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Mediated participatory design for contextually aware in-vehicle user-experiences with autonomous vehicles

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ABSTRACT

This study reports on the empirical findings of a series of participatory design workshops for the development of a supportive automotive user experience design system. Identifying and addressing this area with traditional research methods is problematic due to the different user experience (UX) design perspectives that might conflict and the related limitations of the automotive domain. Consequently, we deploy a pragmatic epistemological paradigm and apply participatory prototyping methods to resolve this problem. We conduct two iterations of design and evaluation with 19 user experience (UX) designers through individual participatory prototyping activities to gain insights into their explicit, observable, tacit and latent needs. We describe the design of a toolkit tailored to the character of the study to be used in relevant studies of ill-defined or wicked problems. The participatory design activities initially allowed us to explore the motivation to use different technologies, the system's architecture, detailed features of interactivity, and to describe our users' needs. As a result, our first analysis of data led us to design implications that translate participants' needs into UX goals. We use these UX goals for the design of goal-directed personas and scenarios of use as actionable insights to develop our system. A medium-fidelity functional prototype of our system was then evaluated, while contextually aware automotive UX practitioners criticised our design decisions. Some of the essential findings when supporting the contextual understanding are generating new knowledge to inform both theory and practice. The results propose that most automotive UX designers are ready to adopt technologies that use sensitive physiological measures such as eyes, face, body tracking using cameras and computer vision. In contrast, non-automotive UX designers who empathise with the passengers and the drivers and perceive the in-vehicle space as something more private are suggesting that this might affect people's trust. The majority agrees to collect data and communicate with the users using implicit and explicit context, as a way to support UX design in the autonomous vehicles would require the consent of the passengers. Even though UX designers suggested a general interest in the social and temporal context of the interactions, the limitations of privacy and safety in the vehicle limit them in collecting task-related contextual data leaving the social, temporal, and physical context unexplored. Safety is arguably a factor that will not restrict the future of autonomous driving experiences research and design since there is no cognitive demand on level five autonomy which hands the passengers with plenty of other options when not driving, assuming that they are ready to trust a fully automated system. However, our study does not provide us with a direction on the privacy of autonomous vehicle experiences and whether privacy will continue being a limitation in the context of self-driving vehicles. Thus, we would recommend further research on trust and privacy in fully automated vehicles. We conclude by discussing the design implications and functional tools of our system, including 1) a video tagging tool that supports saving an occurrence identified momentarily on real-time video. 2) A privacy call-wall which uses implicit and explicit context to avoid intrusiveness in private situations. 3) A human-like avatar tool for mitigating privacy issues, and 4) an interactive interviewing tool to support communication between UXers and the passengers of autonomous vehicles. Finally, 5) exploration tools, including a tool for searching participants' characteristics and target groups of people. We further inform the body of knowledge in participatory UX and HCI methods about the advantages of our methodological approach and the limitations of using it. We discuss why involving non-experts in co-design activities using toolkits tailored to the domain of interest is valuable. Furthermore, we extensively address how, and we give directions for the design of similar toolkits by describing the toolkit that we designed and applied in our study. Conclusively we discuss the broader implications of trust and privacy in other domains and how this related to our findings.

DEDICATION

I dedicate this dissertation to my father, who encouraged me to undertake doctoral research and my mother for teaching me how to withstand shock without permanent deformation. Finally, my brother and my friends for all their psychological support.

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PUBLICATIONS

The following papers have been peer-reviewed and accepted for publication as a result of the research conducted for the degree of Doctor of Philosophy.

Tasoudis, S. and Perry, M., 2018. Participatory Prototyping to Inform the Development of a Remote UX Design System in the Automotive Domain. *Multimodal Technologies and Interaction*, *2*(4), p.74.

Tasoudis, S. and Perry, M., 2018, September. RAUX: A supportive system for remote automotive UX R&D. In *Adjunct Proceedings of the 10th International Conference on Automotive User Interfaces and Interactive Vehicular Applications* (pp. 225-229). ACM.

Tasoudis, S. and Perry, M., 2016, October. Mediated participatory design, for contextually aware in-vehicle experiences. In *Proceedings of the 8th International Conference on Automotive User Interfaces and Interactive Vehicular Applications, Ann Arbor, MI, USA* (pp. 24-26).

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1. CHAPTER ONE: INTRODUCTION

1.1. ESTABLISHING A RESEARCH TERRITORY

1.1.1. THE IMPORTANCE OF THE TOPIC FOR THE DISCIPLINE AND SOCIETY

Autonomous driving in the 21st century unleashes both concerns and possibilities. Secondary tasks or activities which now equally contribute to the driving experience may become a primary concern for researchers and designers, in the self-driving car era. Thus, a new set of experiences will gradually craft the future of vehicles. This places new and additional demands on automotive designers, requiring them to expand their set of design methods to accommodate these shifts in orientation, and exposes new opportunities for tools to support the design process. Autonomous driving is transforming the driving experience in the 21st-century vehicle. Artificial Intelligence is core to this automation in enhancing safety and reducing accidents, although it may bring with it a loss of the traditional driving experience and the sense of being in control. This new paradigm results in a radical shift in the traditional driving experience. While part of the driving experience may be taken away by automation, travellers also have the convenience of using their free commuting time to explore different driving experiences and in-vehicle interactions in the car context. Given the possibilities of web 2.0 and the Internet of things (IoT), what were previously considered as secondary driving tasks or activities, such as interacting with in-vehicle information systems, infotainment, in-car productivity or social interactions and real-life experiences with other passengers in the car, are slowly emerging as primary activities.

For this new era, to structure the automation degree of vehicles, the NHTSA (2013) defined five levels of autonomy from non-autonomous at all to fully autonomous. No automation is given, and the driver is in complete control at level 0. Single functions are autonomous (e.g., electronic stability control) in Level 1, while Level 2 involves automation of at least two primary control functions (e.g., adaptive cruise control in combination with lane centring). When the vehicle is at Level 3, the driver may cede full control to the autonomous vehicle for a period (e.g., platooning). Accordingly, the vehicle in Level 4 acts on a highly automated level, performing all safety-critical driving functions for an entire trip. With ongoing automation of safety-critical driving functions, cars increasingly become autonomous systems, which make intelligent decisions based on sensory data. Utilising this functionality, they relieve the driver from the cognitive load, as they usually have to concentrate on monitoring the traffic and executing driving tasks (Rödel *et al.*, 2014). Finally, Level 5 is defined as full autonomy which we can find on SAE's levels of automation (Figure 1) classification, which we also prefer to use since the Department of Transportation supports it.

Previous research has investigated the non-driving-related activities that drivers want to perform while driving partly or entirely automated and has identified the potential for mobile and ubiquitous multimedia applications in the car (Pfleging, Rang and Broy, 2016). As a result, the recent focus of attention in automotive UX research includes design techniques for exploring automotive interaction in the drive towards automation (Pettersson and Ju, 2017).

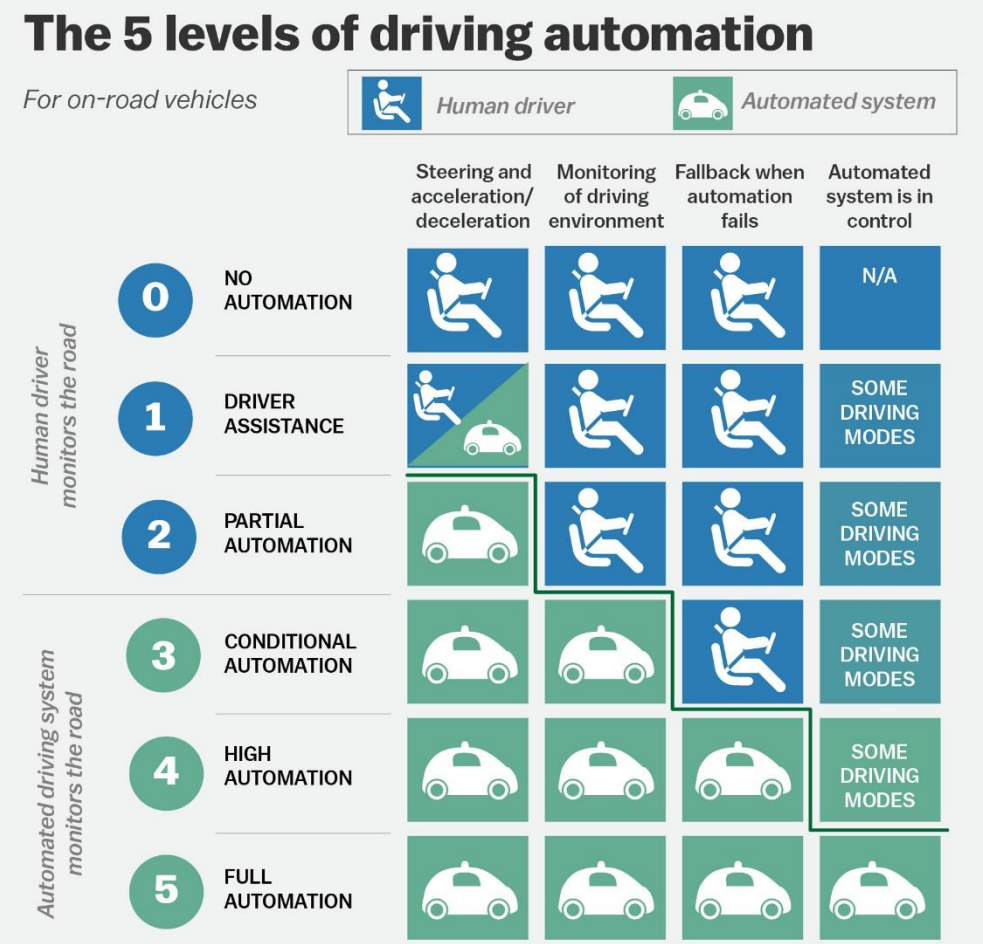


Figure 1: SAE's levels of automation classification.

Furthermore, understanding what it means to drive in an autonomous vehicle shows the potential of a shift from a 'joy of driving' to a 'joy of being driven' through the exploration of new forms of connectivity, entertainment, productivity, gaming as well as transportation-related services (Meschtscherjakov *et al.*, 2016). Previous work reviews and highlights the most common non-driving related tasks that are used in studies on automated driving (Naujoks *et al.*, 2018), many tasks including relaxation and wellbeing related tasks, productivity-related, research and games/skills related tasks. This space hands designers new opportunities for innovation, yet the deficiencies (Tasoudis and Perry, 2016) entailed by the context of the car add layers of complexity to the research and design practitioners.

Designing for user experiences is a field that emerged quite quickly in Economic studies (Experience economy), Marketing and Psychology studies (Customer Experience, CX) and (Technology as experience) and gradually became an essential component of Design and Human-Computer Interaction, HCI (User Experience, UX) studies (Pine & Gilmore 2011, Gentile et al. 2007, McCarthy 2004, Hassenzahl 2010). Many designers have previously defined design for experience in the context of HCI (Kort et al. 2007, Mahlke 2005, Law et al. 2009).

In this study, we use the definition given by Hassenzahl & Tractinsky (2006): *User experience is a consequence of a user's internal state (predispositions, expectations, needs, motivation,*

mood, etc.) the characteristics of the designed system (e.g. complexity, purpose, usability, functionality, etc.) and the context (or the environment) within which the interaction occurs (e.g. organisational/social setting, meaningfulness of the activity, voluntariness of use, etc.). As a result, designing for experiences is dependent on the context of the interactions. Equally designing for in-vehicle interactions requires an understanding of the context of the vehicle according to the definition above. The methods that are used by designers to design for experiences are restricted by the limitations of each domain and its context. Even though supporting the adoption of these methods is crucial, specific deficiencies of some domains such as the automotive play a critical role in the adoption of some of these methods by designers. By highlighting the importance of experience design though, in any domain, Pine & Gilmore (2011) suggest that goods and services are no longer enough to foster economic growth, create new jobs, and maintain economic prosperity. The staging of experiences must be pursued as a distinct form of economic output to realise revenue growth and increased employment. Finally, design for experiences in the automotive domain is essential for a wide range of scientific and industrial processes, due to the large scale of the market of transportation. Thus by achieving it, the impact in society is going to be instantly visible, and according to Pine and Gilmore, it will help maintain economic prosperity.

1.1.2. SYNOPSIS OF LITERATURE

Even though a part of the driving experience is taken away by automation, people have the convenience of using their free commuting time to explore different driving experiences and in-vehicle interactions in the vehicle, especially given the possibilities of web 2.0 and the Internet of things (IoT). Scholars have long researched the automotive domain to inform design decisions and develop the new human-computer and human-machine interactions in the vehicle. A considerable amount of literature has been published on simulation-based studies to understand driving performance, cognitive/mental load or workload, and system-related factors, such as task completion times, and safety of users while interacting with an in-vehicle information system (IVIS) or other proposed technologies. Therefore, design frameworks and significant factors that can help design development are reported for secondary tasks while the primary task is still driving. To mention a few of them, Liu & Wen (2004) conducted a simulator-based study comparing a visual display to an audio-only and a multi-modal display. Sodnik *et al.*, (2008), on his study, compared three types of interfaces for in-vehicle information systems; an HDD was compared to two auditory interfaces. Similar, Weinberg et al., (2011) compared the impact of interacting with combinations of an HDD and text-to-speech (TTS) system, a HUD and a TTS system, and an audio-only TTS representation of lists of choices. Users' safety and the destruction of users are mainly in the focus of previous research examining which interface is less detrimental to driving performance while interacting with an in-vehicle information system (IVIS) or other proposed technologies as previously mentioned.

Despite their empirical success, the studies previously mentioned having many problems according to other researchers (Meschtscherjakov et al., 2011, and 2012), who argue that there has not been a detailed investigation in the context of the automotive. When designing for interactions, context refers to the social environment of the interaction, the physical environment either the space of the interaction is dynamic or static, and the time dependence of the interaction in a specific situation. Any of the above can have a direct effect on the interactive experience. It is generally agreed among designers and researchers, Meschtscherjakov et al. (2011), Visser et al. (2005) and Sanders & Stappers (2008), that the context is both of great importance to a holistic understanding of the interactions taking place and necessary in designing for people and their experiences. The context of automotive is

indeed essential, and a few studies have investigated the influence of automotive context in a systematic way using qualitative methods in real-time driving situations. A study by Laurier et al. (2008) gained many valuable insights drawing on analyses of video records of a series of quite ordinary episodes of car travel during driving journeys, such as the in-car hospitality and the slow conversations that were noticed when the car was going faster (Laurier et al. (2008). Different kinds of contexts were at the focus of researchers' attention. The social context was no exception and the need to identify the most complicated automotive tasks involving interactions in a social context was previously a concern. To achieve identifying these tasks some studies used a follow and film approach, which means that the researcher spends time with the participants inside the car and reflect on their experiences (Cycil *et al.*, 2013). Another approach to capturing the experience as in Lee et al. study (2015) questionnaires and experimental design for capturing pre- and meta- experience perception of in-vehicle technology (Lee *et al.*, 2015). Studies of ethnographic research are not conventional, yet, we can identify some most recent studies using it for applying socio-cultural understanding into the driving experience research in collaboration with Nissan (Jordan, Wasson, and Roth-Lobo 2015). Analyses of video recordings, video ethnography and or sensors to collect data, as mentioned before, are all exciting attempts to in-depth research of the in-vehicle interactions.

Nonetheless, Meschtescherjakov et al. (2012) highlight that the main weakness of these methods is that participants should have the possibility to express their feelings immediately after an event to mitigate retrospective bias (Meschtscherjakov *et al.*, 2012). Immediateness and situatedness (Csikszentmihalyi, 2014) are limitations for capturing the experience when it happens. Indeed, early writings on usability have already expressed the notion that manifestations of usability such as productivity or learnability are not primary. The primary concern is the person's experience at the moment experienced (Whiteside and Wixon, 1987). There are fewer studies (Gellatly *et al.*, 2010) in automotive HCI that have previously investigated the influence of the automotive context in a systematic way using qualitative methods in real-time driving situations. Some of them even introduced early open innovation and co-creation paradigms (Bartl, Jawecki and Wiegandt, 2010). However, drawing from previous research, a critical disadvantage of the traditional context-aware methods (including Contextual inquiry, Ethnography and Cultural probes) is the effect of the physical presence of the researcher within the driving experience itself. Added to other secondary limitations such as motion sickness of the researcher while taking notes inside the car, intrusiveness, loss of privacy, organisational challenges and effort (Tasoudis and Perry, 2016, Meschtscherjakov *et al.*, 2011) these approaches are not ideally suited to our context.

1.2. ESTABLISHING THE RESEARCH NICHE

1.2.1. SPARSITY OF RESEARCH IN THE AUTONOMOUS VEHICLE CONTEXT

Highlighting the inadequacy of previous research in context, designing the user experience of the autonomous vehicle requires user involvement in the design process. This involvement needs to be active, and while the participants are in their real-life environment as we previously argued. Participation through Co-design has rapidly gained the attention of the researchers in Human-Computer Interaction who need to gain rich insights on the explicit, observable, tacit and latent needs of the participants (Visser *et al.*, 2005) and share control, share expertise and get inspired to change (Vines *et al.*, 2013). Researchers across disciplines also recognise the need for more active participation, with psychology having a considerable amount of studies where the attention is on the co-creation or the 'continuum of consumer experiences,' an interplay between traditional, holistic, immersive, and co-creation

approaches (Prahalad & Ramaswamy 2004). Nevertheless, in automotive HCI and HMI, specific deficiencies (summarised by Tasoudis & Perry, 2016) add up to the attractiveness of traditional methods.

1.2.2. CONTROVERSY IN THE FIELD OF STUDY

Previous attempts to mitigate some of the domain-specific deficiencies as mentioned above and support designers in the exploration of new user experiences have led to driving simulator platforms (Alvarez, Rumbel and Adams, 2015) that support the rapid iterative development of in-vehicle user experiences. Other research attempting to explore this design space 'in-context' has led to new methods and tools, such as 'trip experience sampling' (TES, Meschtscherjakov et al. 2012) a context-aware low-tech method of remote user experience research in the car that addresses the immediateness and situatedness of automotive user experience research. Similar tools designed by Niforatos et al. (2015) address in-situ measurement methods and avoid the disruption of users, a limitation for which TES has attracted criticism (Niforatos and Karapanos, 2015). Their work introduces EmoSnaps, a mobile application that captures pictures of facial expressions unobtrusively throughout the day and uses them for the later recall of momentary emotions. Recent research by Martelaro & Ju, (2017) has introduced systems that attempt to make sure that the in-vehicle automotive interactions can be designed, tested and understood before mass production, inspired by previous knowledge in ubiquitous computing and remote user experience research systems including "Dart" and "Momento" (Carter, Mankoff and Heer, 2007, MacIntyre *et al.*, 2004) to support the holistic understanding of a safe driving experience. We, therefore, see the emergence of a research agenda attempting to overcome the difficulties inherent in the setting and which can capture the situated context holistically, by developing supportive user experience design systems to meet the needs of the automotive UX designers.

What the needs of UX designers are in any domain has been the subject of debate within the research community. Much of the available literature in experience design is in line with the needs that TES is addressing, by supporting the capturing of an experience, momentarily, when it happens (Hassenzahl, 2010). Other researchers (Roto, 2007) however disagree that UX is a momentary emotion, and the designers need to capture it, evaluate it with psychophysiological measurements, before later designing for it. In this study, it is supporting the long-term user experience that matters, rather than the momentary emotion that could even be meaningless to the user. Other recent work explores ‘eudemonic’ user experiences (contrasted with hedonic experiences), in accomplishing personal goals through technology use (Mekler and Hornbæk, 2016). This orients to technology design in supporting people's values, such as keeping up with fitness through technology. For instance, eating healthy food is hard and sometimes unpleasant, but it can serve the personal values and eudemonic goals of being healthy in the long term.

Respectively, the needs of the UX practitioners when they remotely design for an autonomous car are ill-defined and to design for such needs is as Horst Rittel, and Melvin Webber proposed in 1973 a "Wicked Problem". An ill-defined or wicked problem occurs because the conflicting perspectives of the stakeholders cannot be accurately modelled or addressed using the reductionist approaches of science and engineering (Rittel and Webber, 1973). In our study, both the automotive domain limitations and the conflicting perspectives on how to approach automotive UX design has led us to deploy a pragmatic epistemological paradigm and to apply participatory prototyping methods.

1.3. OCCUPYING THE RESEARCH NICHE

Summarising, even though there were attempts in the past for in-depth context-aware UX research and design in automotive, there is still a lack of systems to support the state of research methods in Human-Computer Interaction for achieving it. There is still a lack of systems that can support the designers/researchers in the early stages of the design process while mitigating automotive domain deficiencies.

This research examines the emerging role of remote systems to support participatory User Experience design and the Democratization of Innovation in the early stages of the design process in the automotive domain. This study attempts to inform designers of such systems by applying a design science research approach. We design and evaluate the proposed remote UX design system showing how such systems can overcome the primary deficiencies and support context-aware, in-situ participatory design in automotive.

1.3.1. RESEARCH QUESTION

How can a Remote Participation System support, context-aware, in-situ, participatory design in automotive?

Answering this research question is fundamentally a design task that requires shaping artefacts and events to create an envisioned, more desired future (Boland and Collopy, 2004). To addressing it, we must build and evaluate novel and innovative artefacts that extend the boundaries of current scientific knowledge, addressing essential problems.

1.3.2. AIM AND OBJECTIVES

The research goal of this study is to investigate how can a Remote Participation System support in-vehicle context-aware in-situ design for experiences. We aim to identify these under-constrained needs of UX designers so that we can inform the development of a new remote UX design system that democratises automotive innovation. The new remote UX design system is an interactive system that consists of methods and tools similar to TES, Momento, Dart, Emosnaps and Woz Way to support remote UX research and design in the automotive context. This remote UX design system aims to support UX designers on democratising innovation in automotive. As a result, intending to democratise automotive innovation, the system serves as a platform for non-trained UX designers and drivers/passengers to collectively come up with the most innovative automotive experiences. Our research focused on the UX professionals' side of the interactive system and their interactive experience with it. The objectives of this research are:

1. To identify the user 'goals' (Kaasinen *et al.*, 2015) of the proposed remote participatory design system, for use in the early stages of designing for in-vehicle experiences.
2. To implement the UX goals, through the development of an interactive system prototype and evaluate the system and its interactions in the early stages of the design process.

To achieve this, we applied a participatory approach to design the supportive system by actively involving UX designers in the making process. In the first cycle of our iterative design, we explored implications including the participants' motivation to use the supportive technologies, the detailed interactivity of the system, and the system's architecture, allowing us to translate participants' (UX designers) needs into UX design goals that serve as actionable

insights for the development of a relevant system-solution. However, design research should strive to recruit participants that are familiar with the application environment and would be potential users of the proposed artefact. Also, the development of interactive systems holistically includes limitations on the emotional, behavioural, social, and organisational level. Thus, in the second cycle of our iterative design, we tackle these contextual aspects of the experience that limit the automotive UX practitioners and their interactions and not just design a system that we will only later apply in context. To identify all these aspects of our design, we involved automotive UX designers and researchers as special interest groups in our second iteration. Participation at this level helped us understand better the contextual and organisational limitations and apply the proposed critique and design refinements. We conclude on a pragmatic interpretation of our findings to inform the design of such systems and offer directions for future work in automotive user experience design.

1.3.3. RESEARCH APPROACH

In this study, we build on pragmatism as our research epistemology. Human-computer interaction and user experience design as we described is a multidisciplinary research area including psychology, computer science, design and other social sciences investigating the behaviour between people and IT artefacts. Because of the different disciplines involved, there are many schools of thought choosing to focus attention to the IT artefact or the theories emerging from the use of the IT artefact. As Hevner et al. (2010), previously highlighted the most influential IS design science research schools have a strong focus on the IT artefact, in most cases, an exclusive focus on the IT artefact. The schools have minimal discussions and clarifications regarding underpinning philosophies, but most seem to be based on positivism, traditional realism, or pragmatism. The way we apply pragmatism in our study, it presents *'a highly situated perspective on human activity in which our reciprocal capabilities of action and reflection form the basis for sense-making'* (Dalsgaard, 2014, p 146). We use a design science research methodology to answers "*questions relevant to human problems via the creation of innovative artefacts*" Hevner et al. (2010, p 5), thereby contributing new knowledge to the body of scientific evidence. Design science is a problem-solving approach to science whose end goal is to produce an artefact which must be built and then evaluated. Our decision stems from the fact that Natural science research methods are appropriate for the study of existing and emerging phenomena; however, they are insufficient for the study of "wicked problems" (Rittel & Webber, 1973) similar to our research. Finally, we utilize participatory design methods in the interest of designing and evaluating the created artefacts in this iterative design science research study.

For the pragmatist, truth and utility are indistinguishable – the truth lies in utility. Thus, for design research (DR), the relevance is evaluated by a utility provided to the organisation and developers. Therefore DR must pass both the tests of science and practice (Markus, Majchrzak and Gasser, 2002)

1) It should incorporate theory in the development of the artefact as well as

2) Make a theory-building contribution.

It should be stressed that the outcome of DR is not only systems. March & Smith (1995) identify four possible design outputs: constructs models, methods, and instantiations. They further identify two primary activities: build and evaluate.

1.3.4. ORIGINAL CONTRIBUTION

This study advances our knowledge of remote in-vehicle design for experiences of autonomous cars. There are several important areas where this study makes an original contribution. We use a Design science research methodology to answers our research questions relevant to human problems via the creation of innovative artefacts (remote participatory system), thereby contributing new knowledge to the body of scientific evidence.

Firstly drawing on rich data, such as designer needs, wants, and feelings, our research informs the understanding of the practitioners' UX 'goals'(Kaasinen *et al.*, 2015), in the early stages of the automotive UX design in context. Therefore, the UX goals further enrich our understanding of the concept of remote democratisation of innovation in the automotive domain and how to support it. The system itself and the proposed tools contribute to the body of scientific evidence as an implementation of the empirical data collected using rigorous methods of design and evaluation.

Furthermore, the participatory prototyping methods and toolkits that were developed in this study will significantly contribute to the body of scientific knowledge of co-designing of interactive systems. Consequently, the extension and revision of our system provide a clear and verifiable contribution in the area of the design artefact and design methodologies. Well-executed design and evaluation methods used for the utility, quality and efficacy of the system demonstrate the rigour of this study.

Finally, a separate contribution to the most preferred remote UX technologies. Also, how do these preferences differ between the automotive domain and other domains when designing remotely. As a result, our study informs the human-computer interaction and user experience research community about distant UX design.

1.3.5. LIMITATIONS OF THE STUDY

Our study will focus on the implementation of the system to support the early stages of the design process (Discovery an Interpretation)(Efeoglu *et al.*, 2013). Our Artefact does not engage with later stages of the design process, although our study can be helpful to other researchers to explore systems supporting stages such as ideation, experimentation and evolution of in-vehicle interactions. Furthermore, the thesis does not engage in the design and evaluation of a specific IVIS (Navigator/GPS) or an in-vehicle infotainment system. Finally, it is beyond the scope of this study to examine the technical aspects of telecommunication technologies.

