in full autonomous mode. The test was conducted on a test track and an autonomous research car - WOz car - was used. The participants experienced a car that was capable of handling the test track driving environment with full autonomy. When in full autonomous mode the participants got to engage in individually selected tasks, such as use media display, read, eat, drink and carry out work tasks with their own portable device (research question 4). The results show that participant trust the autonomous car and they find it convenient to conduct in-vehicle tasks while in full autonomous mode. In addition to this, the test participants were interviewed in their private cars on their way to and from the test site. These goal with these ethnographic interviews were to ask the participants about how they felt about driving and their cars in general and what they thought about how increasing levels of autonomous driving features could be part of their everyday life. The test gave the participants possibilities to experience the feeling of self-driving mode and during the in-car interviews on the way back from the test site, these experiences opened up the discussion toward new thoughts on what they expected would happen with their driving and relationships to cars that was impossible to know before having tried. These results indicated new ways of combining tests with experiment cars with ethnographic interviews, that deepened the results from the test into including accounts of expectations.

Results and deliverables

The project has contributed to the overall FFI targets:
- Increase research and innovation capacity in Sweden. The work has contributed to knowledge regarding test methods for AD in a user experience focused design process. The long-term radical contribution of this project lies in the ability to intertwine qualitative ethnographically based research with technologically grounded innovative research and development in the field of autonomous driving. The findings in the project have a direct impact on the future implementation of AD functionality for Volvo Cars. Halmstad University will utilize the competence gained in this project to remain competent partners in research within this area. Participation in forward thinking research projects is vital for Halmstad University's ability to attract and retain talented researchers.
- Develop competitive and internationally connected research and innovation clusters in Sweden.
- Promote cooperation between industry, universities and institutes.

The project has supported two areas of the FFI collaboration program "Vehicle Development":
- Vehicle electrics and electronics. The simulation of future functionality using the WOz platform is vital since simulated behaviours of automated functions (e.g. algorithms) can be evaluated early in the design process.

- Methods and tools for vehicle development. HEAD has included research and ideation activities as well as development of tools and processes for design and evaluation, which have already been successfully applied in other ongoing research and development projects. The long-term radical contribution of this project lies in the intertwined qualitative ethnographically based research with technologically grounded innovative research and development in the field of autonomous driving. In addition, this interdisciplinary human centred research approach is vital for the stimulation of technological innovation and long-term competitiveness.

Dissemination and publications

Knowledge and results dissemination

Insights from design ethnography have been developed in dialogue with the experimental studies throughout the project. These have been disseminated through seminars and workshops in order to provide an ongoing flow of ethnographic every day and futures insights to Volvo Cars (research question 1). The project results were presented to a broader public of Volvo Cars employees and invited guests at an exhibition at Volvohallen in June 20 2018.The following presentations and workshops have been held by project members at international conferences:

- Keynote lecture, 'Will my self-driving car kill me?' at Why the World Needs Anthropologists, Lisbon, Portugal (October 2018), https://www.applied-anthropology.com/speaker/sarah-pink/.
- Workshop, 'Creating continuous communication: anthropological research in automotive industry', at Why the World Needs Anthropologists, Lisbon, Portugal (October 2018), https://www.applied-anthropology.com/session/w-creating-continuous-communication-anthropological-research-in-automotive-industry/.
- Invited lecture, 'Should we care if AD cars can kill us?' at Trust, hope and (im)possible digital futures' Digital Studio, University of Melbourne, Melbourne, Australia (September 2018).
- Distinguished Lecture, 'Applied Visual Anthropology' at ICSTE, Lisbon, Portugal (October 2018).
- Workshop, 'A design anthropology approach to experiential futures and autonomous driving', at Participatory Design Conference, Hasselt & Genk, Belgium (August 2018) https://pdc2018.org/programme/interactive-workshops-and-tutorials/ws11-a-design-anthropology-approach-to-experiential-futures-and-autonomous-driving/.
- Public lecture, 'Design Ethnography for Responsible Digital Futures' at Designing our Digital Futures panel Swinburne University, Melbourne, Australia (July 2018).
- Conference Presentation, 'Drivers quickly trust autonomous cars' at AHFE, Orlando, USA (July 2018).
- Public lecture, 'Design, Ethnography and Technology in a World of Uncertainty' at Sonar Music and Technology Festival, Barcelona, Spain (June 2018)
- Invited Conference presentation, 'Autonomous Ride - Trust and Freedom' at Autonomous Vehicle Interior Design and Technology Symposium Europe, Stuttgart, Germany (June, 2018).
- Keynote lecture, 'Smart Mobilities for Human Urban Futures' at Drive Sweden round table, Dome of Visions, Lindholmen Science Park, Gothenburg, Sweden (June 2018).

- Keynote lecture, 'Design Ethnography and the Technological Possible' at NUX Samsung Training Seminar, Campinas, Brazil (May 2018).
- Invited seminar, 'Imagining Autonomous Driving Futures' at SensiLab, Monash University, Melbourne, Australia (May 2018).
- Invited Conference presentation, 'Autonomous Driving Futures: a human approach' at Roads Australia Annual Conference, Sydney Convention Centre, Sydney, Australia (May 2018).
- Invited seminar, 'Autonomous Driving Futures' at Department of Media and Communication, University of Sydney, Sydney, Australia (May 2018).
- Public lecture, 'Emerging Technologies: towards responsible ethical futures' at University of Western Australia, Institute for Advanced Studies Fellowship, Perth, Australia (April 2018).
- Public lecture, 'Emerging Technologies and Automated Worlds' at IT University, Copenhagen, Denmark (January 2018).
- Keynote lecture, 'Designed around you - Multidisciplinary research approach for Autonomous Driving', WEconnect, Berlin, Germany (June 2017).
- Keynote lecture, 'Design Anthropology for Automated Mobilities' at Volvo Industrial PhD Program (VIPP) Conference, Volvo Cars, Gothenburg, Sweden (September 2017).

Publications

Papers

- Osz, K., A. Rydström, S. Pink, V. Fors, & R. Broström (in press) 'Building collaborative testing practices: design ethnography and WOz in Autonomous Driving research', IxD&A Journal.
- Pink, S. K. Osz, V. Fors and D. Lanzeni (forthcoming) 'Simulating and Trusting in Automated Futures: Anthropology and the Wizard of Oz' in S. Abram and M. Kazubowski-Houston (eds) Unimaginable Worlds. London: Bloomsbury.
- Broström, R., Rydström, A., Kopp, C. (2018) 'Drivers quickly trust autonomous cars'. In: Ahram, T., Falcão C. (eds.) Advances in Usability, User Experience and Assistive Technology. AHFE 2018. Advances in Intelligent Systems and Computing, vol 794. Springer, Cham.
- Lindgren, T., M. Bergquist, S. Pink, V. Fors and M. Berg (2018) 'Experiencing Expectations: Extending the Concept of UX Anticipation' 9th Scandinavian Conference on Information Systems (SCIS9).
- Lindgren, T., V. Fors, S. Pink, M. Bergquist and M. Berg. (2018) 'On the Route to Anticipated Car UX' NordiCHI 2018, October 1-3, 2018, Oslo, Norway. https://dl.acm.org/citation.cfm?doid=3240167.3240219
- Osz, K., K. Raats, V. Fors, S. Pink and T. Lindgren (2018) 'Combining WOz testing and ride along video ethnographies: advancing methodologies for Autonomous Driving car development for mixed traffic environment' OzCHI 2018, Melbourne, Australia.
- Pink, S., V. Fors and M. Glöss (2018) 'The contingent futures of the mobile present: beyond automation as innovation' Mobilities. https://doi.org/10.1080/17450101.2018.1436672
- Pink, S., V. Fors and M. Glöss (2017) 'Automated Futures and the Mobile Present: in-car video ethnographies' Ethnography. https://doi.org/10.1177/1466138117735621

Theses

- Lögdahl, T. & Lundholm, F. (2017). 'Lean-back interaction for autonomous driving - Concept development with focus on user experience' at Volvo Cars. Bachelor Thesis, Luleå University of Technology, Luleå.

Design probes

- *Sparks* - A series of speculative videos used to generate ideas and reflections within the project. The videos can also be utilised in broader contexts within the automotive industries, as part of   design processes or as a tool in relation to strategic decision making. As speculative probes the videos are instruments of evocation, promoting lateral thinking and provoking affective dimensions. More info as well as the videos: https://vimeo.com/album/5382602.
- *Design Cards and Concept Cards* - Cards that both visualise and explain insights and implications of the ethnographic studies. These cards have been used in workshops within the project team and in external contexts.
- *Student project design probes* - In a collaborative student project with Eindhoven University of Technology, the task was given to make design concepts on; how people effectively can be brought back into the loop; clear hand-overs when going from AD to manual driving; how to design for privacy in an AD vehicle - "cocoon".
- *Impact map* - strategic planning, focusing on the needs of users.
- *Wizard of Oz (WOz) test cars* - WOz test platforms based on Volvo XC90s has been developed. The cars are used as test platform for autonomous driving in experimental studies. The car gives the ability to put test persons in a real autonomous driving context by simulating all features of the AD car.

Conclusions and future research

The objective of this project has been to apply a multidisciplinary ethnographic and experimental research model that can identify user expectations and experiences of AD-cars. The project has achieved this by bringing together future-focused ethnographic research with automotive user testing. As outlined above this has involved undertaking ethnographic research in both 'ordinary' everyday life and in testing and simulation conditions, the innovative Wizard of Oz-platform, in order to understand how people improvise with existing technologies and how they use an experience future technologies. In doing so we have been able to create a new understanding of trust in AD cars which depends not simply on the testing and measurement techniques that have conventionally been used in this area, but that also accounts for the sensory, emotional and unspoken body experience of drivers/users of AD cars. This is important because it brings to the fore the subjective and personal elements of trust that will determine how humans engage with AD, and determines patterns across our research sample that suggest that trust is a feeling that needs to be accounted for, and provides insights into how to go about creating the circumstances for humans' trust in AD through design for human-machine relations. This subsequently both advances understanding in industry and academic knowledge.

Related work within the area of research methods for understanding user needs and behaviour related to intelligent cars is continued in, for instance, FFI TIC (Trust in Intelligent Cars).

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