1.3.6. SYNOPSIS OF THE CHAPTER STRUCTURE

My thesis is composed of seven themed chapters and begins by introducing the research field, the research gap, and the suggested research approach in Chapter one.

In the next section, Chapter two, we examine and review the previous literature and critically reflect on the previous work. A critical review of critical areas such as Design for Experience (UX), the Automotive Context and Mediated communication and participation will be presented. The third chapter is concerned with the epistemology and methodology used for this study. Specific methods used in each iterative cycle and the reason behind our decision of methods form the content of Chapter three. Methods and toolkits used to design and implement low and high fidelity prototypes of a wicked problem are presented in this chapter. Chapter four will present the findings of the first iteration. The needs identified and translated

into UX design goals and other actionable insights, including goal-directed personas and scenarios of use to inform the design of the system. Both formative and summative results of the design and evaluation of a low-fidelity prototype drive us to the second iteration.

Chapter five presents the findings of the second iteration. We report on conceptualising and designing a system that supports design for experiences remotely. The second iterative cycle includes the design of a detailed interactive prototype and its evaluation. Chapter six contains further extensive discussion on the major findings of our study, the meaning of those findings and how these findings relate to what others have done. We also report on limitations and suggestions for further research and work to follow. Lastly, in chapter seven, we restate our research question and our major findings, highlighting what contribution our study has made to the existing literature. Finally, we state the limitations of this study and the future directions for research.

2. CHAPTER TWO: A CRITICAL REVIEW OF PREVIOUS WORK AND CONCLUSIONS

The chapter aims to introduce and critically reflect on literature relevant to our study while establishing our research territory. We present essential definitions and previous researchers' approaches to identify and analyse the design for experience, automotive interaction design, and distant mediated communication. Proportionally, we subdivide this Chapter into three sections which are the three main pillars of our design research approach. The first section highlights the fundamental theoretical concepts of design for experiences through different disciplines. The second section seeks to assess the impact of experience design in the automotive domain. Moreover, analysing the fundamental limitations of the automotive context. The third section highlights the key theoretical concepts of Computer-mediated communication and remote participation.

2.1. THEORY ON USER EXPERIENCES (UX)

With "Design for experiences" in this study, we refer to the experiences that come about through the use of interactive products, the experiences that in Human-Computer Interaction (HCI) we refer to as the User's Experiences (UX). The same general term has been previously used by (Hassenzahl, 2010). Human-Computer Interaction (HCI) grew out of the collaboration between the disciplines of computer science and psychology. McCarthy argues that the academic aspect of both is more comfortable in the lab than the outside world and directed more toward functional accounts of computers and human activity than toward experience (McCarthy 2004). In this study, we are interested in the outside world and the experience of people interacting with technology in their real-life context. The proposed system aims to support designers designing for experiences in the real world actively involving people in their everyday life. A definition of user experience from IBM website, highlighted by(McCarthy 2004), describes User Experience Design as the discipline that fully encompasses traditional Human-Computer Interaction (HCI) design and even extends it by addressing all other aspects of a product or service that the user perceives. It further broadens the definition by proposing that User Experience Design addresses the user's initial awareness, discovery, ordering, fulfilment, installation, service, support, upgrades, end-of-life activities. We find a widespread understanding of the experience of technology that meets the needs of this study in Preece and Rogers (2002). In their study, we demonstrate that Experience of Technology is something more substantial than usability or one of its dimensions, such as satisfaction or attitude. As such, "User experience goals" differ from the more objective "usability goals". Instead of assessing how useful or productive a system is they are concerned with how users experience an interactive product from their perspective.

Kuutti (2010)previously summarises that in the HCI research community, there are many understandings of experience. Firstly the post-cognitivist theories on HCI, with various orientations including anthropological (Suchman 2007), phenomenological (Dourish, 2001), or activity-theoretical (Kaikkonen, 2009). Besides, there are many philosophers and psychologists, pragmatists like William James (2010) and John Dewey (2005) that have developed conceptions on experience. Csikszentmihalyi has written many books about the experience, (1990), among others, and Middleton & Brown have formulated a perspective on experience from a social psychological point of view (2005). According to Law et al. (2009), UX lacks conceptual clarity, and that is because UX is associated with a wide range of fuzzy and dynamic concepts and is used as a generic term combining several HCI notions. Law et al. (2009) also describe UX research as fragmented and complicated by diverse theoretical

models with a different focus including pragmatism, emotion, affect, experience, value, pleasure, beauty, hedonic quality.

Previous work attempts to answer what UX is in the context of HCI either by studying the basic concepts and assumptions related to UX or by surveying UX professionals about their work. Reviewing UX research(Bargas-Avila and Hornbœk, 2011) informs us that most researchers agree that UX is context-dependent, that the shift in HCI towards UX is accompanied by a change in favour of qualitative methods and that many researchers collect data using self-made items without providing any details about them or the source which is also a tendency when measuring subjective satisfaction metrics in usability. Surveying UX professionals also provide several valuable insights about UX in HCI. The first attempt published in 2007 'the UX Manifesto' (Law *et al.*, 2007) categorised the focus of previous work in user experience using five dimensions. 1) Work that is based on reductive approaches which simplify the complexity of user experience or holistic approaches which aim at a more inclusive understanding of the user experience and a bigger picture. 2) Work that has focused on either user experience evaluation or the development of artefacts proposing an experience to people. 3) Studies that have been collecting and analysing qualitative data versus quantitative studies. 4) Work-based and leisure-based experiences and finally 5) work about experiences that are lived socially with a group of people or individually. The main result was that most works were identified to be evaluating the user experience in a reductive approach, and was concerning individual experiences. Later, Law et al. (2009) used a survey with 275 researchers and practitioners helping on the definition of UX for the ISO 9241standards series. The results are reporting that there is an agreement on the concept of UX as dynamic, context-dependent and subjective, which stems from a broad range of potential benefits users may derive from a product. Also, UX is seen as something new, which must be a part of the HCI domain and be grounded in UCD practices. The same UX survey was recently replicated by Lallemand et al. (2015) by surveying 785 UX professionals from 35 nationalities, and the results confirmed previous findings and are adding some new insights. The respondents agreed on the importance of both user-related factors and contextual factors as important variables shaping UX. The respondents globally agreed on the fact that "*UX is highly dynamic and constantly changes when interacting with a product.*" by (2015, p 44) The report is highlighting that assessment of Momentary UX (while interacting with an artefact) was favoured against Episodic UX (evaluated after usage). In comparison to the previous survey, UX is not seen as a new concept; it is covered in existing engineering approaches and is rooted in design and usability. It is not clear whether it should be approached qualitatively or quantitatively, or whether UX is individual or social. Finally, domain, role, language, and seniority are the main factors impacting the understanding of UX, which is reported to be more central in Industry than in Academia.

Vermeeren et al. (2010a) on an effort of collecting UX evaluation methods from academia and industry describes the type of more than100 different methods. 70% of the methods originate from academia, while the majority of the methods can be used with single users as information sources. Almost half of all methods can be used to study momentary UX leaving the rest to single episodic UX, and test sessions. Finally, 80% of the methods can only be used in later development stages, when we evaluate a functional prototype or product. Most of the methods respond to the needs of the researchers for the evaluation of momentary UX involving individuals as sources of information. As described by Law (Law, van Schaik and Roto, 2014) the implication of using methods to evaluate UX is to redesign the system and the mutual recognition of the value of objective measures, and subjective accounts of user experience can enhance the maturity of the area. UX evaluation metrics are used typically for

summative evaluation for benchmarking a system against competitive ones and for validating the improvement on the previous version. Both usability and UX measures should enable professionals to benchmark competitive design artefacts and to select the right design options (Law and Lai-Chong, 2011). Bevan (2008, 2009) argues that the ISO definition suggests that measures of user experience are similar to measures of satisfaction in usability and that user experience is interpreted in a similar way to usability, but with the addition of anticipation and hedonic responses. UX can be measured as the user's satisfaction with achieving pragmatic and hedonic goals and pleasure. According to Hassenzahl et al. (2015), we can identify perceived hedonic and pragmatic qualities which are the consequences of need fulfilment attributed to the product. When interacting with a well-designed product, the user experiences positive affect. User experience can be measured based on need fulfilment using psychological needs, positive or negative affect of affective experiences including scales like PANAS, in combination with product perception including scales like AttracDiff2 covering both pragmatic and hedonic qualities. Hassenzahl argues the necessity for both an experience-oriented and a product-oriented evaluation.

Partala & Kallinen (2012) suggest that these kinds of measurements can give valuable insight into the users' reflective processes concerning their user experiences. However, quantitative measurements alone are not very informative for designers on how a particular system or product could be improved. UX measures can be formative by having the power to persuade decision-makers to modify the problematic design as indicated by the measures, however how the modifications should be implemented may not be sufficiently informed by such measures. According to (Law *et al.*, 2014), Norman claimed that HCI professionals know theoretical principals but not design. The above explains the current situation in the research field when more and more HCI research groups shift emphasis from evaluation to design even though many HCI researchers essentially have no formal training in design.

2.2. DESIGN FOR USER EXPERIENCES (UX)

The experience approach to designing interactive products as (Hassenzahl, 2010) states, starts from the assumption that if we want to design for experience, we have to put people first, that is, before the products. According to (Hassenzahl, 2010), "without a clear understanding of experience, the interactive products we design will never be able to properly shape experiences, let alone, to create novel experiences." (page 14) 'It is no longer considered sufficient to produce a computer system that is effective, flexible, learnable and satisfying to use – the characteristics of usability; it must also now be useful in the lives of those using it' (McCarthy 2004). In the 1990s, Donald Norman was amongst the first authors to use the term "User Experience" to describe all aspects of a person's experience with a system(Norman, Miller and Henderson, 1995). In their work Lallemand, et al., (2015, p 37) they recently attempted to define User experience by replicating a previous long scale survey (Law *et al.*, 2009, p 723). Among the five main definitions they used in both surveys, we identify the one given by Hassenzahl and Tractinsky, (2006) as the most relevant for our study, as seen in table 1. By breaking down the definition of Hassenzahl and Tractinsky itself, as seen in table 1, we can construct three guidelines for User experience design support:

1. To support the designer identify the user's internal state (including predispositions, expectations, needs, motivation, mood, etc.)
2. To support the designer identify the characteristics of the designed system (e.g. complexity, purpose, usability, functionality)

3. To support the designer identify the context (or the environment) within which the interaction occurs (e.g. organisational/social setting, the meaningfulness of the activity, voluntariness of use)

D1	*"All aspects of the end-users interaction with the company. Its services and its products." "The first requirement for excellent user experience is to meet the exact needs of the customer without fuss or bother." "Next come simplicity and elegance that produce products that are a joy to own, a joy to use." " Real user experience goes far beyond giving customers what they say they want or providing checklist features."* (nngroup.com) (Nielsen Norman Group: UX Training, Consulting, & Research)
D2	*"A consequence of a user's internal state (predispositions, expectations, needs, motivation, mood, etc.) the characteristics of the designed system (e.g. complexity, purpose, usability, functionality, etc.) and the context (or the environment) within which the interaction occurs (e.g. organisational/social setting, meaningfulness of the activity, voluntariness of use, etc."* (Hassenzahl & Tractinsky, 2006, pp. 91-97)
D3	*"The entire set of affects that is elicited by the interaction between a user and a product including the degree to which all our senses are gratified (aesthetic experience) the meanings we attach to the product (experience of the meaning) and the feelings and emotions that are elicited (emotional experience)."* (Desmet & Hekkert, 2007 pp. 57-66)
D4	*"The value derived from the interactions (or anticipated interactions) with a product or service and the supporting cast in the context of use (e.g. time, location, and user disposition)."* (Sward D. & G., 2007, pp. 35-40)
D5	*"The quality of experience a person has when interacting with a specific design. This can range from a specific artefact such as a cup toy or website up to more extensive integrated experiences such as a museum or an airport."* (UXnet.org) (User Experience Network)

Table 1: UX Definitions used Lallemand, et al., (2015, p 37), as drawn from the original survey (Law *et al.*, 2009, p 723).

Breaking down the definition, we understand that even though usability is considered one of the three requirements to design for experiences, there are two more, highly essential requirements that are undermined at the moment. Contextual understanding and mapping of the environment are as crucial to an interactive experience as usability engineering. Accordingly, emotions, moods, and predispositions of the user may affect the acceptance, use, and need of a proposed interactive experience. Therefore, including the users in the process or even designing with the users, it is equally essential to support user experience design.

Over the past 15 years, many theoretical frameworks (Law *et al.*, 2014) in UX have been developed and have enhanced our understanding of the phenomena related to what we empirically call "experience". There are two main frameworks for understanding UX. According to the first one, Hassenzahl's hedonic-pragmatic framework (Hassenzahl, 2005), when people as users experience the product, they perceive the product's features and construct an initial personal evaluation of the product quality including sets of pragmatic and hedonic attributes. Different consequences are the result of the initial perceived product quality as mentioned above: cognitive consequences regarding judging the product appeal (e.g., goodness), emotional consequences (e.g., pleasure, satisfaction), and behavioural consequences (e.g., continued use). We need to mention that these consequences of a specific product quality differ depending on the particularities of the situation of use.

The second one, McCarthy and Wright's framework of sense-making in experience (2004), is integrated with the four threads of experience, as seen in table 2.

McCarthy and Wright's framework of sense-making	
The sensual	The sensual is concerned with our bodily engagement with a situation, characterised as a visceral experience.
The emotional	The emotional involves ascribing importance to other objects concerning a person's (or her social others') needs and desires.
The Spatio-temporal	The Spatio-temporal refers to the time and place where experience is located.
The compositional	The compositional is concerned with the narrative structure of experience.

Table 2: McCarthy and Wright's framework of sense-making

The six processes of sense-making – Anticipating, Connecting, Interpreting, Reflecting, and Appropriating – which are not linear or causal in relation, contribute to holistic 'felt experience'. The two frameworks have different theoretical roots. Hassenzahl's is primarily rooted in motivational psychology, whereas McCarthy & Wright's is rooted in the pragmatism of Dewey and Bakhtin (Law *et al.*, 2014).

2.2.1. DESIGN IN CONTEXT

"*Sensitivity to the particular circumstances of use invokes a qualitative shift in thinking about the design and use of technology. Simple observation demonstrates that technology can get a mixed reception in people's lives.*" (McCarthy, 2004 p. 26) "*Accordingly, different individuals, or even the same individual at a different time, may experience technology in quite different ways, and that is not easy to capture in rationalist models. Rationalist models abstract in a way that excludes particular circumstances, perhaps the very circumstances that turn out in practice to be most salient*" (McCarthy, 2004, 26). Therefore, the data are to be collected using contextual design methods to support the UX designers, designing for the vehicle experience. Consequently, to design for everyday life experiences the data are gathered during conversations and observations of current and potential users in their natural setting, preferably while they are carrying out their daily activities as mentioned in the study of Brodie et al. (2003).

A situation is used to denote a problem. As such, a situation has and includes context, but has more focus on something undesirable or threatening. For example, a situation may involve a threatening person who confronts you on the street, or there may be a situation involving marriage in trouble. Situation awareness is formally defined as "*the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future*" (Endsley, 1988 p. 97).

It is essential to understand what context is, to build applications which know their context. Previous research in context-awareness in mobile computing is focusing on location (Hazas, Scott and Krumm, 2004). Location is a concept that is well understood. Also, the benefit of location-awareness is given; at specific locations, particular services are more important than others. Schmidt et al. (2000) discuss some examples of context-aware applications some of

which are using RF and GPS to determine the users' location others are based on a smart environment like that described by Schilit et al. (Schilit, Adams and Want, 1994). As in context-awareness, the notion of context is used in many different ways. Schmidt et al. (2000) regard situational context, such as location, surrounding environment or state of the device, as implicit input to the system. He is using the term "situational context" to describe implicit interaction fragments. This extends the concept of context beyond the informational context into real-world environments. He also highlights that in general use the word "context" has a multitude of meanings. Even within the field of computer science, different disciplines, such as artificial intelligence, natural language processing, image recognition, and more recently, mobile computing, have their very own understanding of what context is (Schmidt et al., 2000). A broad view of context which is relevant to the user experience of a product is also given by Brown, Bovey and Xian Chen (1997). They suggest considering as context the way a device is used (including the mobile phone in the users' hand, on the table, in pocket). The term "context" is used to describe the environment, situation, state, surroundings, tasks, social settings, and roles, among other things (Lafond *et al.*, 2014). As Lafond describes: "*This context evolves according to events and changes occurring during system operation either by direct, explicit interactions from the user (e.g., a user manually indicates current context parameters such as time pressure, psychophysiological state, availability, and current interest in certain types of information) or indirect implicit interactions based on the situational context (e.g., automatic data monitoring, HCI monitoring, and sensor-based perception).*" (Lafond *et al.*, 2014 p. 71)

The primary interest in designing the application is to know the situational context because we expect that the application can adapt to the context. According to Schmidt et al. (2000). Capturing context, we can observe that an application (mobile or stationary alike) is:

(a) Running on a specific device (e.g., the input system, screen size, network access, portability)
(b) At a specific time (absolute time, e.g., 9:34 pro; class of the time, e.g., in the morning)
(c) Used by one or more users (concurrently or sequentially)
(d) In a specific physical environment (absolute location, type of location, conditions such as light, audio, and temperature, infrastructure)
(e) In a social setting (people collocated and social role)
(f) To solve a particular task (single task, a group of tasks, or a general goal)

Previous research in contextual systems design (Bauer and Dey, 2016) highlights that system designers need to be aware of the relevant combinations and characteristics of context, before they apply an intelligent system in the real world and decide which context to include in their designs. Thus, the analysis of the situational context of the interaction is fundamental to understand and design for a particular environment such as the automotive. The situational context in systems identifies the following questions (Schmidt, 2000):

(a) What happens around an application while the application is in use?
(b) Are there any changes at all?
(c) Do the surroundings (behaviour, environment, circumstances) carry any valuable information for the application? Does it matter for the application?
(d) Are there any means to capture and extract the information in a way that is acceptable for the application or device (processing cost, sensor cost, weight)
(e) How to understand the information

(f) *What interpretation and reasoning are possible and useful? What is an appropriate way for the application to react?*

As a result, previous studies on situational context can, for example, provide us with guidelines on how to design computer-mediated interactions (Schmidt, Aidoo and Takaluoma, 1999):

- Adapt the output to the current situation (font size, volume, brightness, privacy settings)
- Find the most suitable time communication or interruption
- Reduce the need for interruptions (e.g. you do not need to remind someone to go to a meeting if they are already there.)

Contrary to previously published studies, Roto et al. (2011a) argue that by the context of UX, we mean the environment wherein the user can experience the system. As a result, the context of UX is not the same as the context definition used in the field of context-awareness, where context includes not only the environment but also the system and the user (Abowd et al. 1999): *"Any information that can be used to characterise the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves."* Which is a widely accepted definition. (1999, p. 304).

UX researchers focus on the user and the system and consider the surrounding circumstances the context because UX is subjective, and it studies the relation between the user and the system. Roto et al. (2011a) describe that objective context measures are typically insufficient for revealing the effect of context on UX since UX is subjective: '*Objective measures can be used to help participants recall the influence of the context to UX, and to describe the contexts of use, but participants themselves are often the best source to understand how the context affected UX.*' Roto et al. (2011), have categorised a variety of context characteristics, as described in table 3, that may affect UX of mobile and ubiquitous systems. When they use the term context category, they refer to a high-level theme for a class of context characteristics, such as the bolded categories defined bellow. By context characteristics, they refer to the attributes listed under each category.

Context category	Definition
Physical context	The apparent features of the situation in which the human-mobile computer interaction takes place, including spatial location, functional place and space, sensed environmental attributes, movements and mobility, and artefacts present.
Task context	The surrounding tasks concerning the user's task of interacting with a mobile computer containing the subcomponents of multitasking, interruptions and task domain. The task context is related to the demands of the entire situation upon one's attention.
Social context	The other persons' presence, their characteristics and roles, the interpersonal interactions and the surrounding culture that influence the user's interaction with a mobile computer.
Temporal context	The user's interaction with the mobile computer concerning time in multiple ways such as duration, from time of day to years, the situation before and after use, actions about time, and synchronism.
Technical and information context	Relation of other relevant systems and services including devices, applications and networks, their interoperability, informational artefacts or access, and mixed reality to the user's interaction with the mobile computer.

Table 3: Some of the context categories and their definitions suggested by Roto et al. (2011)

From the above categorisation, we can see that there is a variety of context characteristics that may affect the UX of mobile and ubiquitous systems. When we use the term context category, we refer to the attributes listed under each category (Roto *et al.*, 2011).

As we previously described, previous work is highlighting the importance of both user-related factors and contextual factors for shaping UX. UX is dynamic, context-dependent and subjective, which means that users shape the design for their lived experiences. The level of involvement depends on the methods used, the same methods that support designing in context. In the following section, we describe the importance of involving the users in the UX design process.

2.2.2. DESIGN WITH PEOPLE

There are various methods and tools to identify and map the context of experience. Some widely accepted methods are these of ethnographic studies, participatory design and co-design and of contextual inquiry. The main problem for designers is to understand the users, their needs and desires, and how they like to work. Often the work has become a habit to the users that is difficult for them to articulate what they do and why they do it.

In a highly cited study, Leonard-Barton (1998) argue that consumers are presumed to be unaware of their real needs because they successfully adapt to their surroundings. Famous automotive designers such as Henry Ford have also stated it before. *('If I had asked my customers what they wanted they would have said a faster horse.')* Designers, look for cues, which show a hidden or latent need. Cues can be frustrations with a product or situation, confusion, or unexpected usage of products. The empathic design method requires that the observation is carried out by people who have a deep understanding of a potential set of technologies, for example, product developers such as engineers and designers (Leonard-Barton, 1998). This can help to improve translating consumer needs into new product concepts.

In contrast to consumer research relying on self-reported behaviour and opinions, the task format of empathic design, for example, is based on observing consumer behaviour in everyday behaviours. By precisely observing consumers' behaviour, the assumption is that product developers can more easily identify opportunities for products in response to perceived needs. *'Empathic design is a form of observational research in which consumers are watched using products in their environment'* (Van Kleef, Van Trijp, and Luning, 2005). This method suggests that the developer develops empathy for the problems consumer encounter in their daily life, by spending time with consumers. Earlier, Leonard and Rayport, in addressing this issue, suggested that designers who exercise empathy through the observation of the environment in which users operate acquire the ability to share the feelings of users and so design artefacts that meet real needs (Leonard and Rayport, 1997).

Another example of designing with the user in context is 'contextual inquiry' which among other methods is an explicit step for understanding who the users are and how they work day by day. According to Beyer and Holtzblatt (1999) contextual inquiry

1. Reveals the details and motivations implicit in people's work
2. Makes the customer and their work needs real to the designers
3. Introduces customer data as the basis for making decisions

4. It creates a shared understanding of the data throughout the team Design with People.

"*People seek satisfaction and new ways to co-solve their problems through innovative services and greater service innovativeness requires more intensive interaction between the service provider and the customers for effective service delivery. Moreover, effective service delivery leads to improved consumer perception of innovative service benefit"*(Dai *et al.*, 2015, p. 98).

An even more engaging way is that of Gaver et al. (1999) who suggest that researchers and designers should involve users in the design process. Gaver et al. also recommend a direct, subjective and empathetic engagement on the part of designers with everyday users. Co-creation, for example, draws on innovative ideas generated by users, researchers, designers, and stakeholders in general. It redefines how people are involved in the process of value creation and engages them in the various experiences generated in the process (Ramaswamy and Gouillart, 2010). Non trained people when they are helped and encouraged to design can exploit their creativity in Co-creation sessions. Also concerning context, the design process should take place within the context in which the user operates so that the users behave as if they would within a familiar environment and the stakeholders that are involved can operate in a context based on real-life (Buur and Bødker, 2000).

Participatory design in HCI has to do with participation, with how stakeholders – especially users, developers, and planners – cooperatively make or adjust systems, technologies, and artefacts in ways, which fit more appropriately to the needs of those who are going to use them. Participation can be approached as an ideology, and also clearly refers to questions of ethics, politics, democracy, and empowerment. A Participatory Design practice entails tools and techniques that combine telling, making and enacting. Tools and techniques for making give people, both designers, and non-designers (not trained in design users), the ability to create 'things' which helps in externalising and embodying thoughts and ideas in the form of (physical) artefacts. As a result, these artefacts can describe future objects or provide views on future ways of living.

Participatory prototyping using mock-ups and other low fidelity models are most often used in the early stages of the design process. '*Making as prototyping presupposes that you have already identified the object of the design, e.g., you are designing a product or a device or an environment, etc. Thus, in the traditional design spaces, the focus has been on using prototypes to create representations of future objects to give shape to the future, i.e., to help us see what it could be.'*(Simonsen and Robertson, 2013, p. 155)

In different circumstances, on the front end of the design process, when there are new and emerging spaces, the focus is on using making activities to help us make sense of the future. Making activities are used as vehicles for collectively exploring, expressing and testing hypotheses about future ways of living. Probes are a design-led approach that invites people to reflect on and express their experiences, feelings, and attitudes in forms and formats that inspire designers (Gaver, Dunne and Pacenti, 1999). The application of probes was later used to provide information for designers as a way for participation and dialogue (Mattelmäki, 2005).

Generative tools are also used in the front end of design to help untrained users (non-designers) to imagine and express their ideas about how they prefer to live, work and play in the future (Sanders and Stappers, 2008).

User-centred, participatory design and co-design methods, by involving people in the design allow designers to both take advantage of ad-hoc solutions developed by individuals and refine them into products or to identify problems that users have assumed unfixable. In some cases, an observation may not be enough. A conversation with users about products in their possession that they 'love' or 'hate' reveals that emotional connections to products can be related as much to the giver of the product as the product itself (Thomas and McDonagh, 2013). In consequence, maybe empathy is "our intuitive ability to identify with other people's thoughts, and feelings – their motivations, emotional and mental models, values, priorities, preferences, and inner conflicts" (Thomas and McDonagh, 2013) but communication is the design component that unveils the actual situation for which designers design. Furthermore, methods which involve users in various enacting activities are vital to the design of artefacts, because patterns of behaviour, attitudes and personal motivations on the part of users are notable factors in shaping the design and use of artefacts. The role of users in the design process is changing in HCI and Psychology, and as we described in section 2.1.1., and 2.1.2., in this study, the methods used are in favour of UX design. Users, instead of being the passive object of research, they are now seen as active co-designers and co-creators.

2.2.3. INVOLVING PEOPLE IN DESIGN ACTIVITIES

According to Brand et al. (2012), a Participatory Design practice applies tools and techniques that combine telling, making and enacting. Tools and techniques for making give people, both designers, and non-designers (not trained in design users), the ability to create 'things', which helps in externalising and embodying thoughts and ideas in the form of (physical) artefacts. As a result, these artefacts can describe future objects or provide views on future ways of living. According to Simonsen & Robertson (2013), there are three paradigms to 'making activities', generative techniques, probes, and participatory prototyping. Participatory prototyping was introduced in the early 1980s and is historically the most established paradigm (Bjerknes et al. 1987, Ehn 1989). Probes and generative tools were later introduced both in the same year (Gaver et al. 1999; Sanders, 1999).

User-centred, participatory design and co-design methods, by involving people in the design allow designers to both take advantage of ad-hoc solutions developed by individuals and refine them into products or to identify problems that users have assumed unfixable. In some cases, an observation may not be enough. Thomas et al. (2013) explain that after a conversation with the users on loving or hating a product that they own, reveals that their emotional connections to products can be related to both the person and the product itself (Thomas and McDonagh, 2013).

Sanders (2000), highlights other uses of participatory design methods and tools that recently have emerged. Research community have adopted new approaches, including generative tools and co-design. Sanders (2000) describes that researchers are starting to use these tools in collective creativity workshops and that the researchers refer to them as Strategic Visioning Workshops. The goal is to allow a group of people to work together and express both their ideas and dreams. Therefore, the researchers use extensive toolkits, including visual toolkits, which allow people the environment to listen to all the ideas and dreams, leading to a better collaborative outcome. Sanders argues that '*The transformation that takes place when a group of people goes from a verbal exchange of ideas to a collective and visually expressive mode is remarkable.*' 'It is invariably positive and can often be quite therapeutic for the participants.' This is not the only use of collaborative visioning according to Sanders, but

these tools can be useful for other reasons including, collaborative thinking, mapping, dreaming and storytelling (Sanders, 2000 p 9).

Petterson et al. argue that enactment is rooted in participatory design practices and that it aims to elicit ideas and information from people in the broader context of system development practices. Pettersson and Ju, (2017), describe future technology as a way to explore interactions of technology that does not exist yet, supporting a way of probing into future use by low-fidelity ways. Petterson et al., argue that *'when the boundaries of artefacts are absent, enactment gives the possibility to be flexible and contingent to user and system actions and reactions.'* (2017, 149) This technique can be used in three different ways when role-playing (i.e. gesturing and expressing the actions of human and system). Firstly, to rapidly showcase ideas. Secondly, to collaboratively improvise new ideas and lastly for early design evaluation.

For example, in previous studies (Karlsson and Pettersson, 2015), participants were encouraged to draw or narrate any car design and city change; they thought autonomous driving would bring about. The participants were asked what their imagined journey back home with the self-driving car would be. Qualitative data was generated in terms of the user's collages, drawings and narratives, and was sorted into themes. (Karlsson and Pettersson, 2015)

According to Karlsson et al. (2015), both enactment and generative techniques point towards possible ways of probing into the future without time taking and expensive prototypes, providing an open surface to more freely projecting expectations on, as also noted by Ehn and Kyng (1991). The methods applied in Karlsson et al., research is best used in early design processes as inspiration for value-creating interior and interaction designs. The methods must naturally be used in concert with more traditional methods for researching user needs and design requirements in a user-centred design process. (Karlsson and Pettersson, 2015)

An even more engaging way (co-creation) is that of Gaver et al. (1999) who suggest that researchers and designers should involve users in the design process. Gaver et al. also recommend a direct, subjective and empathetic engagement on the part of designers with everyday users. Co-creation, for example, draws on innovative ideas generated by users, researchers, designers, and stakeholders in general. It redefines how people are involved in the process of value creation and engages them in the various experiences generated in the process (Ramaswamy and Gouillart, 2010). Non-trained people when they are helped and encouraged to design can exploit their creativity in Co-creation sessions. Also according to Buur and Bødker, (2000) concerning the context, the design process should take place within the context in which the user operates intending to allow the users act as if they were experiencing an equivalent environment and at the same time allow the stakeholders to work in a real life context.

Creating an experience environment in which costumers can have an active dialogue and co-construct personalised experiences; product may be the same, but the customers can construct different experiences. For example, as Prahalad and Ramaswamy, (2004) highlight, *'Value creation for an automaker, for example, is the result of the individualised negotiations with millions of consumers.ˆ` The OnStar network of GM is another case in point. The system has the potential to allow individuals to construct their own experience. GM provides the platform. As an individual, I can decide to seek advice on restaurants or ask them to alert me to breaking news or the progress of my favourite football team. These are all possibilities. Individuals construct their own experiences.'*

In their work, Ramaswamy and Gouillart (2010), argue that co-creative design starts with people who seek desirable and meaningful experiences. People cannot articulate what these experiences are in advance, just because they have never lived these experiences before. They argue that people identify meaning only through visualisation and dialogue and as a result, the industry should provide them with the tools that support them on this. Ramaswamy et al., highlight that *'the eventual design of the engagement platform will need to incorporate both the "lived" experiences of participants and their imaginative skills, stimulated by the tools and knowledge provided by company designers.'* They additionally describe that in co-creative design, there is an interactive and creative collaboration between the company designer and the co-creator and this is a two-way collaboration. In comparison to the traditional, sequential back-and-forth of design testing and feedback, this is achieved through dialogue, transparency and access. In this fashion, Ramaswamy argues that co-creative design thinking can extend to the strategic architecture of an organisation and its management processes.

2.3. DESIGNING THE IN-VEHICLE EXPERIENCE

The automobile experience due to the continually changing location differs from various other products or services whose interactions are not situated in a dynamic and constantly changing context. The methods we use to communicate in the vehicle, as in a home, and in the workplace have practically no difference. What differs, though, is the context of use. The activities that the users engage in this context create a related but distinctly different set of requirements for home/work and in-vehicle IT systems.

2.3.1. IN-VEHICLE REMOTE COLLABORATION

As we have shown, user experience is contextual and shaped by the people involved. In HMI and HCI research, user participation is usually considered fundamental. The level of participation though depends on the designer/researcher and the cultural and organisational characteristics of other stakeholders and is subject of research in participatory design evaluation studies. Besides its fundamental character, participation in automotive HMI/HCI is not reported to be favoured by automotive researchers. Previous studies in the automotive industry note that the use of individuals as direct sources of ideas, designs or innovation has not been as standard in the automotive industry as in other domains(Ili et al. 2010).

In our search for general guidelines to develop our remote UX Design System, we conducted a review of previous work. We critically reviewed relevant studies including Computer Science, Human Factors/Applied Ergonomics, Design for Experiences/ New Product Development (NPD) and in Human Rights studies as previously mentioned. The multidisciplinary approach we have undertaken in this study is also the reason why we can argue about a holistic result. We reviewed studies that include the words 'Remote Collaboration' and/or 'mediated communication,' plus 'automotive'/ in-vehicle/car. We have further researched in the Automotive UI and CSCW databases for relevant research. Our review started for the 2015-2008 period, but later due to back and front referencing and following citations we have expanded it to what we consider to be the most relevant contributions the past 15 years. We aimed to cover a big spectrum of research in our multidisciplinary study to gain a holistic understanding of the guidelines in remote communication and participatory design systems both in automotive and in other domains. We applied a forward and backwards referencing process since searching with set keywords to find the research of interest for a specific time

was not enough. As a result, we ended up structuring the previous work in chronological order to and highlight how the research focus on the topic changed during time.

Our research to previous work illustrated by this chronological review strengthens the previous argument that communication technologies that involve the user in the design process both in studies about the context of automotive or on other automotive research are overlooked. This sparsity of research might be a result of the numerous deficiencies that researchers have identified in the past (Meschtscherjakov *et al.*, 2011, Tasoudis and Perry, 2016, Martelaro and Ju, 2017) which make research and design for in-vehicle interactions a problematic task. However, updating our databases of previous work till present, we can argue that there is an increase of the research attention on contextual design methods in the automotive domain and the application of remote communication technologies from 2015 till present.

In our study both the conflicting perspectives on how to approach automotive UX design and the automotive domain limitations led us to apply a multidisciplinary approach identifying relevant previous work and critically analyse the guidelines that can support our study and the development of our system. One hundred five studies across different disciplines (table 5) could support us with valuable guidelines about remote communication technologies, automotive UX design and many other valuable themes as we will later describe.

For the period 2015-2011 (table 6), we identified 45 studies, 21 of which were in the Automotive domain. The main focus of Remote Collaboration and/or mediated communication, though it is in Human Factors and Design for Experiences. It worth highlighting that even though we identified 17 studies (Dorneich et al. 2012, Jiang et al. 2011, Fong & Mar 2015, Mull et al. 2015, Park et al. 2014, Shalom et al. 2015, Rae et al. 2015, Biehl et al. 2015, Zhang et al. 2015, Mikal et al. 2013, Park & Sundar 2015, Cahir & Lloyd 2015, Standaert et al. 2015, Seidel & Langner 2015, M. K. Lee et al. 2015, Hyde et al. 2015, Riedl et al. 2014) in Computer Science for the same period only 1 of them (Seidel and Langner, 2015) is for the automotive domain. As we can see in table 6 the rest of the 16 studies are found, in everyday media and e-commerce with eight studies, three studies in an organisation, two studies in telemedicine and 1 for each, Aviation/Automation, Games, E-learning.

The trend is the same for the period 2010-2006 with 28 studies (Table 7). Using this table we identify that the most studies in the automotive domain are either for Design or for Human factors with only 2 (Schieben *et al.*, 2009) in Computer Science category as previously defined. Twelve overall studies out of 28 (Takayama & Nass 2008, Graham 2007, Katz & Te'eni 2007, Derks et al. 2007, Dennis et al. 2008, Derks et al. 2008, Schieben et al. 2009, Simonds 1997, Wu & Miller 2010a, Rhoads 2010, Wu & Miller 2010b) are in the Computer Science category but most of them in different categories/domains. During the period 2005-2001 (See table 8), 15 studies (Christopher A. Miller 2001, Te'eni 2001, Prendinger & Ishizuka 2004, Morand & Ocker 2003, Kock 2002, Liu & Wen 2004, Preece 2004, Bickmore 2004, Parasuraman & Miller 2004, Miller 2004, Kock 2005, Robert & Dennis 2005) were found and most of them in the Computer science domain (CMC, Human-Computer Etiquette, Computer Supported Collaboration, Automation) Yet, only one concerning the automotive context (Liu and Wen, 2004). Nonetheless, still 7 out of 15 in the e-commerce/everyday media and communities context.

The chronological review can describe a trend in the research focus over the years. When the centre of attention of a specific period is in studies that are relevant to the development of our artefact we looked further for more relevant studies of that period or

from the leading researchers publishing at that period. Also, in figure 2, we can identify other contexts different than the automotive that are focusing their attention on remote communication research. This way we can further look for guidelines in other domain and apply them in our ill-defined problem.

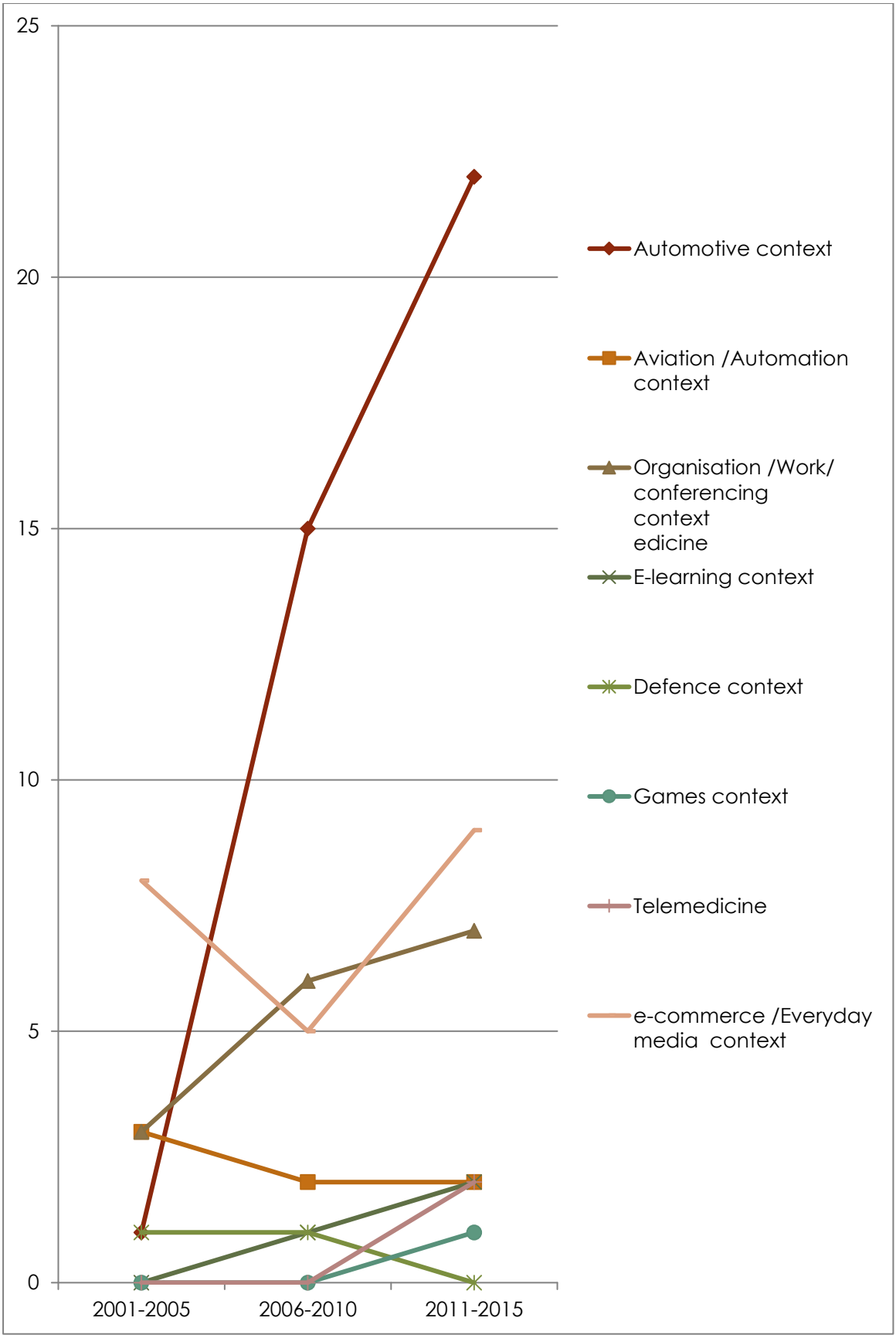


Figure 2: The graph describes the increase in the volume of relevant studies in most domains

	A chronological review of literature																			
2015	14	13	12	11	10	09	08	07	06	05	04	03	02	01	99	98	97	96	95	1994-1987
22	11	6	3	3	10	7	5	4	3	4	7	0	2	3	1	1	4	1	2	6

Table 4: Chronological review of the literature. The number of relevant publications for each year.

	Field of Studies (Multidisciplinary study)																															
	Human Rights (Trust, Privacy, Ethics)					**Human Factors** (Information Overload, Human Cognition)					**Computer Science** (CMC, Human-Computer Etiquette, Computer Supported Collaboration, Automation)					**Design for experiences** (Creative conversation, Productive Conversations, Driving Experience)					**Social Sciences** (Social Presence, Co-presence, Behaviour)					**Linguistics** (Empathetic communication, Conversation)				
	2015-2011					**2015-2011**					**2015-2011**					**2015-2011**					**2015-2011**					**2015-2011**				
	15	14	13	12	11	15	14	13	12	11	15	14	13	12	11	15	14	13	12	11	15	14	13	12	11	15	14	13	12	11
Domains	1	1	-	-	-	3	2	1	1	3	11	3	2	1	-	7	5	3	1	-	-	-	-	-	-	-	-	-	-	-
Automotive context	-	-	-	-	-	3	2	1	1	3	1	-	-	-	-	5	3	3	-	-										
Aviation /Automation context	-	1	-	-	-	-	-	-	-		-	-	-	1	-	-	-	-	-	-										
Organisation /Work/ conferencing context	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	1	2	-	1	-										
E-learning context	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-										

Defence context	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-											
Games context	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-											
Telemedicine	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-											
e-commerce /Everyday media context	-	-	-	-	-	-	-	-	-	-	3	3	2	-	-	1	-	-	-	-											

Table 5: Chronological review, 2015-2011

	Field of Studies (multidisciplinary)					
	Human Rights (Trust, Privacy, Ethics)	**Human Factors** (Information Overload, Human Cognition)	**Computer Science** (CMC, Human-Computer Etiquette, Computer Supported Collaboration, Automation)	**Design for experiences** (Creative conversation, Productive Conversations, Driving Experience)	**Social Sciences** (Social Presence, Co-presence, Behaviour)	**Linguistics** (Empathetic communication, Conversation)

	2010-2006					2010-2006					2010-2006					2010-2006					2010-2006					2010-2006				
	10	09	08	07	06	10	09	08	07	06	10	09	08	07	06	10	09	08	07	06	10	09	08	07	06	10	09	08	07	06
Domains	-	1	-	-	-	3	2	1	-	1	3	1	3	3	2	4	2	-	1	-	-	-	-	-	-	0	-	1	-	-
Automotive context						3	2	1		1			1		1	4	2													
Aviation /Automation context											2																			
Organisation /Work/ conferencing context		1									1			2					1									1		
E-learning context												1																		
Defence context											1																			
Games context																														
Telemedicine context																														

e-commerce /Everyday media context												2	1	1		1															

Table 6: Chronological review, 2011-2006

	Field of Studies (multidisciplinary)																														
	Human Rights (Trust, Privacy, Ethics)					**Human Factors** (Information Overload, Human Cognition)					**Computer Science** (CMC, Human-Computer Etiquette, Computer Supported Collaboration, Automation)					**Design for experiences** (Creative conversation, Productive Conversations, Driving Experience)					**Social Sciences** (Social Presence, Co-presence, Behaviour)					**Linguistics** (Empathetic communication, Conversation)				
	2005-2001					**2005-2001**					**2005-2001**					**2005-2001**					**2005-2001**					**2005-2001**				
	05	04	03	02	01	05	04	03	02	01	05	04	03	02	01	05	04	03	02	01	05	04	03	02	01	05	04	03	02	01
Domains	-	2	-	-	-	1	-	-	-	-	2	5	-	1	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Automotive context												1																		
Aviation /Automation context		1										2																		
						1									1	1															

Organisation /Work/ conferencing context																															
E-learning context																															
Defence context															1																
Games context																															
Telemedicine context																															
e-commerce /everyday media and communities context		1								2	2		2	1																	

Table 7: Chronological review, 2006-2001

2.3.2. VEHICLE CONTEXT CHARACTERISTICS

In our study, we identify the main limitations that are highlighted in previous studies while designing or evaluating in-vehicle interactions to improve the design of our system. We identified four main characteristics, Cognitive effort, Safety, Privacy, and User training.

In our research, cognitive effort refers to the driver's perception of cognitive workload during driving. Cognitive effort is defined as the amount of 'mental activity' or forms a biological perspective the 'amount of brain activity' involved in a communication interaction (Kock, 2002). Kock (2002) also suggests that cognitive effort can also be assessed indirectly, based on perceptions of levels of difficulty associated with communicative tasks, as well as through indirect measures such as that of 'fluency'.

Safety here refers to the "objective" safety of the driving experience. The actual safety is, in many cases, a result of the cognitive effort expected, but perceived safety is also vital for the acceptance of the technology. For example, Multimedia information has proven to be the source of significant distraction since multimedia interfaces are not optimised for driving performance(Alvarez *et al.*, 2010). The same study also suggests that performing two tasks that require visual attention in a moving vehicle is not only distracting but also dangerous.

Another essential characteristic is perceived privacy in the vehicle. The social situations in the car in comparison to the personal situations are part of the context that can alter the driving experience. For instance, when designers and a user need to collaborate in daily basis, that means that one of the two parts is intruding to the personal space of the other by having face to face (FTF) communication or a computer-mediated communication (CMC) while being physically present in the first case or present but not physically in the second case.

During the early stages of designer-to-user communication in civilian applications, we face the situation of a non-trained user being involved in the conversation. In comparison to other domains where trust is build based on training, code of practice and hierarchy in a vehicle is way more challenging to be able to construct meaning. At the same time, creating meaning is fundamental for communication to be effective. This characteristic of communication is also part of the context that comes with the commercial, automotive sector. Examples including Formula1, WRC, and Aviation differ from commercial automotive where both parties of the communication interaction are trained in advance as a prerequisite of the communication.

Organisations that seek to draw on contributions from individuals, as (Seidel and Langner, 2015) explain, will need to motivate the submission of ideas, innovations, or designs. One way to motivate participation in an open innovation platform is through offering extrinsic rewards, such as cash payments in an innovation contest. The factors that motivate participants on participating in a community of innovation are either Intrinsic or extrinsic, factors such as fun of sharing, cash payments or innovation contests with price payments. Intrinsic motivation includes those for which the task is done for the internal satisfaction gained. The fact that people have to be motivated to participate is a limitation the automotive industry has to define for any proposed collaborative platform; be that as it may, our focus in this study is mainly on the designers and their support in the early stages of this collaborative design process. The context limitations of this two-way communication interaction are not primarily affecting the designer but the user. In order though for this interaction to be materialised the designer will have to be supported in bypassing the communication limitations that derive

either from the driver/passenger or the automotive environment and deliver a communication experience that it is not only going to be valuable for him but also non-intrusive and non-disruptive to the overall driving experience.

Previous work indicates a need for more research for the in-vehicle interactions but also describes the limitations when applying specific HCI methods. As we described, UX designers are facing many deficiencies when designing for in-vehicle experiences. Some of these methods could be applied only hand in hand with the right tools or technological interventions. We report the tools and technologies used to overcome the physical limitations in the next section. Remote participation could be an answer to our problem.

2.4. MEDIATED COMMUNICATION AND PARTICIPATION

Co-creating requires that the designer and the user collaborate in real-time. Co-creating within the automotive context faces the context limitations of remoteness, cognitive effort, safety, privacy, user training. For this reason, the primary limitation is the designer not being physically present in the vehicle. There are various ways in which a person can communicate mediated by a computer. CMC can include text communication, sound communication, video communication, and other modalities to produce different communication experiences such as telepresence or embodied communication interaction. Immersive technologies are also applied to communication in different research areas. Popular research areas regarding research focus and quantity of scientific work are healthcare, teleconferencing, organisational communication, and automation. Applications in these areas take advantage of the ability of the technology to mediate human interaction while being in different space and/or time. Remoteness is the main characteristic of these communications and their existence in some areas depends on that.

Media such as e-mail and the internet are better equipped to disseminate information – called 'conveyance' (Rhoads, 2010). Media, such as video conferencing or Telepresence, are better at engendering mutual understanding which is called 'convergence' (Rhoads, 2010). Video conferencing or telepresence has been used many times in the past in organisational contexts and has been defined as 'the use of technology to establish a sense of shared presence or shared space among geographically separated members of a group' (Standaert, Muylle and Basu, 2015). Telepresence installations are set up to resemble a face-to-face meeting as closely as possible: participants at different locations see each other in true life-size, can make eye contact, and each person's voice comes from the direction of their screen image (spatial audio). Also, lighting and furniture across locations are matched for a seamless look and feel of local presence (Standaert, Muylle and Basu, 2015). Teleconferencing is used to provide communication experiences that simulate better the natural human to human communication. Also, teleconferencing and particularly video conferencing, of all telecommunication technologies, is described by Park et al. (2014) as the best to simulate face to face communication in allowing users to see and hear one another.

In this chapter, we describe the differences of various communication theories related to remoteness and collaborative outcomes, and which are applied in different domains. We furthermore, present guidelines on remote communication mediated by a computer, and finally, we highlight the context of communication and how this might affect the communication itself.

2.4.1. MEDIATED COMMUNICATION THEORIES

Many theories were developed and proposed intending to explain the use and acceptance of communication technologies in different domains. Some of the most exciting approaches from previous researchers are critically reviewed in this part. Our goal through this review is to design an artefact based on the most relevant theories of remote and mediated communication.

The most well-known communication theory is Media richness theory (MRT)(Daft and Lengel, 1983). MRT differentiates the rich from the lean media according to the degree of emotional, normative, or attitudinal cues present. Face to face communication is considered the richest, followed by video communication which is richer than the telephone, and email and computer documents are the leanest of all (Rhoads, 2010). According to Robert and Dennis, two dimensions can be used to classify the extent of social presence or media richness perceived by users: In general, media providing same-time and same place interaction are perceived to be higher in 'social presence' and 'media richness' than media providing different time and different place interaction (Robert and Dennis, 2005).

Furthermore, according to Derosa et al., perceptions of technology may also change over time, adding to the richness of technology (DeRosa *et al.*, 2004). Hence, other theories such as Media Synchronicity Theory (Dennis and Valacich, 1999) come to fill the gap, the authors arguing that some technologies allow users to communicate at the same time while others do not. For that, some media (email, the internet, blogs) are better equipped to disseminate information, defined as 'conveyance,' while others (video conferencing or telepresence) are better at engendering mutual understanding, defined as 'convergence' (Rhoads, 2010). According to Media Synchronicity Theory, both conveyance and convergence are equally crucial in completing tasks.

A further exciting approach is described by (Te'eni, 2001) in his study where he analyses not only the medium (channel or technology) but also the message of the communication and digs more rooted to the mechanisms by which people choose to behave. Communication is more complicated than other models, and sometimes the goal is to accomplish a task and maintain a good relationship. Being able to complete a task is one of the most common usability evaluation factors, however in communication just completing a task is not enough if after the completion your relation with the other communicator is negatively affected. For example, if I am asking a question to somebody who is not willing to answer it, I can force him to answer my question so that I can complete my task, but my relationship will not be the same after that.

Another approach adding to media richness theory is Channel Expansion theory. As we have mentioned earlier media richness theory is interested in the time and the place of the communication (same-time and same-place communication is considered a rich communication) but does not consider situational factors that could affect behaviour (Markus, 1987) and social factors that may alter an individual's perception of media (Fulk *et al.*, 1987). As a consequence, Carlson and Zmud (1999) introduced the Channel Expansion theory, which recognises that there are specific experiences that influence how individuals develop 'richness perception' for a given media. They identify four experiences as being most important, the channel experience, the message topic experience, the organisational context experience, and the communication co-participants experience.

Channel expansion theory is not the only one to build on the media richness theory. Another theoretical approach is Social Dynamic Media Theories examine the use of ICT technologies within the context of cultural and organisational settings, arguing that communication behaviours depend on social and organisational systems and their environment (DeRosa *et al.*, 2004, Montoya *et al.*, 2009). The implication here is that barriers to efficient ICT use may have to do with improper training or lack of clearly defined goals resulting from the culture of organisations and social habits. In Social Information Processing Theory (SIP), one particular social dynamic media theory, (Walther, 1992) argues that computer-mediated teams can reach levels of interpersonal interaction that are similar to face-to-face groups, given sufficient time (Walther, 1992). According to SIP, those involved in communication use the cues available in developing relationships, and if specific nonverbal cues are unavailable, communicators ''adapt their language, style and other cues to such purposes'' (Walther, 2005). A typical example would be emoticons placed throughout text-based communications.

There are also theories to contradict media richness theory and the richness hypothesis. Media Naturalness theory (MNT) (Kock, 2005) follows from the analysis of evidence in connection with our evolutionary past that using modes of communication that veer away from natural communication is likely to put an extra burden on the brain as our brain has been designed for that type of communication. MNT can be defined from the ability of the communication media to support co-located and synchronous communication by employing facial expressions, body language, and speech (Kock, 2005). Kock suggests five key elements:

- A high degree of co-location, which would allow the individuals engaged in a communication interaction to and hear each other, as well as share the same environment while engaging in communication
- A high degree of synchronicity, which would allow the individuals engaged in a communication interaction to exchange communicative stimuli quickly
- The ability to convey and observe facial expressions
- The ability to convey and observe body language
- The ability to convey and listen to speech

The theories presented above, their use, and how people understand them in their real-life context can be evaluated in practice. People though understand these theories when they are applied under a specific context of collaboration or participation. Therefore, after reviewing the main theories and their differences, in the next section, we report on some critical guidelines for the application of the theories in practice.

2.4.2. MEDIATED COLLABORATION AND PARTICIPATION

Previous research has demonstrated that CMC can be better than face to face communication for many reasons, as mentioned below. For example, CMC can increase opportunities for participation since the more vocal people have fewer means to dominate the setting than they do in face-to-face encounters (Rhoads, 2010). Of course, this does not mean that the communication partner has to be invisible, but just not physically present. Moreover, other researchers have shown that the ability to see the other person improves collaborative outcomes (Rae *et al.*, 2015). It is not a matter of why CMC, but rather how to

work collaboratively with CMC. For that reason, CMC as in FtF communication, the implementation of some basic guidelines are required. The Cooperative Principle, e.g., suggests (Simmons, 1994): Make your contribution as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged which suggest acting according to the situation.

In contrast, though another guideline for collaborative outcome suggests that predictability of communication is a crucial dimension that fosters trust and allows virtual teams to perform effectively (Morand and Ocker, 2003) Rico *et al.*, 2009). By paying attention to absent others, by sending or reading text messages, participants reported a sense of disruption to situations of co-presence, which in turn stimulated anxieties about the deterioration of more abstract social, moral codes (Cahir and Lloyd, 2015). We presented a few guidelines and good practices above because as we previously argued the question with CMCs is not only why to adopt them but also how to adopt them. The medium of communication is also vital when it comes to collaborative outcomes.

To achieve social presence in communication, the medium that is selected has to fit the goal of the communication. Studies in social presence identify that to communicate effectively the level of personal involvement and attention that is required for the communication task should be matched with the social presence of the medium (Standaert, Muylle and Basu, 2015). For example, when teleconferencing, employees are more aware of others' status and reactions, thereby being more cautious about their self-image and behaviours (Park *et al.*, 2014). For the above reason, impersonality, formality, coldness, "bureaucratic or official-sounding," map onto high social distance (Morand and Ocker, 2003).

On the other hand, the loss of social presence can have dramatic results. Social presence theory predicts that people working in highly virtual teams experience psychological and relational distance from their co-workers because the social salience of others is drastically reduced (Morand and Ocker, 2003). According to (Derks, Fischer and Bos, 2008), the absence of visible others in CMC is assumed to lead to fewer negative appraisals, explicit negative emotions expression. Individuals feel less embarrassed or anxious to communicate their feelings.

On the contrary, anonymous communication is not an attribute for all the CMC technologies (video, telepresence). However anonymity is in the centre of attention due to the general concern about privacy while using technology, more important in our case is that anonymity and absence of nonverbal cues may lead to changes in the quality and content of the interaction including increased self-disclosure and intimacy on the same way that it provides more control over self-presentation (Shalom *et al.*, 2015). If people tend to trust an anonymous computer-mediated communication more than a more social present one (close to the FtF communication) is not answered without the context of the communication. What we know though is that once people are exposed to the social sharing of emotion, it is widespread that receivers, in turn, share the episode with a third person, thus anonymity is not guaranteed at all in human to human communication.

2.4.3. MEDIATED COMMUNICATION CLARITY UNDERSTANDING AND TRUST

Wlodkowski identifies clarity in 24 behaviours which include items (Simonds, 1997b) including, explaining things simply, repeating things we do not understand, describing the work to be done and how to do it, and preparing us for what we will be doing next. They also highlight three types of explanation. Firstly, interpretive explanations answer 'what' questions about the content of the course. Secondly, descriptive explanations answer 'how' questions about procedures or tasks of the course. Finally, reason-giving explanations answer 'why' questions which address the rationale for content or procedures. Interpretive explanations address the content clarity; whereas, descriptive and reason-giving explanations, at least in part, address process clarity.

It is reasonable to say that people use their body to communicate in different ways and to convey different messages. The absence of physical presence in CMC does not mean that the convenience of messages is not as effective as the FtF communication. It is difficult though not to highlight Media richness theory (Rhoads, 2010): A medium is considered to be richer if it can convey multiple verbal and nonverbal cues, allows for immediate feedback, uses natural language, and has personal focus (Standaert, Muylle and Basu, 2015). Accordingly, 'modality' is defined as the medium's capacity to transmit multiple cues (e.g., physical presence, voice inflexions, graphic symbols)(Park and Sundar, 2015). For example, in a communication interaction, visual cues increase the effectiveness of giving feedback or clarifying an issue (Standaert, Muylle and Basu, 2015) and thus, they are perceived as valuable. When humans analyse the words being spoken, we attempt to imagine and interpret the communicator's intention behind them and therefore the non-verbal and para-verbal (tone, pitch. and inflexion) components in a conversation are as important as the verbal (Rhoads, 2010) Para-verbal, and nonverbal cues control conversation flow, turn-taking and mind reading. Lack of these cue controls for conversation flow results in an unregulated and disordered conversation, which can lead to confusion and incoherence (Rhoads, 2010). Verbal, Para-verbal, nonverbal, territorial behaviour, and use of personal space operate actions resulting in patterns that signify comfort, meaning, or misunderstanding and discomfort (Rhoads, 2010). One rule is the association between someone's voice intensity and spatial location. People use intensity as the primary auditory distance cue (Zhang, Lakens and IJsselsteijn, 2015). In the same manner, Brown and Levinson suggest that negative politeness is generally accompanied by higher voice pitch. Absent such cues (i.e., in the leanness of CMC) one would anticipate a greater tendency for message misinterpretation (Dai *et al.*, 2015).

Additionally, telecommunication users experience the illusion of non-mediation and thus adopt the 'louder as closer' rule from face-to-face communication (Zhang, Lakens and IJsselsteijn, 2015). Remote communication mediated by a computer requires designers to think of the guidelines and limitations mentioned above to be able to replicate the clarity and understanding of F2F interaction. For example, when the medium does not offer video communication, para-verbal and nonverbal cues which control conversation flow and turn-taking need to be replaced by alternative technological interventions to keep the clarity and understanding of the communication.

On the other hand, though as previously mentioned in the social presence theory impression management is vital for people. The lack of immediate social context and unavailability of nonverbal cues in CMC can help socially anxious individuals become less preoccupied with impression management (Shalom *et al.*, 2015). Except for the non-verbal cues, other modalities can serve for similar reasons. For example, 'Emoticons' serve the

function of clarifying textual messages which are similar to non-verbal displays in F2F (such as tone of voice) (Derks, Fischer and Bos, 2008). Even in the perceived communication, the addition of picture or other modalities to textual messages has shown positive effects on users' perception of the experience (Park and Sundar, 2015). Clarity and understanding are two vital factors for people to trust and engage in communication. A misunderstanding, for example, can affect the feelings and emotions of a communicator who will undervalue the level of trust.

In human-human relations, we tend to trust those who behave trustworthily and/or those with whom we enjoy interacting (Parasuraman and Miller, 2004). In a team, Trust is defined as the willingness of a team member to be vulnerable to the actions of other team members based on the expectation that they will perform an action that is important for the trustor irrespective of his/her ability to monitor or control developments (Rico *et al.*, 2009).

The stage of communication defines how trust is perceived and communicated. Early on (from the project starting-point to one week before the project mid-point), the communication behaviours associated with trust are characterised by a combination of socially and task-oriented communications and the conveyance of enthusiasm. Later on (from the project mid-point to the project end), communication behaviours associated with trust are those that create a sense of predictability in the interaction (through regular patterns of communication and appropriate warning of absences) and offer substantive responses (Rico *et al.*, 2009).

Trust builds and develops within teams in steps and can be characterised as social or task-oriented. Task-oriented concerning the ability to complete tasks while social trust deals with relationship bonds (Rhoads, 2010). Which mediums though do people trust the most either in social or task-oriented communication? Richness theory attempts to answer. The richness of cues better enables communications and trust (Rhoads, 2010). Possibly the life-size presence, sense of shared space and eye contact may help participants transmit cues that have been identified to be important in virtual teams to 'convey trust, warmth, attentiveness, and other interpersonal affections' and to transmit 'emotion and strength of feeling' in business communication (Standaert, Muylle and Basu, 2015). The evaluation of a communication interaction with a specific target group is a way to identify which models and methods fit for specific situations and which rules apply to achieve reliable communication. The target group is central to the evaluation of the communication since there are differences in tendencies and expectations of communication interaction. For example, some people prefer to reveal their innermost thoughts and feelings to a computer screen than to a real person (Derks, Fischer and Bos, 2008).

Furthermore, online communication seems to reinforce rather than inhibit the expression of emotions (Derks, Fischer and Bos, 2008). While CMC elicit a similar physiological response of anxiety as FTF, it is perceived as less threatening, more controllable and as a facilitator of a greater sense of success (Shalom *et al.*, 2015). Anxiety in CMC which refers to the extent to which individuals feel unpleasant when using or considering using a particular technology, including such emotional states as frustration, apprehension, and fear (Park *et al.*, 2014). On the other hand, the expression of strong opinions, accompanied by the display of negative, antagonistic emotions expression in the form of insulting, swearing, offending, or hostile comments (flaming) is more likely to appear in CMC (Derks, Fischer and Bos, 2008).

Emotions, clarity and understanding of the communication can change the level of trust between the communicating parties. The limitations of the technology to convey as

rich messages as FtF communication can result in misunderstandings in the conversation. Some people though still prefer to be mediated in their communication and trust technology more for their expression of emotions. We have previously highlighted that in mediated as in non-mediated communication politeness can lead to avoidance of face-threatening acts and misunderstandings, but we have not thoroughly explained the rules of etiquette to be applied. As a result, in the next section, we will explore the mediated communication etiquette, and we will describe some of the guidelines to be used when designing for such communication.

2.4.4. MEDIATED COMMUNICATION ETIQUETTE

Etiquette is a matter that is still concerning scientists not only in social sciences but also in computer sciences where human has to communicate with a computer. The perception of the computer seems to be similar to humans in this kind of interaction (Derks, Fischer and Bos, 2008). If the interacting parts have different codes of etiquette because they do not interact directly in a human to human communication interaction, this is proved to be dependent from the context and the modalities used as we will later explain (Cahir and Lloyd, 2015).

Different types of technology require different forms of etiquette (Rokeach, 1973), and there are different kinds of etiquette for different settings and domains (Torrance, 1974). Most norms, including rules of etiquette, are learned through experience in a community. For example, children observe how adults and other children behave, absorb these norms and learn their community etiquette at an early age (Preece 2004). Etiquette rules attempt to observe good practices already existing in 'polite society' and then formulate them for others and/or infer from existing practices to propose etiquette for new situations (Christopher A. Miller, 2001b). In essence, politeness means 'phrasing things in such a way to take into consideration the feelings of the others' (Morand and Ocker, 2003).

For most home-based usage purposes, proper etiquette might mean politeness, subservience, helpfulness, and 'the sensitivity of an intuitive, courteous butler. However, those might be inappropriate behaviours to exhibit to a pilot or a power plant operator (Miller, 2004). If the system were replaced by an ideal human assistant, albeit one constrained to act through the interface modalities. How would people, for example, regard a human office assistant who, several times a day, interrupted their work to offer them help to write a letter? (Miller, 2004) A simple request for information – as for the time – threatens face; the requestor has presumed some right of access to the hearer's time, energy, and attention (Morand and Ocker, 2003). Etiquette is believed to be underestimated in communication both in automation and in interfaces and critical technical work (Olsen, 2011; Parasuraman & Miller, 2004). Also, CMC users wishing to avoid misattribution may compensate by being less polite, more direct. If so, we would expect the ratio of positive to negative politeness to increase in CMC, in comparison to FtF (Morand and Ocker, 2003).

Politeness, both as a form of respect and as a protocol, is as vital in the virtual world as in the physical (Olsen, 2011). Etiquette operates (when obeyed) to make social interactions more pleasant, polite, and cooperative and (when violated) to make them insulting, exploitative, and unpleasant (Miller, 2004). Scientists have attempted to form rules of etiquette that are applied to automation and mediated communication (Christopher A. Miller, 2001b). Generally, there are two basic rules of communicative competence guide for all social interaction: 1) make yourself clear, 2) be polite (Morand and Ocker, 2003). The paradox is that these two are contradictory. As clarity and consideration are opposing communication principles and often do clash, as to be polite entails being ambiguous, while

to be straightforward can offend. For many tactics, water down is the 'illocutionary force' which means the intent behind a speech act (Morand and Ocker, 2003). Contrarywise, automation using proper etiquette, defined as 'non-interruptive' and 'patient', rates perception of trust considerably higher, and so does the user performance (Parasuraman and Miller, 2004). Tactics of politeness can be reliably observed and thus quantitatively measured; as such they can be used in the assessment of relational ties within CMC, at a linguistic level of analysis (Morand and Ocker, 2003).

Opposite to politeness manners and etiquette, we have face-threatening acts (FtA). Face-threatening acts (FTA) include acts of criticising, disagreeing, interrupting, imposing, asking a favour, requesting information or goods, embarrassing, dumping into, and so forth (Morand and Ocker, 2003). As we later explain, FtAs are also dependent on the context of the communication and not only from the medium as previous researchers have identified. There number of ways that a person's face can be threatened. Ways that can be mitigated or exacerbated by a multitude of factors (Simmons, 1994) including, the immediate environment, the primary participants, the observers, formality, the relative power one participant has over another, and the physical and emotional distance of the participants.

In ascertaining face-threatening acts, the first place to start is with Grice's Maxims. (Simmons, 1994)

- Quality: non-spurious—tell the truth and avoid unsubstantiated rumour
- Quantity: succinct—give no more and no less information than is required
- Relevance: relevant—stick to the topic
- Manner: perspicuous—be straightforward, brief and orderly

Conclusively we describe those different forms of etiquette to suit different technological settings and situations. Manners and politeness are essential to avoid FtA, which is also the main reason why communication is also context-dependent. In the following section, we will describe what constitutes the context of communication and present some of the effects it can have on communication.

2.4.5. MEDIATED COMMUNICATION CONTEXT

Computer-mediated communication (CMC) lies at the intersection of several disciplines – including computer science, systems science, organisational theory, and social psychology (Morand and Ocker, 2003). Furthermore, what is most important is that the context in which the medium is used has been found to influence the medium's perception and effectiveness (Standaert, Muylle and Basu, 2015). E.g., in the context of mobile phone use in co-present social situations, prioritising the intimate other may be displayed through acknowledging the importance of co-present individuals, by ignoring the call or text message (Cahir and Lloyd, 2015). Hence, context is not only the space environment but also the presence of another person which also defines whether it is a social or a non-social situation. The presence of another person can also influence the perception of the situation and in our study the perception of the communication experience. The notion of social appraisal has highlighted this effect on social behaviour. Social appraisal theory is proposing that the way an individual appraises an event is influenced by the way other individuals appraise and feel about the same event. The so-called 'social appraisals' are more likely to play an important role when others are present than absent (Derks, Fischer and Bos, 2008).

For instance, a person may perceive a communication technology as inappropriate because his or her friends or family who is present got intimidated by a communication event.

'The effect of social appraisals can be seen in online communities of practice. Communities of practice (CoPs) develop shared public resources, such as routines, sensibilities, artefacts, vocabulary, and styles of doing things that help create a sense of community that socially binds members' (Jennifer Preece, 2004). Unwritten rules of etiquette are followed by members to sustain the previously mentioned social bonds. Accordingly, another study in CMC identifies that people use more emoticons in socio-emotional contexts than in task-oriented contexts. This is possibly related to the social norms of our society. It is more appropriate to show one's emotions and feelings towards friends than towards colleagues (Derks, Bos and Grumbkow, 2007).

Since the context in which people communicate is not only formed by socio-emotional experiences as we have mentioned previously but also by task-oriented experiences we need to highlight that positive perception of others can strengthen task-oriented communication and, to that end, competent specialists should be chosen for teams (Shalom *et al.*, 2015).

2.5. PREVIOUS WORK CONCLUSIONS

The literature that we critically presented above covers our study's three main areas. As previously mentioned, we covered essential definitions and previous researchers' approaches to identify and analyse the design for experience, automotive interaction design, and distant mediated communication:

•Key theoretical concepts of design for experiences through different disciplines.

•The impact of experience design in the automotive domain and analysis of the primary limitations of the automotive context

•Key theoretical concepts of Computer-mediated communication and remote participation. Background information on distant communication theories, methodologies, models and technologies

This literature supports our research in two ways:

First, it supports the synthesis of the designer 'goals'(Kaasinen *et al.*, 2015) which initiate our design of the system and inform our decisions in this iterative process. We include in our study a separate chapter where the designer goals are analysed, highlighting the relevant literature in this study. Furthermore, we connect the literature with the design decisions in this design science research paradigm.

Second, it helps us evaluate the theory through the design of our system and direct the analysis and interpretation of our data set. We are informing the theoretical concepts of the current state in remote user experience design and communication in automotive that we used to synthesise our initial 'goals' by interpreting our data set. As a consequence, in the following chapter, we present this thesis research approach and methodology as well as the specific methods used to complete this work as mention above.

3. CHAPTER THREE: THE THESIS RESEARCH PARADIGM

This chapter discusses the research paradigm, the ontology, epistemology, methodology and methods standpoint with which we conducted the research. Both the overall methodological approach and the specific methods used are going to be critically and exhaustively analysed. Therefore, this section will attempt to carefully link our research question, aims, and objectives with the relevant design and evaluation methods. In the first part of this chapter, we relate the overall methodological approach to the nature of the research problem and elaborate more about the implementation of the research methodology in our study. In the second part, we synthesise the essential methods previously used, and we highlight the most relevant and appropriate ones.

3.1. EPISTEMOLOGICAL STANDPOINT: PRAGMATISM

Following a pragmatic epistemological standpoint, we agree with (Dalsgaard, 2014) that "The meaning of our conceptualisations of the world—including but limited to, ideas, theories, and assumptions—should be evaluated by their consequences and implications in practice." Pragmatism regards the world as emergent and never fully finalised. The world and phenomena in it are emergent, and it is in our nature to make sense of it in practice and form transient constructs in the attempt to attain stability. Pragmatism represents a highly situated perspective on human activity in which our complementary capabilities of action and reflection form the basis for sense-making (Dalsgaard, 2014). Pragmatism presents a situated world view in which practice is the essential testbed in which conceptualisations prove their value. Dalsgaard describes that with pragmatism, the world of practice is emergent, in the making, through the ongoing interactions between subjects and surrounding environments. This resonates with the understanding that design is a situated and systemic activity in which the designer must engage with the design situation both to get an initial understanding of the challenge they are facing and in the ongoing design process in which various components of the situation "talk back" to the designer in the conversational metaphor of Schön et al. (1986). As a result, we apply participatory design methodologies to actively involve the participants in the early stages of the design process. We explicitly identify the most relevant methods and tools to achieve a pragmatic result and have a valuable contribution to the body of science.

3.2. RESEARCH QUESTION

Based on our literature review, automotive in-vehicle designers need to design-in-context and in-situ in automotive. To achieve that, due to various limitations stated in our literature review, they need to do it remotely. Therefore, the research question that arises is:

How can a Remote Participation System support, context-aware, in-situ, participatory design in automotive?

Sub-question 1: How can designers, design for automotive experiences remotely? : What are the 'goals' of a user experience designer when designing for the in-vehicle interactions remotely?

Sub-question 2: How can a supportive tool enhance the design results and be more effective and efficient? Which are the processes and interactions and specific tools that can effectively and efficiently support the UX designers in their goals in the early stage of the design process?

The two objectives of this research previously mentioned are linked with the artefacts of this study as follows:

1. To identify the UX design 'goals' (Kaasinen *et al.*, 2015) of the proposed remote participatory design system, i.e. for the early stages of designing for in-vehicle experiences.

2. To design the system and its front end interactions in the early stages of the design process based on the UX design goals previously identified.

Following on our aims, we analyse our methodological approach to reach the goals of this study. Design science research must produce a viable artefact in the form of a construct, a model, a method, or an instantiation (A. R. Hevner and Chatterjee, 2010).

Artefact 1 (A Framework) for developing a remote communication system in automotive

The objective of design science research is to develop technology-based solutions to important and relevant business problems (Hevner & Chatterjee 2010). As a result, Objective 1 is expected to inform the design and evaluation of the artefact of this study. In our holistic design approach, we need to determine whether the system is acceptable for other stakeholders. We are expected to feedback to our design process with new insights and will enhance the understanding and implementation of the system.

1. We need to identify the designers do goals in the early stages of designing for experiences. (Which are the activities they want to be able to achieve in the context of automotive and how?)

2. Following the UX model of Hassenzahl (2010), for 'be goals' and 'do goals,' we also need to identify the designers 'be goals.' (How would the designers want to feel while interacting). The feelings they want to feel while interacting for achieving personal needs. Moreover, the feelings and values they want to reflect while interacting and communicating, in respect to the Brand identity of their organisation. Possible archetypes they wish to express.

Artefact 2 (A supportive Interactive system)

This artefact reflects on the second objective by many rigorous cycles of design and evaluation. Design science research relies upon the application of rigorous methods in both the construction and evaluation of design artefacts. Low and high fidelity prototypes can serve in the early stages to iterate on the design and evaluation of the prototype system. Design and evaluation will help us optimise the system and provide valuable scientific insights for future application.

We are expecting an extension and revision of this artefact through the evaluation processes. Effective design science research must provide transparent and verifiable contributions in the areas of the design artefact design foundations and design methodologies. We will rigorously demonstrate the utility, quality, and efficacy of the design artefact via suitable and well-executed evaluation methods.

3.3. RESEARCH METHODOLOGY

Design science research is a research paradigm in which a designer answers questions relevant to human problems via the creation of innovative artefacts, thereby contributing new knowledge to the body of scientific evidence. The designed artefacts are both useful and fundamental in understanding that problem (Hevner & Chatterjee 2010). The fundamental principle of the design science research is that knowledge and understanding of a design problem and its solution are acquired in the building and application of an artefact.

Information systems (IS) research to date has produced knowledge by two complementary but distinct paradigms: behavioural sciences and design sciences (A. Hevner and Chatterjee, 2010). Behavioural science, which draws its origins from the natural science paradigm, seeks to find the truth. It starts with a hypothesis, then researchers collect data and either prove or disprove the hypothesis. Eventually, a theory develops. Design science, on the other hand, is fundamentally a problem-solving paradigm whose end goal is to produce an artefact which must be built and then evaluated. Working with the technology and going through the process of construction and understanding the salient issues with the artefact is central to this paradigm. Design Science, as conceptualised by (Simon, 1996), supports a pragmatic research paradigm that calls for the creation of innovative artefacts to solve real-world problems. The design science paradigm has its roots in engineering and the 'sciences of the artificial' (Simon, 1996). It is fundamentally a problem-solving paradigm. Natural science research methods are appropriate for the study of existing and emerging phenomena; however, they are insufficient for the study of "wicked organisational problems,"(Rittel and Webber, 1973) the type of problems that require creative, novel, and innovative solutions. Such problems are more effectively addressed using a kind of paradigm shift offered by design science. These creative, novel and innovative solutions are the artefacts that Simons (1996) proposed which are not exempt from theories. They rely on kernel theories that are applied, tested, modified, and extended (Hevner & Chatterjee 2010).

In our research, it is important to highlight our participatory design ethos and our paradigm, which uses participatory design and open innovation in two different ways under the same study. As we further explain in our methods chapter, we designed a toolkit towards the development of the system with the users and also the result (the system) of this collaborative effort aims to support participatory design paradigms and the democratisation of innovation.

Firstly, our approach in this study incorporates the state of the art participatory design methods and applies co-designing to gain access not only to what people say and do but also to their experiences and dreams similar to previous research by Sanders and Dandavate (1999). As a result, we co-design a remote UX design system by actively involving participants in the design process. Therefore, in the first and second cycle of our iterative design approach, we apply participatory design to develop a support system with the users by providing them with the tools and toolkits to prototype. Secondly, the developed system itself supports participatory design in the context of the autonomous vehicles, which means democratisation and end-user involvement for the design of novel in-vehicle interfaces. As we previously described this research examines the emerging role of remote systems to support participatory User Experience design and the Democratization of Innovation in the early stages of the design process in the automotive domain.

3.3.1. CYCLES OF INSPIRATION DESIGN AND EVALUATION

On a recent study Kaasinen et al. (2015), based on cases studies and literature proposed five different approaches to acquiring insight and inspiration for UX goal setting which has been identified around the areas: Brand, Theory, Empathy, Technology, and Vision. There are several different approaches to experience-driven design, each with a different process for defining the intended UX. For example, Sanders and Dandavate promote co-designing to gain access not only to what people say and do but also to their experiences and dreams (1999). Hekkert, Mostert, and Stompff, in contrast, leave the experience to be defined by the designer (Hekkert, Mostert, and Stompff 2003; Hekkert, van Dijk, and Lloyd 2011). Hassenzahl Hassenzahl (2010) utilises a list of basic psychological needs when defining experiential goals for design, while Wright and McCarthy (2008, 2010) emphasise dialogue and co-production to build empathy. According to (Kaasinen *et al.*, 2015) there are no publications that would analyse the differences of these experience-driven design approaches, although they seem to introduce striking disparities in their starting points.

Our pragmatic epistemological paradigm and our participatory approach to design science let us in deploying methods that actively involve people in the design process. The context of interest in this study is autonomous vehicles and previous research only deployed methods that allow for user-centred design. The autonomous vehicle context and the experiences of the driver are ill-defined. As a result, we cannot design an experience that is experienced by people if we do not include them in the design process. Scientists have explored open innovation co-creation and the democratisation of innovation ethos in the past without having enough applications in the automotive. The current shift to autonomy gives people more opportunities to participate, co-create and innovate. The approach to iterative empirical research adopted for this study was based on the viewpoint of Sanders and Dandavate (1999), who as we previously highlighted promote co-designing to identify and analyse what people say, do, and also what people make to access their experiences and dreams. As a result, in all our design cycles of iterative research, we applied participatory design methods with a different level of active participation of the user. In our design methodology, we incorporated all the various aspects of the user experience inspirational techniques previously proposed either on the same iteration stage of the design process or on a different one. We believe that the primary difference to incorporating only one inspiration, design and evaluation method is that designing and implementing a design is more complicated than a stand-alone theory. The success of a product, service, and or system is more likely when a complete understanding of the design space is mapped and analysed, and to accomplish that, addressing most of the design methods mentioned above is necessary. Previous research describes design methods (Gaver, Dunne and Pacenti, 1999) including cultural probes or generative methods as inspirational that aim at bringing inspiration for developers when they create new products and designs. The inspirational strategy we followed was applied flexibly to fit our research. Even though we suggest that inspirational methods in other iterative design cases can be used in a different order than in our design, we highly recommend incorporating as many inspirational techniques as possible in the early stages of the design process.

Inspiration and design are followed by evaluation in an iterative cycle. The focus of evaluation methods is to help in choosing the best design to ensure the development is on the right track or to assess if the final product meets the original UX targets (Hevner & Chatterjee 2010). A significant and growing body of literature has investigated UX evaluation. Many previous researchers have tried to identify and/or use different ways of evaluating UX. The approaches vary according to the specific research area and the

product service or system that researchers evaluated accordingly. As a result, of a multiyear effort Vermeeren et al. (2010), have collected 96 available UX evaluation methods in their study, drawing from a pool of literature review, workshops, Special Interest Groups, and surveys. They taxonomised them according to; the study period of expertise; the study type; the development phase; the evaluator/info provider of the information; the type of data; the requirements for each evaluation method and the possible applications Vermeeren et al. (2010). On their work on taxonomising the UX evaluation methods, they take the stance that UX subsumes usability. They argue that the implication is that UX evaluation entails the augmentation of existing methods for usability evaluation. As we previously highlighted, usability tests tend to focus on task performance, whereas UX focuses on lived experiences. While the notion of user experience is not new, what can be considered new is the emphasis on its importance over traditional usability. Bevan (2009), explains that although there is no fundamental difference between measures of usability and measures of user experience at a particular point in time, the difference in emphasis between task performance and pleasure leads to different concerns during development.

Our iterative design research approach consists of two iterative cycles (Table 9, Figure 3). The methods incorporated in the steps we took as summarised in the following table helped us in the development of a functional prototype of the proposed system. In the graph below (Figure 3), we can see the corpus of our research methodology and our epistemological standpoint. As we previously explained in this study, we follow a pragmatic epistemological standpoint, and we mainly incorporate participatory design methods. Although user-centred design (UCD) has influenced our methods, our study deploys participatory design and co-design techniques to actively involve non-expert users (automotive domain experts) to the generation and conceptualisation of our prototype system. UCD is a design method whose application conducts designers to develop usable design solutions for end-users. Co-design, on the other hand, is a set of creative techniques whose aim is to inspire design. Creative exercises are usually applied to enhance idea generation and concept design; they are characterised by the presence of non-designers (experts) as participants, and often led by designers (Rizzo, 2011). The reason for incorporating these methods is due to the actionable insights/findings that we can use for both formative and summative feedback. A summary of the actionable insights and the artefacts that we get as a result of applying these methods are also shown in the graph below.

Iterative design research	
First cycle	Second cycle
1. Guidelines 2. Components and design of a toolkit 3. Workshop for the design and evaluation of a low fidelity prototype 4. Analysis of the do say make triangulation 5. Translating needs to Goals 6. Design Goal-Driven personas and scenarios 7. Design 2 medium- high fidelity prototypes with different tools.	1. Workshop for critiques and co-design 2. Analysis of the do say make triangulation 3. Informing the Goals 4. Informing the personas and scenarios 5. Design of one medium-high fidelity prototype

Table 8: Steps of iterative design and evaluation for each iterative cycle.

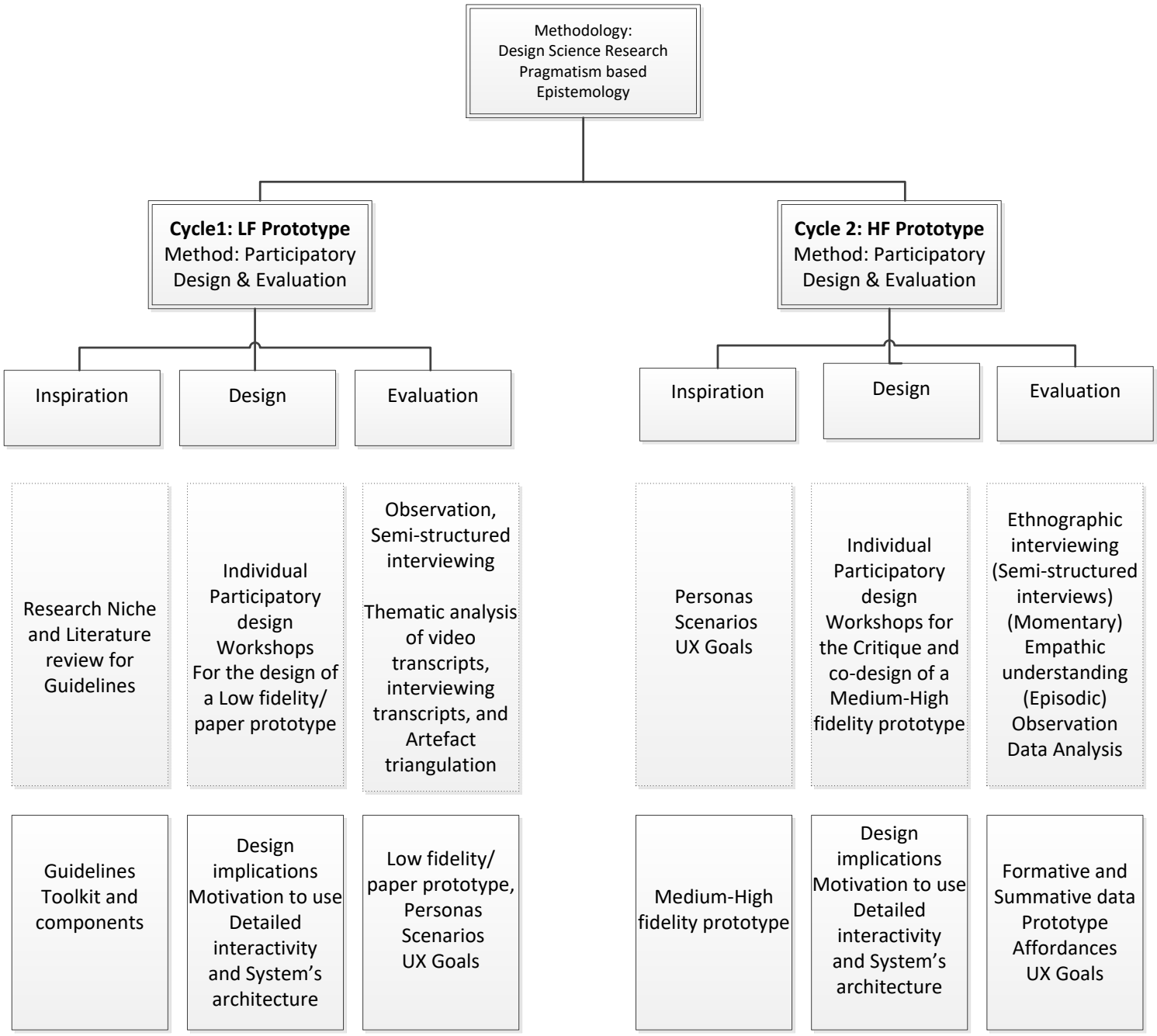


Figure 3: Methodology graph: We decided to implement our research project in two iterative cycles. Our objectives are to get inspired, design, and evaluate in every iteration. As a result, we used many methods presented under these three aims. Under each method that we used to meet the objectives, the graph displays the results of applying these methods.

In the following section, we describe the methodology used in detail. We explain the reason why we planned two iterations and the reason why we decided on the specific methods used to achieve the design result in the first iterative cycle.

3.4. METHODS: 1ST CYCLE

Our research gap, as defined in the first chapter of this study, served as the problem space of the design. Given the 'wickedness' of the problem as we have previously mentioned and in line with (Kaasinen *et al.*, 2015) user experience goal-driven design, we start exploring the problem using a combination of "Empathy-based approaches" and "Technology-based approaches." As Kaasinen et al. explain Technology-based approaches may provide focused UX goals, but focusing on the possibilities and limitations of a particular new technology does not necessarily cover all aspects of the overall usage situation. Consequently, combined with Empathy-based approaches, we have the potential in also gaining access to the deep emotional aspects of the users' world. Therefore, we involve people in the early stages of the design process to participate in activities that can provide us with information on what people say, do, make. We achieved active participation as a result of applying many HCI methods as we will later explain.

As participation in this study, we refer to the term that in HCI, as part of the participatory design, means democratisation and end-user involvement in the design process and it is used in the design of innovative technological interventions. Previously, the use of the term within HCI research often described the involvement of people in a design process (Frauenberger *et al.*, 2012, Lindsay *et al.*, 2012, Halskov and Dalsgård, 2006, Uzor, Baillie and Skelton, 2012), or the gathering of insights and requirements to inform future design (Vines *et al.*, 2012, Hook *et al.*, 2011). As Vines et al. described, the term participatory design generates reflection on participation in design in broader terms than if we were to reduce ourselves to tight definitions or specific traditions. They also explained how within HCI, many previous researchers describing participatory processes provide examples of working with groups who might be excluded (Frauenberger *et al.*, 2012, Le Dantec and Christopher, 2012, Uzor, Baillie and Skelton, 2012, Vines, Blythe, Dunphy, *et al.*, 2012), including people with special needs in terms of health and emotional wellbeing (Lindsay *et al.*, 2012, Balaam *et al.*, 2011) or in contexts where the introduction of information and communication technologies might conflict with cultural traditions (Vines *et al.*, 2013). The automotive context— as a result of the long tradition in different research methods and tools, which is mostly a result of the many limitations of the domain as explained in this study—does not follow the current trends in opening the design process to non-trained individuals and the gathering of insights and requirements to inform future design.

In the past, participatory design approaches, including narratives, games, and artefact construction, have been applied in different contexts (Muller, 2002). In co-design, the participants are active design partners. The co-design process deploys tools and generative techniques (Sanders and Stappers, 2014) to access people's feelings, aspirations, and imaginations and delves deeper into the explicit, observable, tacit and latent needs of the participants. By co-designing an artefact in our study, the prototype of the system designers can gather data on what the participants say, do and make to get a deeper understanding of their needs: "*One should keep in mind that the relationship between designer and user (consumer, recipient) is bi-directional. It is not as if users have well-defined requirements, which only wait to be discovered. Indeed, requirements are co-constructed in the ongoing dialogue between the user and designer*." (Hassenzahl, 2010).

As we have shown, previous work developing remote automotive UX design systems does not provide us with well-defined requirements. Consequently, we followed a top-down approach which initially capitalises on the available knowledge of the UX design processes, automotive limitations and remote communication guidelines from previous research.

Driven by our pragmatic epistemological standpoint and the nature of the problem, we apply individual participatory design workshops that actively involve participants to prototype the proposed remote UX design system and triangulate our findings (See Figure 4). The analysis of qualitative data is our primary source to inform theory and design. Tonetto et al. (Tonetto and Desmet, 2016) highlighted the fact that quantitative data are more precise and are useful for attracting investments or convincing stakeholders about the effectiveness of design decisions. This fact could explain, to some extent, why quantitative data are widely used in automotive research and design. Some of our participants also preferred a combination of the two.

Our methodology includes the following:

- a review of guidelines;
- a tailored to the problem design toolkit;
- participatory prototyping sessions;
- analysis of the rich data on user needs; and
- the translation of user needs to UX goals.

The use of these methods allowed us to identify users' needs and provide actionable insights in the form of UX design goals to help practitioners in the development of relevant systems.

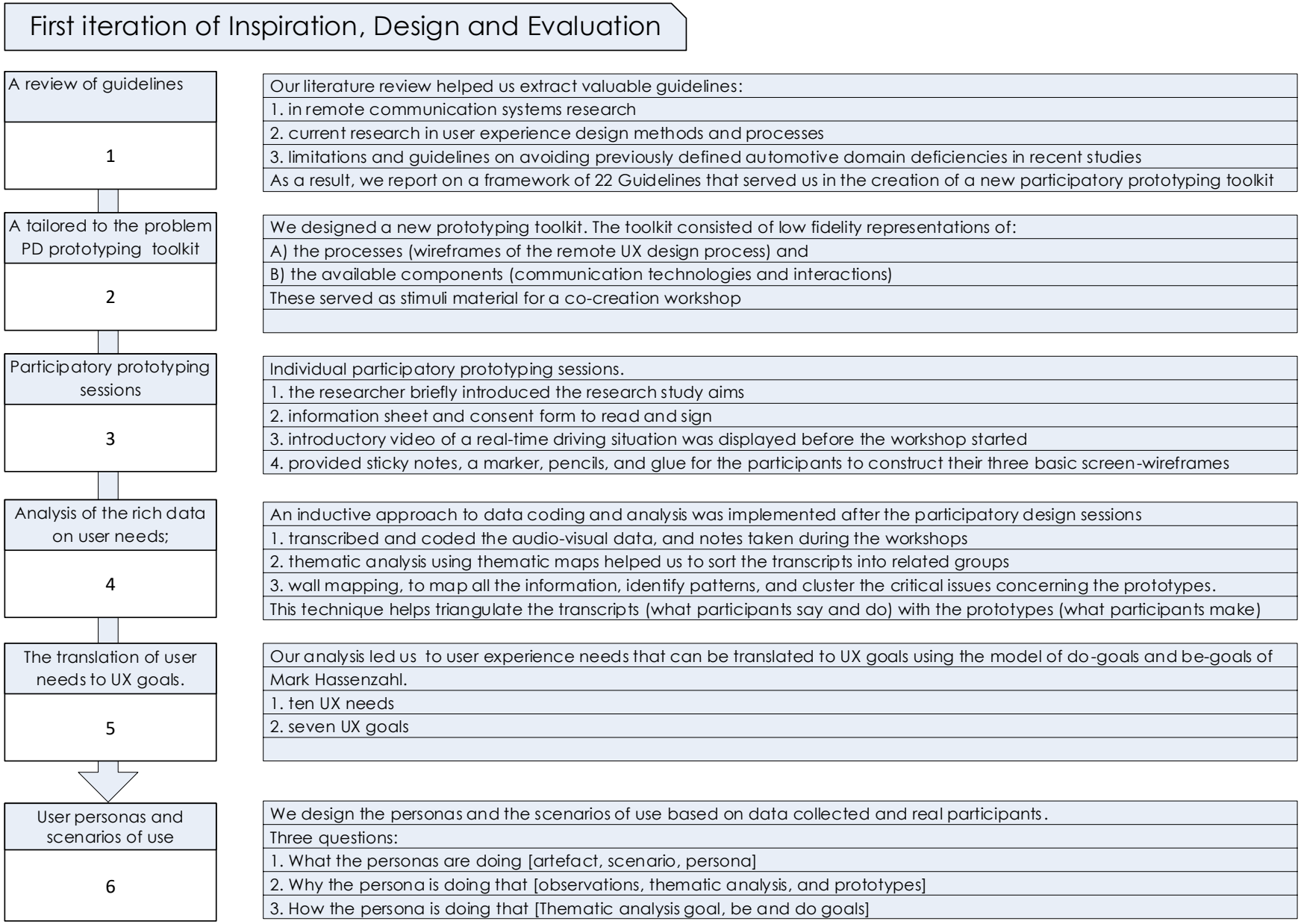


Figure 4: First iteration methodology. Detailed activities.

3.4.1. DESIGN FRAMEWORK AND GUIDELINES

As previously explained, in our study, the UX goals of the designers in the automotive domain of autonomous vehicles are as Horst Rittel, and Melvin Webber proposed a "Wicked Problem." An ill-defined or wicked problem occurs because the conflicting perspectives of the stakeholders cannot be accurately modelled and cannot be addressed using the reductionist approaches of science and engineering (Rittel and Webber, 1973). To approach this problem in our research, we framed several relevant guidelines based on previous work in the research areas, as explained in chapter two. Our literature review helped us extract valuable guidelines for a remote communication system as well as current research in user experience design methods and processes — furthermore, limitations and guidelines on avoiding previously defined automotive domain deficiencies. As a result, based on previous work, we report on a framework of prior findings, which served us in the creation of a new participatory prototyping toolkit to help us identify a design solution for our ill-defined problem.

We analysed our data of previous work by applying a combination of inductive and deductive approaches, known as thematic analysis. Thematic analysis is defined as "a method for identifying, analysing and reporting patterns (themes) within data." (Braun and Clarke, 2006, p. 79). In order to do that, we segmented relevant quotes of previous researchers from our systematic literature review of their studies in the field of Computer Science, Human Factors/Applied Ergonomics, and Design for Experiences/ New Product Development (NPD) and in Human Rights.

We synthesised these quotes into meaningful groups in a way that each of these segments presented one concept; we then coded these segments (Braun and Clarke, 2006). In the coding process, the main points of each segment were first noted (using different highlighters), then codes that were most suitable to these main points were identified (using a different colour). We gradually and iteratively improved our coding based on the new segments that emerged we used this as a basis for the rest of the coding and analysis process. The first principal codes that were used in the thematic analysis of previous work used in this study to support the development of the toolkit include Human-Computer Etiquette, trust, empathetic communication, driving experience, user experience, and telepresence. These codes reflect the focus of attention of our Human-computer interaction research relevant to remote design and communication systems in different domains. Our analysis of the codes resulted in 22 guidelines under four main themes. Some of the guidelines are direct quotes we found on previous work, and they, in some instances, represent limitations, and requirements. The final guidelines are a result of excluding and categorising these codes under four main themes. The first theme, the design process, includes previous guidelines, technologies or limitations to be considered for the development of our system. These are relevant to the way UX designers approach the design process when designing for experiences. In the same manner, three more themes were identified, remote communication, organisational needs, and automotive deficiencies. Remote communication guidelines and technologies that support users to overcome the limitations of space and time. Organisational needs in terms of what are the guidelines for good UX design proposed by the industry — finally automotive deficiencies theme including guidelines and technologies on how to mitigate automotive design limitations. Initially, we identified one more theme; the theme of the system-specific needs, but it was later excluded due to the overlapping of the guidelines with other themes.

The framework mentioned above, consisting mainly of technology-driven guidelines, was used to design a participatory prototyping toolkit. To actively involve the participants and be able to delve into the latent explicit and observable and tacit, we developed this

new prototyping toolkit based on the Design Thinking model for designing new artefacts. The toolkit consisted of low fidelity representations of A) the processes (wireframes of the remote UX design process) and B) the available components (communication technologies and interactions). These served as stimuli material for a co-creation workshop. The toolkit was not only successful in giving us rich insight on the needs of the designers, but it also helped us co-design prototypes and allowed us to inform our iterative design of a remote participatory design system. We applied a set of design analysis and evaluation methods, as we will more thoroughly analyse in the evaluation section, to reflect on rich data about both the pragmatic/instrumental and hedonic or eudemonic /non-instrumental qualities. The need for collecting and analysing rich data in this study, to achieve a deep understanding of the participants' values, needs, and goals, is serving the duality of our research paradigm. In other words, we inform the design/redesign of the system through rigorous cycles of iterations and also inform, refine or extend the "UX goals" in our design science research study, having a dual contribution to science. To further explain our framework, we present a summary of those guidelines on the process of the design, the remoteness of the communication and the automotive context.

Based on previous literature on the design process of designing for contextually aware user experiences, we can synthesise the most relevant guidelines and suggest the components to support the deployment of the system accordingly. Therefore, on a higher level, based on the manifestation of the Design Thinking process (Kenny, 2018), at the early stages of the design process, a design supportive system must be able to help the designer through 1) the understanding of the challenge, 2) the preparation of the research and 3) the gathering of research inspiration supporting the 'Discovery' circle. The system would also require to 4) support storytelling, 5) the search for meaning and 6) the framing of opportunities at the 'Interpretation' circle. As previously mentioned (section 1.1.2), 7) the social environment of the interaction; 8) the physical environment and; 9) the time dependence of the interaction in a specific situation need to be observed by the designer in order to trigger inspiration or to help him to gather fruitful insights and achieve a deep understanding of the user. Based on the previous insights the designer must be supported 10) adapting the interaction to the contextual needs and 11) the right timing for communication or for interruption (Schmidt, Aidoo and Takaluoma, 1999) as seen in section 2.2.1. A system that supports the user experience design process according to (Hassenzahl and Tractinsky, 2006) will 12) need to support the designer in defining the user's internal state and 13) the context when the interaction occurs (see section 2.2.). Finally supporting the previous process of understanding the user 14) immediately after the interaction, when the situation occurs (Csikszentmihalyi, 2014) [1.2.1]

The fact that consumers are feelers, as well as thinkers (Addis and Holbrook, 2001) as highlighted in section [2.1.2], suggests the need for 15) Supporting the identification of emotions in user behaviour. According to (Whiteside and Wixon, 1987), productivity or learnability are not primary. Thus we need the system to 16) Support the identification of the person's experience at the moment experienced [1.2.1] As previously mentioned in section [2.3.2] 17) Support the mapping of the context is both of great importance to a holistic understanding of the interactions taking place and necessary in designing for people and their experiences 18) while involving them (Meschtscherjakov et al., 2012; Visser et al., 2005; Sanders & Stappers, 2008). As seen in section [2.1.2] (Prahalad & Ramaswamy 2004), the system should 19) support the co-creation of users unique experiences with the company. According to them, companies provide artefacts and contexts that are conducive of experiences and which can be appropriately employed by consumers to co-create their own unique, experiences. [2.1.2]

Guidelines for the design of remote communication systems are also of great importance to our study. Different media are better equipped to disseminate information – called 'conveyance' and others as seen in Section [2.5] are better at engendering mutual understanding which is called 'convergence' (Rhoads, 2010). Thus, 20) a communication strategy of conveyance and convergence support according to the context is required. What is most important though is that the context has been found to influence the medium's perception and effectiveness (Standaert, Muylle and Basu, 2015) as previously mentioned in section [2.5.3] Besides the so-called 'social appraisals' are more likely to play an important role when others are present than absent (Derks, Fischer and Bos, 2008). For instance, a person may perceive a communication technology as inappropriate because his or her friends or family who are present and got intimidated by a communication event [2.5.3]. Accordingly, 21) Supporting the choice of the medium according to the contextual environment is required. Previous research by (Morand and Ocker, 2003) (Rico *et al.*, 2009) as seen in section [2.5.2] for collaborative outcome suggests that predictability of communication is a critical dimension that fosters trust and allows virtual teams to perform effectively [2.5.2]. As a result, the communication interactions are required to be 22) predictable to function effectively under a common trust. The system also needs to 23) support the identification of cues such as frustrations, confusion, or unexpected usage, which show a hidden or latent need, as seen in section [2.2.2] to support designers and observant. Because of abstract social, moral codes [2.5.2], the system needs to 24) support the avoidance of disruption to situations of co-presence(Cahir and Lloyd, 2015). Studies in social presence identify that to communicate effectively the level of personal involvement and attention that is required for the communication task should be matched with the social presence of the medium. (Standaert, Muylle and Basu, 2015). For example, when teleconferencing, employees are more aware of others' status and reactions, thereby being more cautious of their self-image and behaviours (Park *et al.*, 2014). The system should also support the 25) avoidance of Face-threatening acts (FTA) including actions of criticising, disagreeing, interrupting, imposing, asking a favour, requesting information or goods, embarrassing, dumping into, and so forth. (Morand and Ocker, 2003) as seen in section [2.5.2]. Furthermore, the system should 26) support etiquette in communication to make social interactions more pleasant, polite, and (Miller, 2004) as seen in section [2.5.2].

Other than the guidelines for UX processes and remote communication, some essential requirements for design communication in the automotive domain are also highlighted by researchers (Meschtscherjakov *et al.*, 2011). At a higher level, a requirement would be to support the holistic understanding of the automotive context. The requirements for the automotive domain seem to be identical in many cases to the experience design process requirements, due to their contextual character. As a result, we include 27) mitigating the distortion of the experience by the physical presence of the researcher and 28) avoiding the motion sickness effect of the researcher while seeking for insights inside the car, 29) Intrusiveness regarding privacy, 30) and minimising the effort of traditional contextual methods. [See section 1.1.2] According to McCarthy (2004a) identifying 31) the uniqueness of the individuals experience by eliciting the salient situational circumstances. [See section 2.2.1] Support in 32) Capturing the integration of the interaction in a real-life environment (Jakus, Dicke and Sodnik, 2015) is as essential for the system in the automotive domain as in other relevant fields. [See 2.3.1] We cannot neglect the fact that the communication interaction of our system is dual, involving a designer and a driver/passenger, for that, supporting the mitigation of 33) perceived cognitive effort, 34) safety and 35) privacy of the driver/passenger is equally crucial for the overall experience.

We formally documented guidelines in the following table 10. Initially, they were more than twenty-two, but many of them were excluded since they were overlapping. The table illustrates the relationship of each component with a guideline. The stimuli components that we include in the participatory design sessions are attached to each of the guidelines to be used as a provocation to generate a design. The guidelines are grouped into themes as we see in the first column of the table. As a result, the table relates the stimuli components with the guidelines of the four main themes. The first theme, the design process (DP), includes previous guidelines, technologies or limitations to be considered for the development of our system. These are relevant to the way UX designers approach the design process when designing for experiences. Three more themes were identified, remote communication (RC), organisational needs (ON), and automotive deficiencies (AD). Remote communication guidelines and technologies that support users to overcome the limitations of space and time. Organisational needs in terms of what are the guidelines for good UX design proposed by the industry — finally automotive deficiencies theme including guidelines and technologies on how to mitigate automotive design limitations. The stimuli components help the participants generate ideas and co-design the system. They provide a space for innovation guided by previous work and state of the art technology.

Guidelines (22) derived from the themes		**Stimuli Components (See table 10)**	
Themes identified	**Guidelines**	**Component explanation**	**Process (Early Stages of the lean design process) (see table 10)**
Theme1: design process (DP)	1.Understanding of the challenge	Real-time contextual information	1
Theme1: design process (DP)	2.Preparation of the research	Real-time contextual information	1
Theme1: design process (DP)	3.Gathering of research inspiration	Rich data of participants context	2
design process (DP)	4.Support storytelling	Techniques and tools to support storytelling	3
Theme1: design process (DP)	5.The search for meaning	Different communication and presentation techniques and UX design tools	3
Theme1: design process (DP)	6.Framing of opportunities	Different communication and presentation techniques and UX design tools	3
Theme1: design process (DP)	7.The social environment of the interaction	Number of people in the car and behavioural tendencies (friends/family/intimate other)	1
Theme1: design process (DP)	8.Physical environment either the space of the interaction	Real-time video of the environment surrounding the situation and the environment in the vehicle	1

Theme1: design process (DP)	9.Time dependence of the interaction	Time / date	1
Theme1: design process (DP)	10.Adapting the interaction to the situational needs	Communication modality based on contextual factors such as behaviour predisposition emotions	2
Theme1: design process (DP)	11.The right timing for communication or interruption	Communication time based on contextual factors such as behaviour predisposition emotions	2
Theme2: remote communication (RC)	12.Conveyance and convergence support	Communication tools for both rich media and not so rich	2
Theme2: remote communication (RC)	13.Support the identification of cues which show a hidden or latent need	Video and audio and probing tools are some of the rich media modalities to support the identification	2
Theme2: remote communication (RC)	14.Avoidance of Face-threatening acts	Pre-structured or semi-structured questions as guidelines of communication to avoid FTA	2
Theme2: remote communication (RC)	15.Support etiquette in communication	Pre-structured or semi-structured questions as guidelines of communication to communicate based on the occasion	2
Theme3: organisational needs (ON)	16.Support the identification of the person's experience momentarily	Probing, qualitative interviewing	2
Theme3: organisational needs (ON)	17.Support co-creation of user experiences	Involve the participants in two-way communication for deeper understanding	2
Theme4: automotive deficiencies (AD)	18.Mitigating the distortion of the experience, by the physical presence	Remote communication and identification of context	2
Theme4: automotive deficiencies (AD)	19.Avoid the motion sickness	Remote communication and identification of context	2
Theme4: automotive deficiencies (AD)	20.Support non-intrusiveness	Remote time-dependent communication and identification of context	2
Theme4: automotive deficiencies (AD)	21.Minimising the effort	Tools and techniques for minimising the effort of the design process	1,2

Theme4: automotive deficiencies (AD)	22.Mitigating perceived privacy	Keeping interactions private with anonymity tools	2

Table 9: Guidelines that derived from each theme related to stimuli components.

3.4.2. THE TOOLKIT

Participatory design tools and methods are widely used to share control, share expertise and get inspiration for change (Vines *et al.*, 2013). Participation through co-design has attracted the attention of researchers in HCI who need to gain rich insights into the explicit, observable, tacit and latent needs of the participants (Visser *et al.*, 2005). In line with this, McCarthy et al. (2004b) suggested identifying the uniqueness of the individual's experience by eliciting the salient situational circumstances. Previous research (Sanders, Brandt and Binder, 2010) summarises the terminology used to highlight techniques and toolkits when one uses a participatory design method. It describes a method as a collection of the material components (toolkits) and techniques that are used in combination with participatory design activities to serve a specific purpose. Previously, Sanders et al. and Sleeswijk et al. used participatory design toolkits (2010, 2007) and Pettersson et al. (2017) used participatory design techniques in co-design and co-creation activities, to achieve higher active involvement of the participants.

In some cases, previous researchers even delve into the latent explicit and observable needs of the participants when using them. Sanders et al. (2002) explained that to gain insights into experiences, thoughts, feelings, and dreams, we should provide the participants with tools which are focused primarily on what people make in addition to what they say and do. To serve this purpose, we designed and applied a participatory prototyping toolkit as part of our method.

We based our prototyping toolkit (See Figure 5 and 6 on Design Thinking (DT) model for designing new artefacts (Kenny, 2018). The toolkit consisted of low-fidelity representations of (A) the processes, which involved three basic screen-wireframes representing the three steps of the process used to support the need for discovery and interpretation; and (B) the available components, including communication technologies and interactive elements. Two previous low-fidelity designs served as stimuli material for the co-design workshop.

Process stage (Early Stages of the lean design process)	**Stimuli Components**
1.Context • Support the understanding of the challenge (DISCOVERY) • Support the preparation of the research (DISCOVERY)	User Context and social context: • How many people (1 or many) • Behavioural tendencies Relation (friends, family, Intimate other) • Predisposition • Emotion • Skills Physical and temporal Context • Where (map) • When (time and date) • Weather (sunny- rainy etc.) • Temperature (C/F) • Noise (Very Loud- Not loud at all) System Context • Percentage of use of IVIS

	OTHER
2.Communication • Support the Gathering of research inspiration (DISCOVERY)	• Unstructured-Semi Structured-Structured • Video/Audio/text/Emoticons/Gifs • OTHER
3.Presentation • Support the storytelling (INTERPRETATION) • Support the Search for meaning(INTERPRETATION) • Support the Framing of opportunities(INTERPRETATION)	• Charts/pies • Raw data • Video • Audio • Snapshots • Text • Infographic • Storyboard • Customer Journey (Touchpoints) • OTHER

Table 10: Detailed components as part of our toolkit. Stimuli components for the early stages of the design process. The explanation of the need for these components in our design can be found in table 9, a table which relates the components to the guidelines collected.

The first part of the toolkit consists of cards of low-fidelity paper illustrations of components (see Figure 5) derived from the guidelines of previous work. These cards are based on previous examples described in chapter 2.2.2., and they both serve as stimuli for discussion (i.e., to collect data on what the users say and do and identify their needs and desires) about the design and application of the system in context, the acceptance of the technologies used, the system's architecture and interactivity, and lay the foundations as a tool for co-design prototyping (to collect data on what the users make and identify their dreams). Similar tools presented by Sanders' and Stappers' "make" tools (2014) are commonly used by practitioners, including the "interface toolkit" by Frog design (Frog Desgin, 2014). The components used (See table 11) include the following: car passengers (1 or many); behavioural tendencies; relation (friends, family, and intimate other); emotion, skills; physical and temporal context; where (map); when (time and date); weather (sunny, rainy, etc.); temperature; noise (very loud, not loud at all, etc.) system context; percentage of use of in-vehicle information systems (IVIS); video/audio/text/emoticons/gifs; charts/pies; snapshots infographic; storyboard; and customer journey. The components are reflecting the possible technologies and methods to support the three stages of the design process, as seen in table 10. They aim to generate discussion around the support of the contextual understanding of the domain, the support of the communication with the users, and the support in presenting the findings.

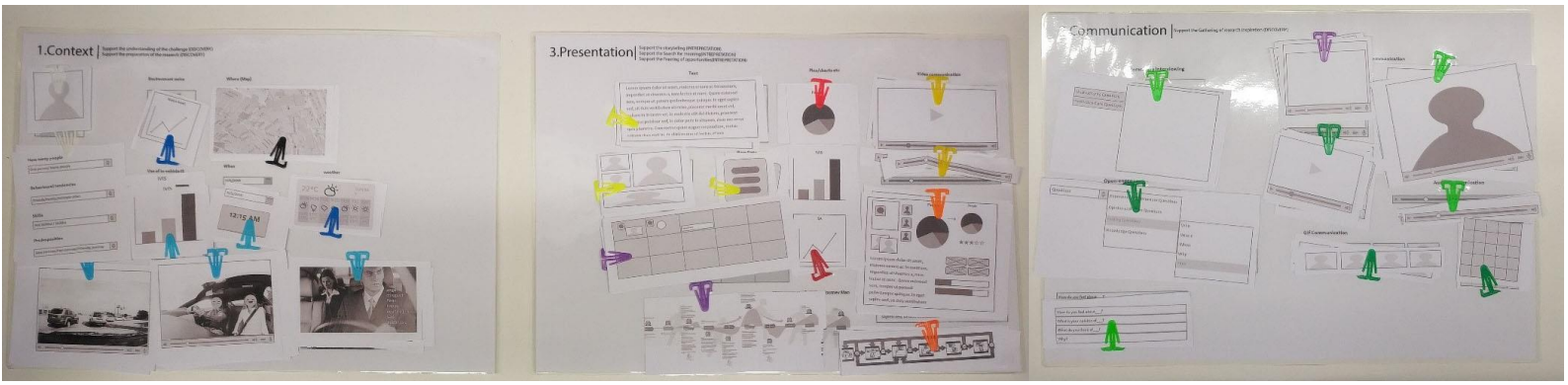


Figure 5: The paper cards represent technologies or tools previously used to help in identifying the context of the vehicle, supporting the remote communication, and presentation. We base the selection and design of our cards on previous work on remote communication, automotive domain deficiencies, and UX Design process guidelines.

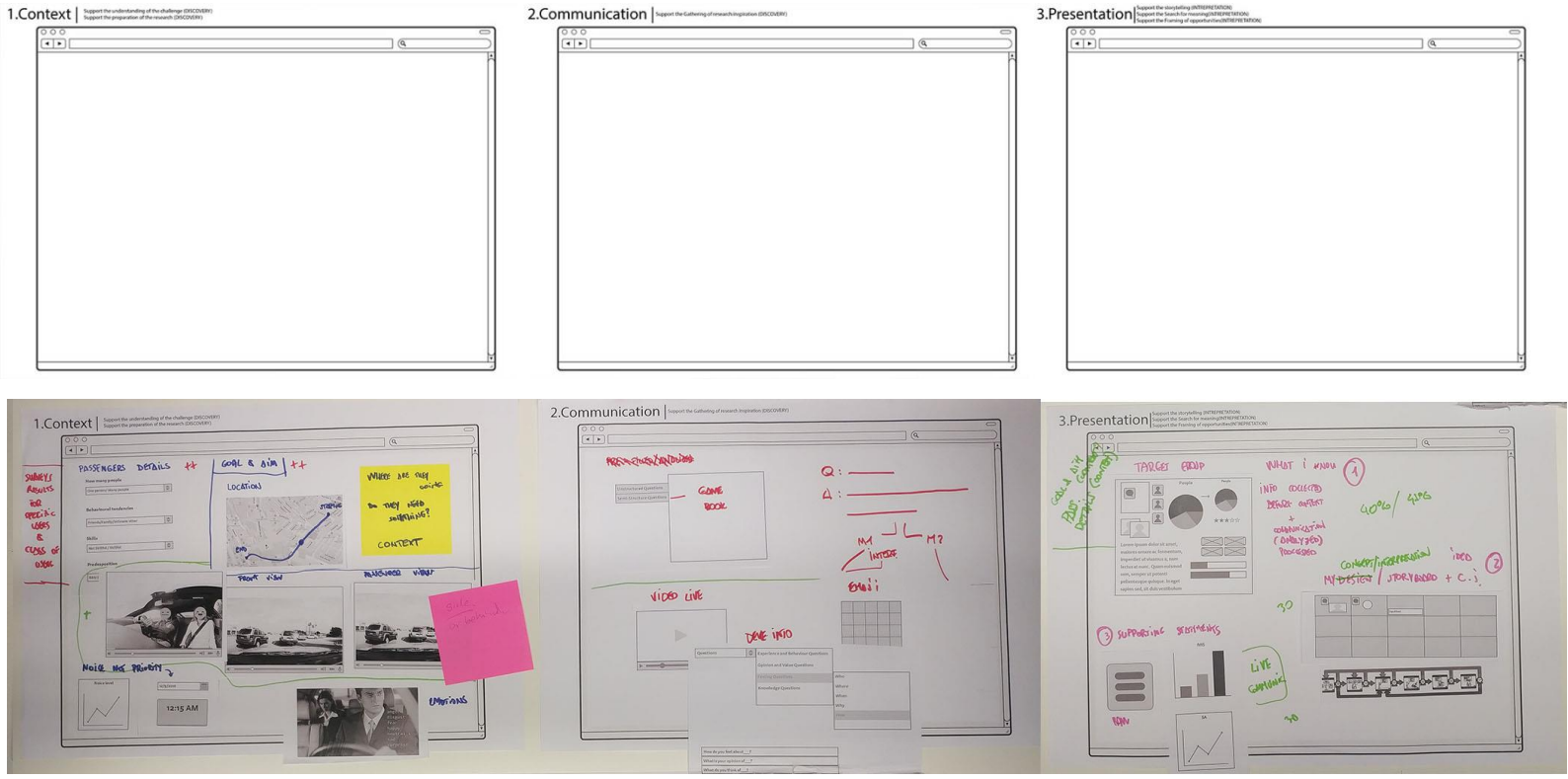


Figure 6: The P6 participant's basic-screen paper prototypes of the interaction. The three basic screens represent the early stages of the design thinking process. UX researchers/designers individually co-designed their versions based on their needs. The empty paper is filled using the cards of components of the tailored toolkit presented in Figure 2

Based on the IDEO's design thinking methodology, the second part of the toolkit serves the early design stages of the process of the new experience. Three sheets of A3-size paper served as the space for low-fidelity prototyping of the basic-screens and interactivity for the proposed system. We designed the basic-screens as an empty web page with only a title and information on the design thinking processes. The technique that we recommended for the prototyping was for participants to fill the basic-screens with information, notes, and the cards that we provided (See Figure 3).

3.4.3. PARTICIPANTS

Iversen et al. (Iversen et al., 2010) argued for a value-led participatory design approach. They saw a co-design process, at its core, as a negotiation of values that all participants bring to the table or which emerge from a collaborative experience. What is important In this method is not only which are the participants' values, but also whose (participants) values drive the design process (who are the participants). To assess these values, we chose to involve UX designers who were not directly involved in the automotive domain. The democratisation of UX design in automotive has two ends. The first one is to include drivers and passengers in the design process actively. The second and most important, since it is the focus of this first cycle of iteration, is to involve UX designers (not trained in the automotive context) in the automotive co-design process. It is in the interest of this first cycle of iteration not to fixate on preconceived views of what are the right methods and tools based on Automotive UX designers since our end users are not necessarily UX designers with automotive design experience. Furthermore, our conversations with designers inside the automotive industry suggest that the industry is exceptionally traditional regarding the methods and tools used to design and evaluate interactions in comparison to other domains.

To achieve an innovative outcome, we wanted to avoid traditional thinking or recreate existing or obsolete solutions. Since the system itself aims to provide support not only to expert users such as automotive UX designers but also to general UX designers, this decision fits our purpose. To this end, we recruited 12 UX professionals aged 18–34 years. Even though we tried for an equal amount of males and females, our participants consisted of three females and nine males. These consisted of eight UX designers/researchers working in academia and four in industry, recruited from a "snowball" referral of seven initial participants. All participants had expertise in design and high familiarity with new technologies as you can see in table 12. The workshops were individually assessed. These were all holders of a driving license and were therefore non-professionally aware of the driving experience and driving context. The intention of this was to secure the holistic nature of our design and to make sure that we did not exclude other stakeholders' values, such as the drivers' values from the design result. Each study participant received a reward/token and a box of chocolates for their time and effort.

Participant Number	Gender	Age	Experience	Education	Familiarity with technology	Domain
1	Male	25-34	Four years	Doctoral degree	I could teach others	Academia/IT
2	Male	25-34	Three years	Doctoral degree	I could teach others	Academia/IT
3	Female	18-24	Two years	Doctoral degree	I could teach others	Academia/IT
4	Female	18-24	Three years	Doctoral degree	I could teach others	Academia/design
5	Male	18-24	One year	Doctoral degree	I could teach others	Academia/IT
6	Male	35-44	Three years	Doctoral degree	I could teach others	Academia/design
7	Male	18-24	Two years	Doctoral degree	I could teach others	Academia/IT
8	Male	25-34	Four years	Master's degree	I could teach others	Industry/design
9	Male	25-34	Six years	Master's degree	I could teach others	Industry/design
10	Male	18-24	1.5 years	Doctoral degree	I could teach others	Academia/design
11	Female	25-34	Three years	Doctoral degree	I could teach others	Industry/design
12	Male	25-34	Five years	Doctoral degree	I could teach others	Industry /IT

Table 11: The table is describing the characteristics of the participants we have recruited in detail. Characteristics including, gender, age, experience, education, familiarity with technology, and domain expertise.

3.4.4. PARTICIPATORY PROTOTYPING PROCEDURE

Participatory design limitations, including recruitment limitations and time and location sensitivity, dictated that we start our iterative cycle based on theory (Kaasinen *et al.*, 2015) derived from previous work. A top-down approach which initially capitalises on the available knowledge from previous research was later triangulated with our participatory design sessions wherein we actively involve participants to co-ideate and co-design following UX paradigms of Hassenzahl (2010): "*One should keep in mind that the relationship between designer and user (consumer, recipient) is bi-directional. It is not as if users have well-defined requirements, which only wait to be discovered. Indeed, requirements are co-constructed in the ongoing dialogue between the user and designer.*" In the past, participatory design approaches, including narratives, games, and artefact construction, have been applied under different contexts (Muller, 2002). In co-design, the participants are active design partners. The co-design process deploys 'make' tools and 'generative' techniques (Sanders and Stappers, 2014) to access people's feelings, aspirations, and imaginations and delve deeper into the specific, observable, tacit and latent needs of the participants. By co-designing an artefact in our study, the prototype of the system designers can gather data on what the participants say, do and make to get a deeper understanding of their needs.

Even though there are many advantages in using participatory group sessions, including the fact that participants can react to each other's experiences which results in a global view of the context and various user experiences, individual sessions were used in our research, over group sessions. This is because although a large amount of diverse information is generated in one session, without professional moderation, one dominant participant can influence the group. Adding, Sanders et al. highlights probing, priming and understanding applications are best made individually to be able to capture unique individual experiences (Sanders, Brandt and Binder, 2010). Even though a participant can feel inhibited, because it may feel as if a psychologist is testing him/her about feelings, experiences, and needs, a lot of attention and time can be devoted to a participant, and this can bring out detailed information.

The developed an innovative system, and we understood the need for many different insights that in the group sessions would be undercut. The design result in comparison to the group sessions is more detailed and personalised due to the time spent with only one individual at a time. In our study, even though the researcher is an experienced moderator, he was also involved in the discussion and in the co-creation of meaning and content, which would be somewhat tricky in a group session. Finally, even though the sessions are conducted similarly as the group sessions, the moderator is more involved with the discussion, without leading or biasing participants, which is more time-consuming. Prototypes can give direction to research by embedding and being the primary means to ask particular research questions. They can be used in the unfolding of research, with the goal of either substantiating it or challenging it (Brandt *et al.*, 2011, Rachel Charlotte Smith *et al.,* 2016). In this sense, they can have different purposes and generate different knowledge. They can help open up a not entirely unanticipated design space (Giaccardi *et al.,* 2016). They can be a vehicle for theory building (Koskinen *et al.*, 2012, Michel and the Board of International Research in Design., 2007). They can help establish critical areas of concern and judgment (Gaver and William, 2012).

Often combined with mock-ups and co-design tools such as design games, workshops, and scenarios, they can also generate contextual knowledge and layout directions for design opportunities that evolve around lived experiences (Sanders and

Stappers, 2012). The goal pulls the design forward, while physical manifestations play a vital role in the inquiry and in shaping the direction and arch of the research. Researchers can apply prototyping to use the prototype as a stimulus in the testing of an overarching theory for which it constitutes an instantiation or as a provocation, both about the artefact and around the part of people's lives that it addresses. A definition of prototyping explains the relation of the method with problem-solving and requirements elicitation: "*Prototyping is a venerable system development methodology that involves construction and test of prototypes of systems, often for purposes of clarifying vague requirements and often in collaboration with the prospective users*." (Baskerville et al., 2009, p. 2). Participatory design limitations, including recruitment limitations and time and location sensitivity, dictated that we actively involved participants in individual sessions.

Furthermore, individual sessions were useful because the system being designed was relatively new, and therefore it was 'under-constrained', that is when the unknowns outnumber the equations. Using group sessions would have undercut part of these insights. In contrast, in comparison to the group sessions, the results were more detailed and personalised due to the time spent with one individual at a time.

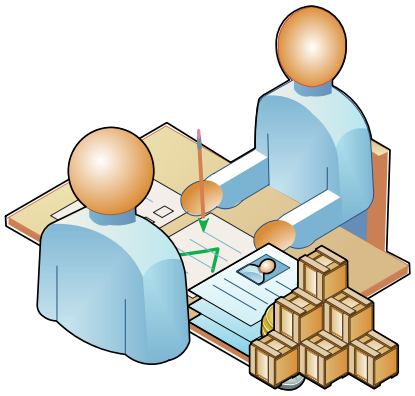
In each session (Figure 7), the participants co-designed a low-fidelity prototype of the front-end interactions of the system using the components that were previously provided to them. To conduct the paper prototyping along with the cards of the components, we provided sticky notes, a marker, pencils, and glue for the participants to construct their three basic screen-wireframes. We encouraged them to use whatever means they felt were most natural to them, and in many cases, we constructed meaning with them collaboratively. The sessions were conducted similarly to a group session with one researcher involved in the co-creation of meaning and content without leading or biasing participants. When the researcher is one of the artefact designers, they should be cautious not to introduce personal bias into the presentation of the artefact. We tried to avoid bias on a prototype design since we provided the participants with the basic platform and raw materials that were then used to obtain their prototypes and be the dominant contributors to the design of the artefact. An introductory video of a physically present designer interviewing a driver while they are driving in a real-time driving situation was displayed before the workshop started. This was to inform UX designers of the current field methods used in Automotive Design and Research and to allow them to empathise with the automotive deficiencies mentioned above. Sessions lasted 50–60 min, with approximately 15 min for each of the three tasks to which the participants were assigned. We were mainly concerned with capturing "how" and "why" the participants would like to be supported in the discovery and interpretation phase in the early stages of the remote automotive UX design. Observation and semi-structured interviewing took place beside other complementary methods, such as co-designing the artefact. Observation without following a specific observation scheme was mainly a tool to capture the "do" and "make" data other than what they say. Notes of critical points were taken to support the findings, and video/audio recordings of the sessions were taken for later analysis. At the end of the participants' tasks, we used a semi-structured interview to ask participants to identify the following:

- The contextual data that would support the UX designers in designing for people's "driving experience" in an autonomous vehicle. When we say "driving experience" in an autonomous vehicle, we mean understanding and designing mostly for secondary activities and interactive experiences in an autonomous vehicle including infotainment, productivity, and gaming or other digital services.

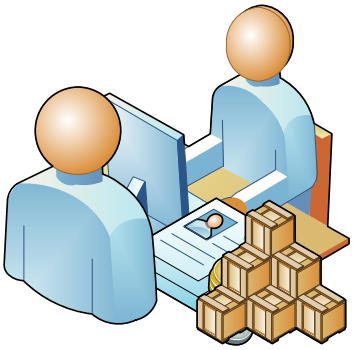
- The tools and techniques they would use for in-depth communication and information elicitation; what existing tools and techniques might support synchronous and asynchronous communication.
- The tools and techniques that would support them in communicating their results to other stakeholders; how to support them in presenting their rich findings.

Based on good interviewing practice (Kvale, 1996), we used complementary "why" questions to shed light on short or unarticulated answers. We encouraged the participants to provide critical comments about their choices and designs. Furthermore, we prompted a discussion by asking them to structure the information, the main groups of the content and add any other components that are not present in the stimuli material. As a result, we have captured rich data of what the participants say, do, and make, using a combination of observation, momentary qualitative interviewing and video records of the interaction. We also gathered the artefacts of each session and analysed them to support the findings.

The researcher briefly introduced the research study aims to the participants and handed them the information sheet and consent form to read and sign.



An introductory video of a physically present designer interviewing a driver while they are driving in a real-time driving situation was displayed before the workshop started.



To conduct the paper prototyping along with the cards of the components, we provided sticky notes, a marker, pencils, and glue for the participants to construct their three basic screen-wireframes.
Observation and semi-structured interviewing took place beside other complementary methods.

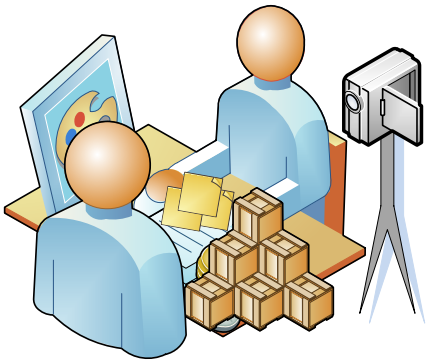


Figure 7: The participatory prototyping procedure that we followed to co-design the system wireframes in three steps.

3.4.5. DATA COLLECTION

In our study we are interested in the early stages of the design process, as a result in each session we were mainly concerned about capturing the 'how' and 'why' participants would like to be supported in the discovery and interpretation phase in the early stages of the remote automotive UX design.

For each of the initial guidelines, we have previously collected; we assigned low fidelity paper visual components to be used as stimuli for the intended workshops. We provided the visual components to the participants who took part in an individual session of

low fidelity co-design. Co-design was used in our study as a common practice in participatory design where designers/researchers work together to envision future environments of use in different contexts (Muller, 2002). The outcome of our workshops consisted of low fidelity prototypes of the interaction, transcripts of the interview during the workshop and videos of each session. To conduct the paper prototyping along with the cards of the components, we provided sticky notes, marker, pencils and glue for the participants to construct their three primary interfaces. We encouraged them to use whatever means they felt was most appropriate and in many cases, we constructed meaning collaboratively.

We have captured rich data of what the participants say, what they do, and what they make, using a combination of observation, momentary qualitative interviewing and video records of the interaction. The artefacts designed in each session were also collected and later analysed to support the findings from the observations and recordings.

3.4.6. DATA ANALYSIS (TRIANGULATING WITH THE ARTEFACT)

In contrast to the top-down approach we have previously used to translate the 22 guidelines, to low fidelity paper visual components, an inductive approach to data coding and analysis was implemented after the participatory design sessions. Respectively, we transcribed and coded the audio-visual data. Affinity diagrams (Lucero, 2015) and thematic maps (Visser *et al.*, 2005) helped us shorting the data into related groups from which we later drew our themes. As Kaasinen et al. explain, we use Empathy-based approaches to gaining access to the deeply emotional aspects of the users' world. Therefore, we involve people in the early stages of the design process to participate in activities that can provide us with information on what people say, do, make (Figure 8). As a result, we can elicit information that help us identify the participants'' needs, goals, and meanings. We used this information later to synthesise our findings into actionable insights, including UX goals and goal-directed personas of use.

To analyse our primary data we conducted thematic analysis (Braun and Clarke, 2006) followed by thematic mapping (Visser et al., 2005) which was based in coding the most valuable quotes of our participants and triangulating them with the artefacts that our participants created. A six-phase approach to TA was used as a guideline to add structure to our process. The six-phases according to Braun et al., (2006) include, familiarising yourself with the data, generating initial codes, searching for themes, reviewing potential themes, defining and Naming Themes, and finally producing the report. To analyse and report patterns (themes) within data, we segmented the interview transcriptions from audio and video recordings into meaningful paragraphs or sentences to presented one concept for each segment. We then coded these segments. In our process of coding, the essential points of each segment were first noted, and then codes that were most suitable to these critical points were identified. We later generated enhanced codes for the rest of the analysis process. We mapped the participants' exact quotes/statements to the relevant concepts based on the definitions of the concepts in literature. The initial codes that we used include Technology, Interactivity, Experiences/services (initial ideas on IVIS), novel design solutions, content hierarchy and grouping. Initial themes, including Intrusiveness, Emotion and behaviour, Empathetic design, Usability and information architecture, Preferred communication medium, and contextual components, were later analysed further and categorised in the final themes. The final thematisation included further detailed analysis in order to triangulate the patterns that are found in the participants' artefacts. We proceeded into a thematic mapping technique as it is previously described by Visser et al. (2005) to

come up with our themes. We applied the thematic mapping method as Visser et al., (2005) recommends in previous work, by printing out all interesting quotes, photographs on sticky notes and artefacts so that we could see all of them at once, and move them around. We applied an Inductive—bottom-up—grouping, in which we immersed in the data and allowed them to suggest new groups. It is impossible to be purely inductive as we always bring something to the data when we analyse it, and that is our knowledge and familiarity with the field of studies.

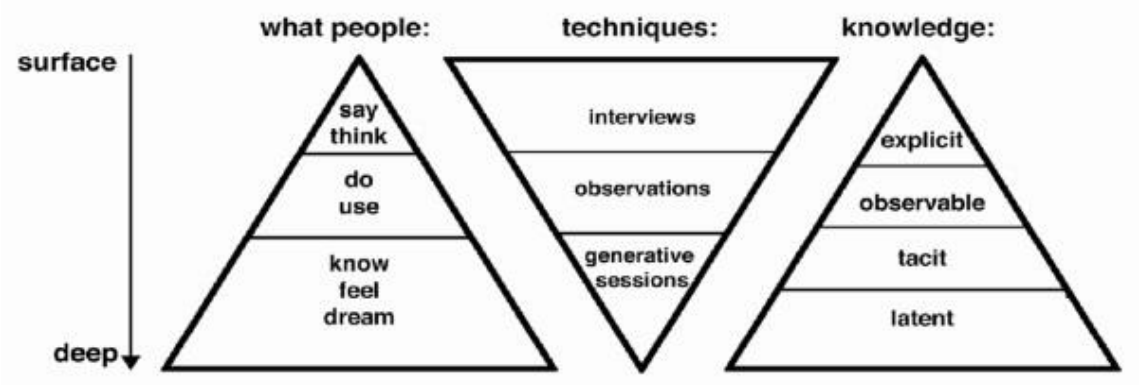


Figure 8: Different levels of knowledge about the experience are accessed by different techniques (Visser et al., 2005)

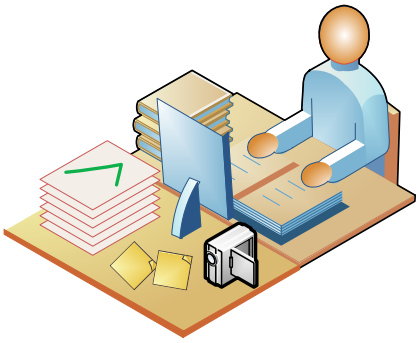
What is essential in this section is that we prioritise the participants' meanings. Later we go beyond the participants' meanings, and the themes derived from our analysis and discussed an interpretation of the goals of the UX Designers. The four-layer model of insights into human needs and aspirations for design and innovation NADI-model (Van Der Bijl Brouwer and Dorst, 2014) explains how we translate our in-depth participants' insights from themes to goals to scenarios and finally solutions through our iterations. According to the NADI-model, the themes represent the participants' meanings and values outside the direct context of the problem. Participant's goals represent what to achieve within the context of the problem, in our case designing for user experiences in the automotive context. The interpretation of the findings is presented to support the summative insights of our study on the levels of themes and goals. In addition to the summative insights presented in this study, other formative insights also inform our iterative design on the scenarios and solutions which we will see later on.

After the participatory design sessions, we implemented an inductive approach to data coding and analysis (Figure 9). We transcribed and coded the audio-visual data. Thematic maps helped us to sort the transcripts into related groups from which we later drew our themes. What is essential in this first part, as previously mentioned, is that we prioritised the participants' meanings. We concluded on the user experience designer's values that need to be fulfilled when we design such systems. These findings are presented as the needs of the UX designers in the automotive context and support the summative theoretical contribution, which aims to evaluate such systems. Asking the why questions on the data collection process helped us identify the attitudes, personal goals, and trends that our participants perceive as vital to them and why are these important to them to map of psychological needs that the need to fulfil.

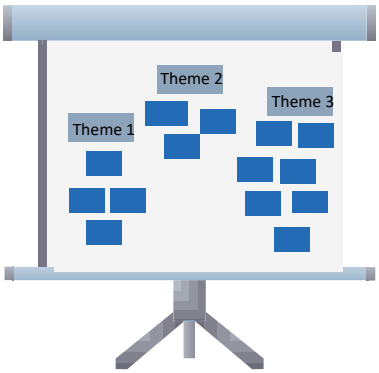
The prototypes (wireframes) created are the means that the participants use to express their multi-layered needs and the experiences they want to have when interacting with similar systems. Therefore, we can extract more in-depth information from the explanation of

the created prototypes and even relate them to the previous data. Consequently, we go beyond the participants' meanings and the themes that are derived from our analysis and suggest a pragmatic interpretation of the UX Goals of the UX Designers based on context mapping techniques, which include the illustrations of the artefacts. Affinity diagrams (Lucero, 2015) and context mapping techniques (Visser *et al.*, 2005) are both techniques that analyse rich qualitative data. They both use the coding of participants' quotes or notes, and they both try to identify patterns or clusters of behaviour or activity. They both use big spaces as tables or walls to map, structure, and cluster the previously collected data and extract meaning. We achieved a holistic understanding using these techniques (see Figure 9) to triangulate the video and audio transcripts (what participants say and do) with the paper prototypes (what participants make) in the second part of the analysis.

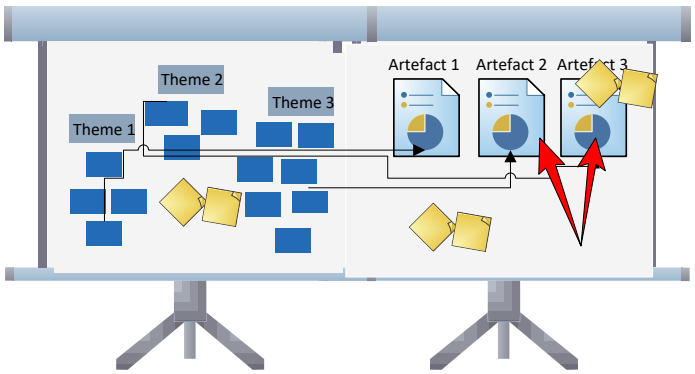
Approaches for visual element analysis in isolation, including Zmet and Kansei, were previously explored (Visser *et al.*, 2005) without satisfactory results. More information is found in the stories of the participants and their relationship with the visual elements, in our case, the prototypes. The participants' hidden or latent values that needed to be fulfilled based on our findings were later translated into seven UX goals. UX goals, as previous researchers explained (Kaasinen *et al.*, 2015), support designers in developing products or systems. In this study, these findings support the formative practical contribution to the design and development of remote UX design systems in the automotive domain. Nigel Bevan (2008) also highlights how important it is to establish criteria for UX/usability goals at an early stage of the design and to use summative measures to evaluate whether designers achieve them during development.



An inductive approach to data coding and analysis. We transcribed and coded the audio-visual data, and notes taken during the workshops using colours and labels.



Thematic analysis using thematic maps helped us to sort the transcripts into related groups from which we later drew our themes.



Wall mapping was used to map all the information available, identify patterns, and cluster the critical issues concerning the prototypes. We used this technique to triangulate the video and audio transcripts (what participants say and do) with the paper prototypes (what participants make).

Figure 9: Our data analysis process after the collection of rich data, including co-designed artefacts from participatory workshops.

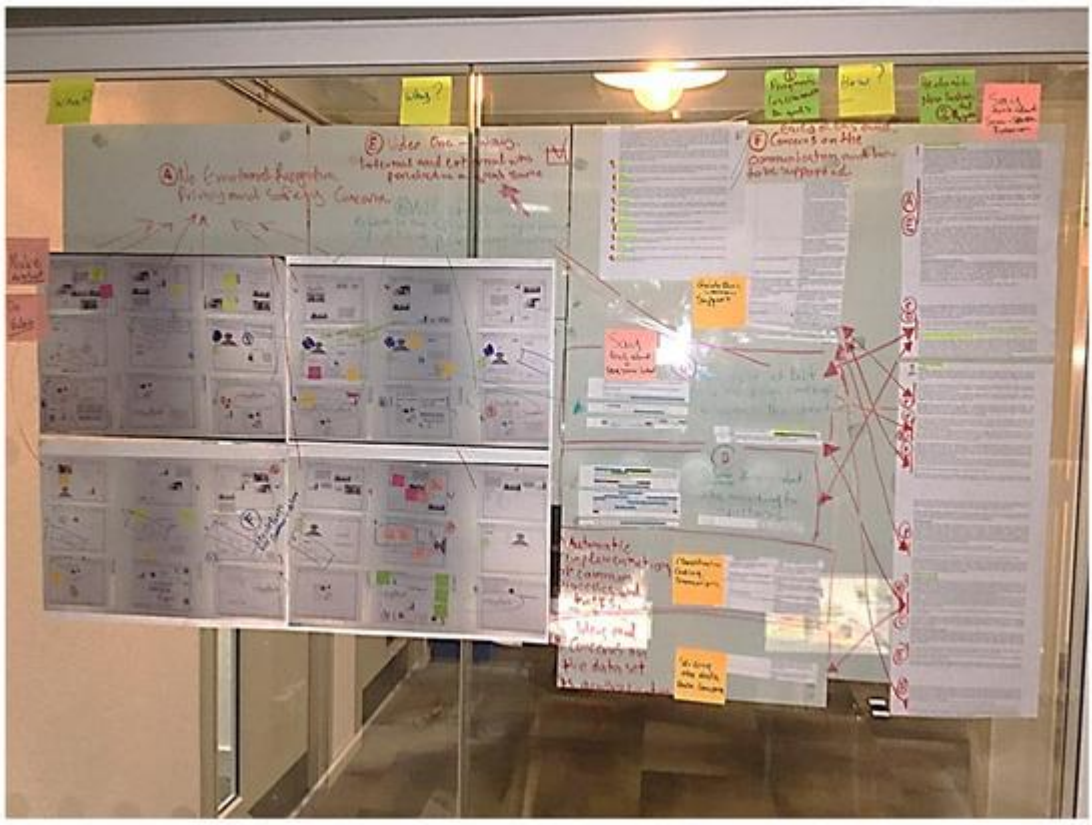


Figure 10: A glass wall was used to map all the information available, identify patterns, and cluster the critical issues concerning the prototypes. Ten needs and seven UX goals emerged from this analysis.

As (Visser *et al.*, 2005) previously highlighted, the information of the contexts of product use, as stated in the preparation section, is fragmentary and multi-layered. The created artefacts are the means that the participants use to express their experiences. Therefore, the analysis focuses on the stories the participants tell about the artefacts. Approaches for analysing visual elements alone, such as Zmet and Kansei were previously explored by Visser et al. (2005) but have not led to satisfying results, because much more information is anchored in the stories of the participants and the relationships between the visual elements and the stories. In contrast, using a Grounded Theory approach for analysis(Corbin and Strauss, 1990), data is studied to discover structures without using pre-set expectations of the data. Potential indicators of a phenomenon are discovered during the analysis, rather than being hypothesised in advance. All the impressions and insights are written down to analyse the data. Making notes on small items or stationary post-it notes facilitates their rearrangement. The goal is to find patterns and create an overall view. In the search for a variety of patterns, all the annotations and the data are organised and reorganised. Determining recurrent and/or striking themes about the experience creates an overview. Working spatially, e.g., on a wall or large boards, supports creating overviews and may show the relations between different experiences and themes visually (Visser *et al.*, 2005).

After coding our transcripts, we are using thematic analysis (Figure 9) to help us with the identification of the participant needs. We did not use any predefined categories to support the emergence of new themes. We triangulate the participants' needs that emerged from the thematic analysis with the insights we extracted from the artefacts (low fidelity prototypes). To achieve that we apply the methods explained above using wall mapping

(Figure 10) and grounded theory, as Visser et al. (2005) describes. We conclude into 9 UX design goals after creating overviews and identifying relations between different experiences and themes visually on the wall. A pragmatic interpretation of these findings will later help us design a medium to high fidelity prototype; 'goal-directed personas'; and 'scenarios of use.'

3.4.7. DATA SYNTHESIS (UX GOALS, AND GOAL-DIRECTED PERSONAS)

Generating our UX goals and designing our Goal-driven Personas and scenarios of use was part of the same process. We followed the process that Kim Goodwin and Alan Cooper have described in their work (2009) for capturing patterns and defining goals that can lead to goal-directed persona creation.

We enhance their framework with how to identify UX goals based on empathy with the previous work of Kaasinen et al. (2015) as we more extensively describe. This is because a strong common denominator for the participants' behaviour, was user needs, values, and preferences. Empathising with these users needs, values and preferences as previous researchers described (Goodwin, 2009) was the source of generating their UX goals. Thorough user understanding was a source for UX goals in all the cases. We aimed at stepping into the users' shoes and understanding the users' world with empathy. The empathy was gained from the user observations while participating in the workshops their answers to the interviews and probes and the artefacts that were created.

We followed the bellow steps into designing the personas based on our findings and UX goals.

1. From our data, we identified behavioural variables—ways in which user behaviour differed (The themes in our findings section describe behaviour)
2. We mapped the interviewees against the variables using the wall mapping technique.
3. We looked for people who cluster together across multiple UX needs and UX goals
4. We formulate explanations for that clustering, and then we looked for any other patterns.
5. We then turn each behaviour pattern into a persona by articulating UX goals and adding more details from the data we have been collecting.
6. We fine-tuned our personas as a set by clarifying the distinctions among them
7. Finally, we prioritised the personas to the most relevant and developed the narrative and any other artefacts needed to describe them (Using word document, adobe Photoshop, and a library of online images).

Our step by step approach starts by analysing the user needs of our participants with a single-case analysis, which is focusing on understanding what we heard and saw with one participant at a time. Social scientists begin the single-case analysis by categorising each comment or observation. What is essential in this first part, as previously mentioned, is that we prioritised the participants' meanings as we previously highlighted. We concluded on the user experience designer's values that need to be fulfilled when we design such systems. These findings are presented as higher-level needs of the UX designers when using the system in the automotive context (a final version of these needs after the cross-case analysis is in table 13).

We also tried to articulate each respondent's mental model of the world as it relates to our design problem without investing a lot of our analysis time to this particular technique. We used this time to include what the respondents call various objects, how they define them, and how they view their relationships to our coding. This was very helpful for describing what the participants understand of our interactions, the words they use to refer to various objects, and

the relations between them that they perceive. A mental model though is more than a taxonomy (Goodwin, 2009, page 214) since it includes the way that someone imagines a process or structure to work (as opposed to what happens) in our case, how the participants imagined that the system should work to meet their needs.

Later as we explained above, we move on to cross-case analysis, which involves grouping and comparing the participants' cases to identify trends and behaviour patterns. As we previously explained, we displayed our data using a wall mapping technique. There we placed all the basic screen paper prototypes which were filled using the cards of components of the tailored toolkit based on each participant's needs. Equating two behaviours in some instances was very clear since, during our workshop, we asked the additional "why" questions to understand the participants' intention to action, framing the right problem to be solved. For the most part, our cross-case codes included the initial goals, frustrations, skills, quantity, mental models, and some basic demographics. At this point, we already had enough codes to conclude the UX goals of our participants. The themes that we explained in findings explain the behavioural patterns, including skills, goals, and mental models.

In line with Goodwin, the richest form of cross-case analysis generates our personas, which are composite models of user behaviour patterns. The behaviour patterns for our study emerged from the glass wall mapping and the affinity diagramming techniques we used to analyse our data. The idea of the wall mapping and affinity diagram technique, as explained above, is to understand the range of user characteristics and begin to identify patterns. The wall mapping and affinity diagram did not identify our personas, but it serves as a useful basis for identifying behavioural variables.

We summarise the behavioural patterns in our findings under the themes that we concluded. These themes become our user findings, which *"lay the groundwork for people to understand and accept the personas and requirements"*(Goodwin, 2009, p 215) (UX goals in our study).

According to Goodwin, "Creating personas involves identifying the critical behaviour patterns and turning them into a set of useful characterisations" (Goodwin, 2009, p 242). Thus, we tried to avoid patterns based on demographics rather than behaviour.

3.4.8. UX NEEDS AND GOALS

Previous work by Eckoldt et al. (2013) supports the notion that meaning and positivity are related to the fulfilment of universal psychological needs (an experience becomes positive and meaningful if it fulfils a psychological need) and explores the potential of an experience-oriented approach to design for interactivity in and through cars. Identifying these needs for design and evaluation purposes attracted the focus of automotive research measuring both momentary (Körber and Bengler 2013) and long-term (Kujala et al. 2011) user experiences. In this study, the analysis of our rich data led us to identify the following needs of our participants. Our participants' goals express their aim to fulfil specific needs, as Hassenzahl et al. (2015) explain. Our summative interpretation of these needs, based on empirical evidence drawn from our co-design workshops, informs relevant theory in automotive design for experiences. Furthermore, we suggest a formative interpretation of our findings in the form of UX Goals as actionable insights. Each of these UX goals relates to one or more user needs (table 12), as presented below.

Previous research in HCI has shown an extension of the focus from the work-style, goal-oriented office applications, to the experience of the user (Hassenzahl, 2010; Sutcliffe, 2009). They recognise emotion's role as an essential requirement for successful interactive systems

(Norman, 2004). Requirements Engineering, in contrast, has barely acknowledged that goal-oriented applications exist apart from the occasional treatment of emotional requirements (Sutcliffe, 2009) and values (Thew et al., 2008). In contrast, SYSTEM USABILITY ISO 9241-11 (2018) defines usability as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.

NEEDS	**UX DESIGN GOALS**
Empathy Effectiveness	1.Support the contextual understanding
Privacy	2.Reduce the intrusion of people's lives
Effectiveness	3.Support long term understanding of behavioural patterns
Flexibility Effectiveness	4.Operate even when the problem is ill-defined
Efficiency Ease of Use Flexibility	5. Avoid redundant information at any interaction
Privacy Engagement Naturalness Self-Image awareness	6. Avoid anxiety about self-presentation
Efficiency Ease of Use Information retrieval	7.The feeling of intelligent interactivity
Politeness Naturalness Engagement	8.Experience of fluent and empathic communication
Effectiveness Information retrieval	9.Support large scale understanding

Table 12: The relation of the users' need and UX goals. A detailed analysis of the UX needs and goals can be found in Chapter 4.7 and 4.8

Usability is commonly measured in product development to obtain a complete understanding of users' needs, improve the product and provide better user experiences. As Bevan previously argued, formative evaluation could be used to identify UX/usability goals, to obtain a better understanding of user needs and to refine requirements. He also highlights how important it is to establish criteria for UX/usability goals at an early stage of the design and to use summative measures to evaluate whether these have been achieved during development (Bevan, 2008). From an organisational perspective, quality in use and usability in use is about the achievement of task goals. However, for the end user there are not only pragmatic task-related "do" goals, but also hedonic "be" goals (Carver & Scheier, 1998) and as we later see eudemonic "be" goals (Mekler and Hornbæk, 2016). For the end-user, effectiveness and efficiency are the do goals, and stimulation, identification, evocation, and pleasure are the be goals. We prefer to use the term goal instead of the

term requirement for the experiences to design for because a designer can only facilitate, not guarantee, a certain UX. Experiences with interactive products and services are context-dependent, dynamic, and subjective (Law *et al.*, 2009). What a designer can do is design for experience (Sanders & Dandavate 1999). As the design process proceeds to a more specific level, the UX goals should be defined at a more specific level that can be interpreted regarding design implications. During the later design phases, each design solution implementation should be traceable back to the UX goals initially defined (Kaasinen *et al.*, 2015).

A user experience goal (UX goal) is an actionable insight for the development of products, services or systems. It describes the intended momentary emotion or the emotional relationship/bond that a person has with the designed product/service/system, as Lu and Roto (Lu and Roto, 2014) described. The same research also highlights that, in multidisciplinary product development and marketing process, these concrete UX goals can be quite valuable since various stakeholder groups need to agree on what to design. Väätäjä et al. (Väätäjä *et al.*, 2012) considered a UX goal to be useful when it guides design towards a positive experience, helps in communicating objectives and is measurable. These UX goals, as presented later, can inform the design of goal-directed personas and scenarios and the development of high fidelity prototypes. Designers use scenarios and personas to realise their users and their users' goals and place them in context. "A scenario is a concise description of a user using a software-based product to achieve a goal" (A. R. Hevner and Chatterjee, 2010) where the goals stem from the persona description. The prototype system or systems are then built based on the scenarios of use.

3.4.9. PERSONAS AND SCENARIOS

In this section, we will describe different approaches to designing personas and scenarios to explain the reason why we chose the 'goal-directed personas' and scenarios approach. We will explain the process that we used to generate the personas from our data, and we will illustrate the connection between our main findings and our personas. The relevance of each persona creation technique will be explained, referring to previous work in personas and scenarios. Firstly it is essential to highlight that Alan Cooper (1999) links personas and scenarios. He describes the scenario as the investigation of tasks. "*A scenario is a concise description of a user using a software-based product to achieve a goal*" (Alan Cooper, 1999, p. 179), where the goals stem from the persona description. As previously mentioned in the Encyclopaedia of HCI (2019), personas have no value in themselves for UX. Not until the moment where the persona is part of a scenario - the story about how the persona uses a future product - does it have real value. Personas can help the designers maintain the perspective of the users. The moment the designers begin to imagine how a possible product is to be used by a persona, ideas of interactions emerge. Thus, we maintain that the actual purpose of the method is not the persona descriptions, but the ability to imagine the product. It is in scenarios that you can imagine how the product is going to work and be used, in what context it will be used and the specific construction of the product.

Moreover, it is during the work with developing scenarios that the product ideas emerge and are described. The persona descriptions are thus a means to develop specific and precise descriptions of products. The personas and scenarios have been formed based on the interviews to address the design of the remote system.

Previous research in the HCI encyclopaedia (2019) has presented different types of personas including goal-directed personas, role-based personas, engaging persona, fiction/based personas, user archetypes and marketing personas, some of which we describe in table 14. Cooper characterises his persona method as "Goal-Directed Design" and maintains that it makes the designer understand the user. Thus, Goal-Directed Design is meant as an efficient psychological tool for looking at problems and a guide for the design process. The central core of the method is the hypothetical archetype that is not described as an average person, but rather as a unique character with specific details. This way, personas are created based on in-depth ethnographic research. The initial personas grasp an intuitive understanding of user characteristics. Later on, these are condensed into final personas, one persona for each kind of user (Floyd, Jones and Twidale, 2008). In the design process, we begin to imagine how the product is to work and look before any sketch is made or any features described. If the design team members have many persona descriptions (Figure 11) in front of them while designing, the personas will help them maintain the perspective of the users. The moment the designers begin to imagine how a possible product is to be used by a persona, ideas will emerge.

Other perspectives on persona design (Interaction Design Foundation, 2019)	
The role-based perspective	The role-based perspective is based on qualitative and quantitative data, and it suggests that there should be a clear relationship between data and the persona description. However, it is based on criticism of a current IT system. The role-based perspective focuses on the users' roles in the organisation.
The engaging perspective	The engaging perspective is based on the ability of stories to produce involvement and insight. By understanding characters and stories, it

	becomes possible to construct a vivid and realistic description of fictitious people. Broad knowledge of the users is required when using the engaging description and data should include information about the social backgrounds of the users, their psychological characteristics, and their emotional relationship with the focus area. The persona descriptions balance data and knowledge about real applications and fictitious information that is intended to evoke empathy.
The fiction/based perspective	The personas in the fiction-based perspective are often used to explore design and generate discussion and insights in the field. Ad hoc personas are based on the designers' intuition and experience and used to create an empathetic focus in the design process. Extreme characters help to generate design insights and explore the edges of the design space.

Table 13: Different perspectives on personas design

In the first column, Table 15, we include the needs of the participants. Asking the why questions on the data collection process helped us identify the attitudes, personal goals, and trends that our participants perceive as vital to them, and why are these important to them in order to map their needs that they want to fulfil. These findings are presented as the needs (Table 15) of the UX designers in the automotive context and support the summative theoretical contribution, which aims to evaluate such systems.

What is essential, as previously mentioned, is that we prioritised the participants' meanings. As we previously described, we concluded on the user experience designer's values, and what the participants need to fulfil when interacting with the designed system. The UX goals describe these values and need fulfilment (see 2nd column, Table 15). We did not use any predefined categories to support the UX goals. The prototypes (wireframes) created are the means that the participants use to express their multi-layered needs, what they value, and finally their UX goals for the experiences they want to have when interacting with similar systems. Therefore, we connect the UX goals with more than one needs in the same table (Table 15), to describe which needs are going to be fulfilled when the participants achieve the specific goal.

To achieve the specific goal should strive to design for the participant needs and UX goals. Therefore, after concluding in 9 UX design goals, creating overviews, and identifying relations between different experiences and themes, we synthesise our actionable insights (personas and scenarios of use) inform design. A pragmatic interpretation of these findings, as explained later in this study, helped us design a medium to high fidelity prototype; 'goal-directed personas'; and 'scenarios of use.' In table 15, column 3, we assign personas to our UX goals. Each persona has a minimum of one UX goal, and this is why we assigned some personas to more than one goals. Personas represent the participants, their multi-layered needs and describe their UX goals.

The scenarios of use, Table 15, column 4, are also actionable insights that support the Personas in design and evaluation, and they are designed based on the persona description. Extracting more in-depth information from the explanation of the created prototypes and even relate them to the previous data, serves as a useful basis for identifying

behavioural variables, and for people to understand and accept these personas and scenarios of use (Goodwin, 2009, p 215).

NEEDS	UX DESIGN GOALS	Personas	Scenarios of use
Empathy Effectiveness	1.Support the contextual understanding	Jonathan, and Marta, and Julia	A
Privacy	2.Reduce the intrusion of people's lives	Nikolas	B
Effectiveness	3.Support long term understanding of behavioural patterns	Maria	C
Flexibility Effectiveness	4.Operate even when the problem is ill-defined	Jonathan and Marta and Julia	D1
Efficiency Ease of Use Flexibility	5. Avoid redundant information at any interaction	Julia	D2
Privacy Engagement Naturalness Self-Image awareness	6. Avoid anxiety about self-presentation	Jahn and Laura	E1
Efficiency Ease of Use Information retrieval	7.The feeling of intelligent interactivity	Jahn and Laura	E2
Politeness Naturalness Engagement	8.Experience of fluent and empathic communication	Jahn and Laura	F
Effectiveness Information retrieval	9.Support large scale understanding	Jonathan, Marta and Julia	G

Table 14: Relation between the UX goals and the goal-directed personas and scenarios of use.

Personas
A: Nicolas: He likes setting goals and being productive in the process of achieving them. Productivity, privacy, and 'form follows function' are the most important values that he shares with his co-workers. He has a family of two, and he is quite protective as a parent. He likes extreme sports, and he loves sharing his experiences with his friends using high-end technology to capture them. He likes playing card games, and others think of him as a good player because he knows how to hide his emotions.

Nicolas needs to get inspired by the real use of the car to design for new experiences. However, he does not feel comfortable analysing data that come from personal interaction with people. For him, privacy and safety while interacting come first. He prefers to give his information to third parties only when there is a matter of functionality and convenience that can make his life better. He feels the same about using this information as a designer. To use physiological measures, he believes there has to be a fundamental reason, and of course, people who give their data must always be conscious of their decision. Intruding the driver's space and his privacy is not negotiated at any time. He prefers analysing video recordings with protected faces or even avatar representations of the people inside the car when he is opting to find non-verbal cues that voice recognition does not give you. He also does not believe in the effectiveness of anything else than observation because, as she says it is difficult to get emotion from facial expression because this can be affected by so many factors.' As far as he could go is 360 video of the environment with protected layers of the participants in the car.

B:

Maria:

- She is an experiential psychologist currently working in a UX design team in user research
- She is a person with long term goals that affect her short term decisions. She likes being ethical and considers her role to society even in the most straightforward decision she takes.
- She has long career aspirations and, she promotes the same values to her other siblings.
- She perceives herself as part of a broader ecosystem and that to solve problems, she needs to approach any situation holistically.
- A complete story is always what she wants to communicate with her colleges.

Maria believes that experience is only defined in an episode or a long-term behavioural pattern. The time between the moments the driver enters the car until the moment they exit the car is the felt driving experience. Therefore she wants to have a long-time behavioural understanding of the driving episodes of the user before she proceeds into designing for experience. In the same manner, when she identifies an insight, she wants to communicate to the other stakeholders holistically representing the complete episode when the interaction and the felt experience happened.

C:

Jonathan:

- He is an innovation manager, and he is currently part of a UX design team.
- He has a good friend with special needs. That helped him a lot as he understands to see the world differently and still inspires him towards change.
- He is a very creative person, and he values innovation. For that, he is always trying hard to be ahead of the competition in anything he undertakes.
- He can work in a complex environment, and he likes being challenged.
- He can work with the same effectiveness; both in projects that are highly creative, hard to define and their goals are ambiguous, and in projects that are clearly defined and the problem space and requirements are set by a third party.

Jonathan likes to design innovative experiences. Usually, in his company, there is a set brief for the design outcome, and then he needs to follow his most preferred process to go through a new design. On the other hand, when he needs to innovate in the fuzzy front end of a product system or service, he is 'blue sky' as he says. He makes this distinction between projects where he is given the aims and objectives of the goals and the ones which he has none of them, and he has to figure it out by himself. He would prefer a tool to help him understand some crucial bits of the context of the driver when he has no clearly defined design goal. Sometimes this contextual information about the driver should be information gathered over a long time. On the contrary when everything is provided to him, and he knows what he wants to look at he would prefer a flexible tool, which allows him to choose all the contextual information he believes is essential.

D:

Julia:

- She is an architect and experience designer
- She likes high-quality products, and she values a good brand that delivers quality services.
- She has no kids and not willing to have any in the future.
- She is hard-working, and she barely has free time to spend for herself. Therefore she values quiet moments, minimal interactions and healthy food to keep her going.
- She is an introvert and communicating to people is mostly through her work. Her interpersonal communication skills are not her strongest characteristic, and she prefers staying out of focus in a social environment.

Julia, as a designer prefers a minimalistic experience in any interaction, she designs or interacts. She hates redundant information and believes that good designs are both minimal and hustle free. Interactivity is essential for Julia, both for aesthetic reasons and for convenience reasons. She likes when colour is being used intelligently to communicate and support her activities as a designer. She believes that interactions that make people feel smarter add value to any product service or system.

E:

Laura:

- She is a new product development lead to a design firm.
- She is a calm and spiritual person.
- She enjoys activities in nature since her daily environment is a significant industrial setting.
- She has long experience in communicating with people, and she also helps community projects with the government.

Laura delves more in-depth in the perceived experience by interviewing participants. She believes that communication is the most critical layer in new product development. Especially when she has to deal with experiences in everyday life context, she wants her participants to trust her so that her communication will be more comfortable and more in-depth. She believes that self-presentation is also essential when she is discussing with participants, and there are many occasions in which her presentation helped or ruined that trust relationship between her and the participant. Therefore she chooses her appearance carefully, her tone of voice and always uses an introductory chit chat to make the participant feel comfortable. She does not like a structure communication even though sometimes clarity dictates that she keeps some pre-structured questions.

F&G:

Jack:

- Jack is a postgraduate student and part-time Game designer in a UX design company.
- He has a dog, and he likes to spend his free time with her.
- He is technologically savvy, and he loves to comfort his life with the use of technology.
- He is not just a gamer but a champion in online gaming in Brazil.

Jack is not an experienced UX designer, and he lacks communications skills. However, he is good at implementing raw ideas in high-quality services and systems. His main concern is that he does not know how to sustain a polite conversation due to his cultural differences and that his pronunciation is not as proper as a native speaker therefore sometimes he faces some clarity problems when in a discussion. Playfulness in any experience is what keeps people using it in the long term, according to Jack. He believes that there are various ways to be playful through your interactions and that people hate a boring interaction, and that makes your company lose engagement.

H:

Marta:

- Marta is an HCI researcher at the university.
- She is helping and being helped at the meetings in the maths society meetup teams at her city.
- She enjoys research, and she is very experienced in the statistical analysis of data.
- She enjoys working with other researchers, and she has in the past used other researchers work to see if their findings are generalised to a larger population.

• She is generally a positivist, and she likes quantitative work. However, she finds that her research is based on qualitative findings several times. Marta is a UX researcher and wants to gather a respectful amount of data before she is sure that there is a phenomenon that she and her team can design for. She always makes sure to know if the phenomenon is transferal to other contexts or other people with the same context, and then she argues of the importance of her findings due to the scale of them. She wants to collect long term data over a few months and then look further in the details.

Table 15: The user personas we designed based on real users and the findings of the first iteration. The UX goals are used for these goal-directed personas to reflect our participants' needs.

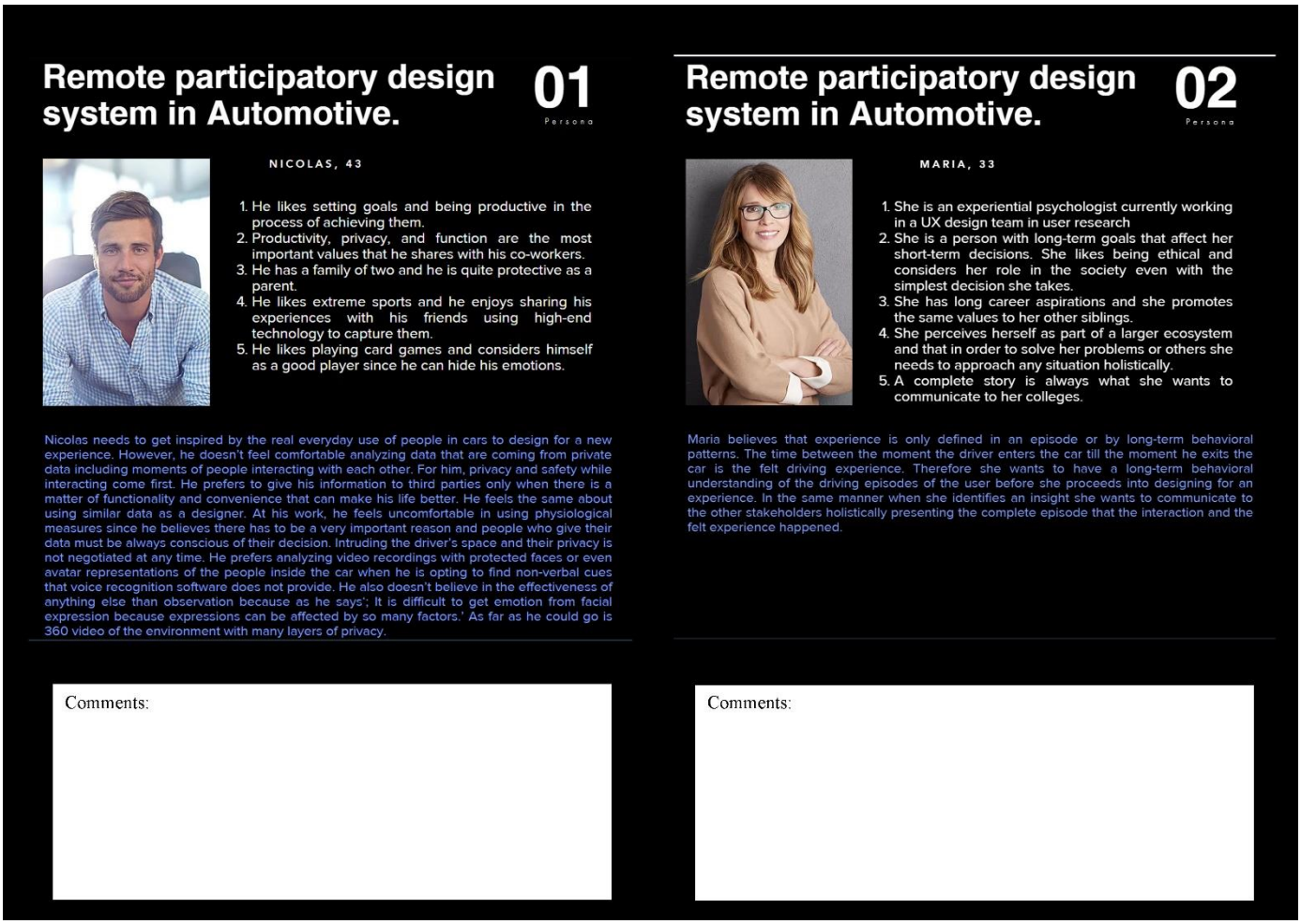


Figure 11: An example of two of our personas card that we used as an actionable insight in the second iteration

The actual purpose of the method is not the persona descriptions, but the ability to imagine the product. To translate the needs and expectations into 'user scenarios'. By creating scenarios you can imagine, firstly how the product is going to work and be used, secondly in what context it will be used, and finally, the specific construction of the product.

Moreover, during developing scenarios, product ideas emerge and describe the product. As a result, the persona descriptions are a means to produce specific and precise specifications of products. In IT system development, we use the persona description as the foundation for describing a scenario that investigates using a system from the particular user's perspective. Cooper et al., (2007) indicate a progression from initial, high-level scenarios to

more and more complicated ones with an increasing emphasis on the user-product interaction.

Figure 12: The cards of personas and scenarios of use used during the second participatory workshop with Automotive UX designers.

Some scenarios of use include more than one personas. UX research and design work are often in teams. The needs and expectations, as explained in the first iteration, are materialised in the personas and scenarios of use to be used as actionable insights to design the high fidelity prototype of the system. As we see in the second iteration, they are also used as stimuli to inform participants about the needs and UX goals that were previously identified.

We design the scenarios of use (see Figure 12, Table 17) based on these three questions

- What the persona is doing [artefact, scenario, persona]
- Why the persona is doing that [observations, thematic analysis, and prototypes]
- How the persona is doing that [thematic analysis goal, be and do goals]

Scenarios			
No	**Context**	**Communication**	**Presentation**
1	A Driver triggers a communication and Nicolas responds. He observes the drivers avatars as well as the passengers. He is trying to find any social cues. He compares their behaviour with the external environment at the time and the place, and he concludes that they are a family going to school, and they are anxious about being late.		
2		Maria has identified some pain points in the driving experience of a	She wants to present as much information as

		fixed case of a driver (Julia) in her daily life. She believes that there is much potential into solving this problem creatively, and she wants to communicate it to her colleagues and her boss to start designing for it.	possible to support her case, but she does not want to make it confusing for them to understand the case, so she uses a customer journey map with attached important video and audio content on it. Text and photos to illustrate the experience are also attached. Some analysed information is presented on the side to be explained as well.
3	System 2 (No call on the old man case 2 of fixed). Jonathan does not know anything about the driver and the passengers. He is choosing a default contextual setting to get inspired. Almost at the end of the episode, he understands that the driver and the passengers did not use any of the interactive systems that the car is providing., having only 31% of the battery used for all the in-vehicle information systems. He wants to move into a communication scenario to validate his assumptions or co-create for a problem that occurred or an experience that he likes and he finds potential. He writes that as a note along with the time of the episode for the next time, he will be triggered in an interaction with the same car since the communication is not possible at the moment. (System 2, trigger) Two weeks later, he is triggered by the same vehicle. He	He calls on a communication interaction to delve deeper into the reason why. He finds out that he was right and during the weekends they go to the countryside with the family, and they prefer to discuss different themes than focus on the infotainment, games or other IVIS that are provided. He notes an idea for the personalisation of their experience, 'the silent mode' and he verifies its usefulness with the family.	

	sees the comment, and he is choosing a different setting for the contextual data gathered. One of the options is In-vehicle information system use. He finds out that the users are not using any of the systems on the weekends.		
4	Julia starts working on her first car. She reads quickly primary punctual information about the driver and passengers demographics and then she chooses one of the available drivers to identify the context.	When she wants to communicate with the driver to get more insights, it is not possible due to the situation of the driver, which is set as private. She needs to know more about the specific activity of the driver, so she tries different forms of communication. She opens an inspiration section for the driver to add something that he feels comfortable. She also sends a request for communication, just in case the driver will not snooze it. The driver is busy sending some emails, but a passenger is not, and she accepts the request for communication.	
5	Jack adds tags to the video every time he finds something exciting happening, and he feels this will help him later to explain the finding his colleges. He adds some comments under the video as well, which he chooses to appear at his presentation as well. He snapshots the mood level which is automatically classified using voice recognition and emoji's	Laura initiates communication with the driver in a car. She starts by choosing some pre-recorded questions. She can also choose among different characters that she thinks much the situations and will gain the trust of the conversation initiated. Asks the driver if she can interrupt using a ring tone based on the conversation and the external environment.	
6	Laura is already observing a video of the driver and the passengers of a car and the external environment for a while, and he already feels that there are a few new	She wants to start the conversation in an unstructured way and use her skills to communicate with the passengers. It is just that most of the times do not	

	behavioural insights that she wants to tackle and possibly co-design for them.	know how to stop the conversation when she already got what she wanted; therefore she uses one of his favourites ending quotes that he had saved in the system. Voice recognition software gives him the mood of the users speaking. The voice recognition technology also writes all the transcripts automatically to help the retrieval of information. As a result, Jack knows how to react now, and he picks up some questions based on the themes that were previously predefined by more experienced designers. The Gamebook guideline gives him possible similar answers to choose how he will continue the conversation. He finds the closest similarity to the answer, and he continues with that the probing in a structured and polite way.	
No7	Marta is browsing in the agents' section, trying to find an agent that suits her purpose. She cannot find on, so she sets a new agent to look at some contextual information for a buffer zone of a few weeks. She is choosing a luxury vehicle to be driven by a technologically savvy female, and her car brand is a Land Rover. After a few weeks, she gets the results from the agent, which is two females with the above characteristics. She then observes and tries to find any insights.	She is exploring the same data with observation in passengers and drivers in cars. She gets to communicate with a car under the defined situation, and she gets to extract precious insights and co-value from and with the passengers.	If there is something she finds important, she goes back and sets a new agent to run in for a couple of weeks for a more narrowed number of contextual information this time, like time of the event, areas of living, etc. She then reports the findings, the generalisation the transferal and any other insight to her team to go further with the design.

Table 16: detailed table of the scenarios of use. We tried to include all three phases of the early design process (Identifying the context, communicating, and presenting the findings) in each scenario of use.

3.5. METHODS: 2ND CYCLE

Iversen and Kyng 2010 argue for a value-led participatory design approach. They see a co-design process, as its core, as a negotiation of values that all participants bring to the table or which emerge from a collaborative experience. It is not only which values but also whose values drive the design process and how much this is visible.

In this first cycle of iteration, we are interested in UX experience designers who are not directly involved with the automotive context and domain deficiencies. Thus, we first make these values visible and prototype for them. Only later in the second iterative cycle, we expose our prototype to the critique and co-design (Figure 13) of automotive UX related participants. We were led to this decision because the automotive industry is more traditional regarding the methods and tools used to design and evaluate interactions and the development of the system would not reach the state of research standards of UX research and design. To achieve this standard and claim the innovative outcome of this process, we recruited people who are practising user experience design in other domains. However, design research should strive to recruit participants that are familiar with the application environment and would be potential users of the proposed artefact. Also, the development of interactive systems holistically includes limitations on the emotional, behavioural, social, and organisational level. Thus, in this study, we want to tackle these contextual aspects of the experience that limit the designer and their interactions and not just design a system that we will only later apply in context. To identify all these aspects of our design, we involved automotive UX designers and researchers as special interest groups in our second iteration. Participation in the design process at this second iteration means that we include the automotive practitioners who will help us understand better the contextual and organisational limitations with their critiques and design refinements. We identified automotive domain insights at this stage, and the limitations or opportunities based on the insights helped us update the "UX goals" and propose directions for further developing the system. Identifying other special interest groups for future development is equally important.

Along with the prototype, goal-driven personas and scenarios are designed to be used by automotive designers in our second critique and co-design session. In this cycle, we use the designed prototypes, the personas, and scenarios as our core stimuli to communicate the 'UX goals' to our participants. The materialisation of the goals is evaluated. The evaluation process of this cycle is different because of the nature of the artefact (prototype) and of the role that the Special interest group participants play at this stage.

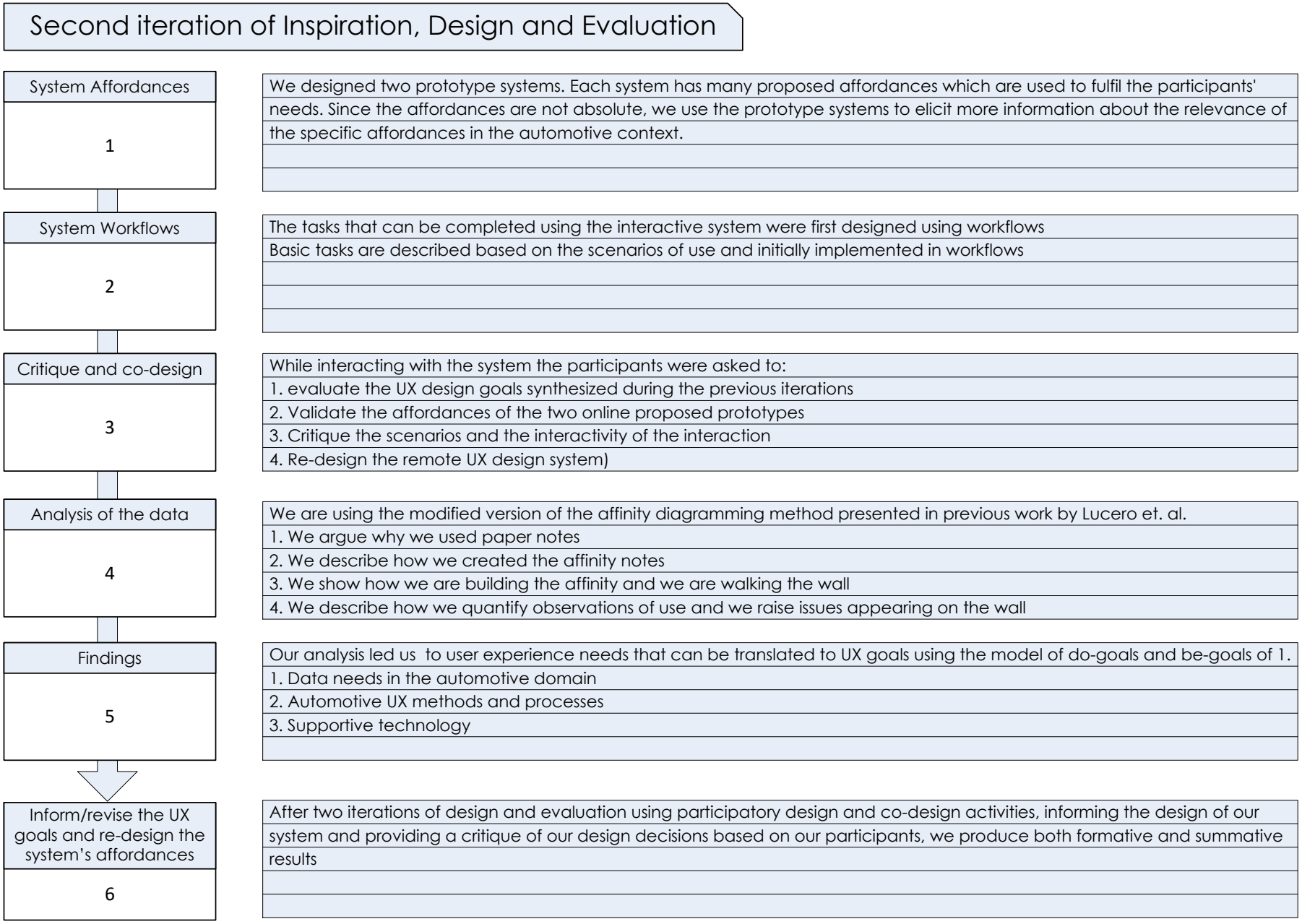


Figure 13: Second iteration methodology. Detailed activities.

3.5.1. INTERACTIVE PROTOTYPES OF THE SYSTEM

We explore this space by developing RAUX. The main aim of RAUX is to support the activities of automotive UX designers and researchers. At the same time RAUX is overcoming the automotive domain limitations highlighted in previous work (Tasoudis and Perry, 2016) including mitigating the distortion of the experience by the physical presence of the researcher; avoiding the motion sickness effect of the researcher while seeking for insights inside the car; Intrusiveness in terms of privacy; and minimising the effort of traditional contextual methods.

We use artefacts as a means to inform science applying by a pragmatic epistemological standpoint. We use a Design science research methodology to answer research questions relevant to human problems via the creation of innovative artefacts (RAUX), thereby contributing new knowledge to the body of scientific evidence. We propose an interactive demo of a remote UX R&D system to support UX designers in automotive and especially in the research and design of the automated driving experiences.

We designed two medium to high fidelity prototypes of the system. For each UX design goal, we designed personas to represent the needs and scenarios of use to specify the tasks and expectations of the personas when interacting with the system. To materialise the personas and scenarios of use and to use previous low fidelity prototypes (wireframes), we designed two prototype systems. Each system has many proposed tools which are used to fulfil the participants' needs. Since the tools are not absolute, we use the prototype systems to elicit more information about the relevance of the specific tools in the automotive context.

NEEDS	UX DESIGN GOALS	Personas	Scenarios	Tools
Empathy Effectiveness	1.Support the contextual understanding	**Jonathan and Marta and Julia**	**A**	**Video one way Internal and external for behavioural understanding Triggers for communication**
Privacy	2.Reduce the intrusion of people's lives	**Nikolas**	**B**	**Communication Support and Prevention. The difference in the communication technologies video or avatar/3D representation/avatars to enhance privacy even more**
Effectiveness	3.Support long term understanding of behavioural patterns	**Maria**	**C**	**Holistic experience/ customer journey**
Flexibility Effectiveness	4.Operate even when the problem is ill-defined	**Jonathan, Marta and Julia**	**D1**	**Blue Sky or set Brief / Explore-Fixed case**
Efficiency Ease of Use	5. Avoid redundant	**Julia**	**D2**	**Size Importance Minimalism, colour**

Flexibility	information at any interaction			**use and interactivity. No redundant information, zooming, size importance**
Privacy Engagement Naturalness Self-Image awareness	6. Avoid anxiety about self-presentation	**Jahn and Laura**	**E1**	**Natural pre-recorded questions, characters options to communicate the question**
Efficiency Ease of Use Information retrieval	7.The feeling of intelligent interactivity	**Jahn and Laura**	**E2**	**Automatic implementation of conventional processes and tasks. Voice recognition software will understand and write everything down**
Politeness Naturalness Engagement	8.Experience of fluent and empathic communication	**Jahn and Laura**	**F**	**Favourite questions and Gamebook guidelines**
Effectiveness Information retrieval	9.Support large scale understanding	**Jonathan, Marta and Julia**	**G**	**Transferal situation. Data generalisation and the size of it. Agent initiation.**

Table 17: This table describes the connection between the needs the UX goals the personas and scenarios of use and the tools of our system that were attached to them.

The above table (see table 18) shows the relationship between needs that need to be fulfilled, more specific UX design goals that express these needs, personas that represent the participants and their behaviour, scenarios that explain the tasks and expectations of our personas when using the system, and finally proposed tools that can potentially fulfil the needs and expectations of the personas.

Norman (2013) describes the structure of human action as an execution-evaluation cycle comprising seven stages: (1) setting a goal, (2) developing an intention to act, (3) planning a sequence of actions, (4) executing the sequence of actions, (5) perceiving the state of the world caused by the execution of the action sequence, (6) interpreting the perception,

and (7) evaluating the interpretation. If the goal is achieved, the action is completed. If not, the cycle is repeated over again, or the action is terminated.

Figure 14 This is a table of the primary user flow of the system. Possibilities of interaction and content of use are draftily presented before prototyping. The tasks of the system are extended to illustrate the elements of interactivity of the system, as seen in the above three scenarios of use.

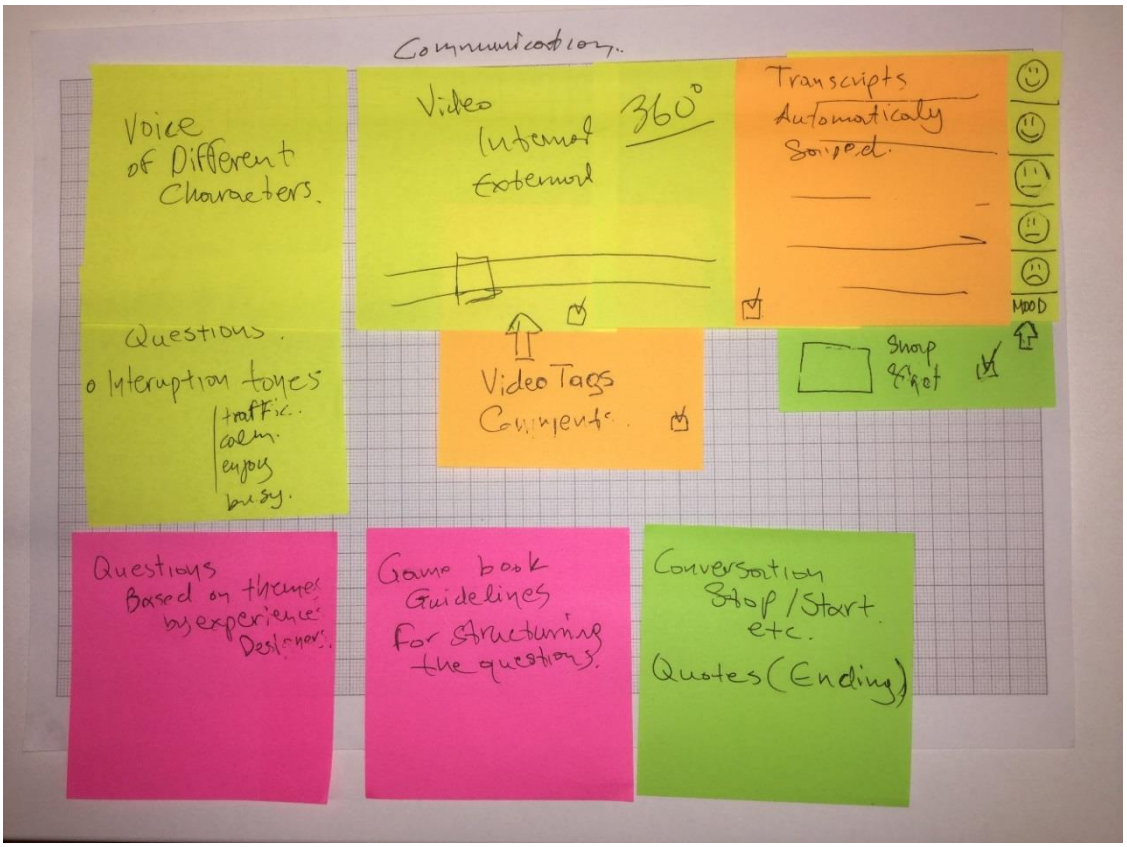


Figure 15: Basic screen interactivity based on the findings of the first participatory prototyping workshop.

User flows are designed before the actual interactive prototype to explore the different screens of the interaction and the possibilities of interactive paths. The tasks that were previously defined and based on the do-goals of the UX designers form the main flows of interaction for our systems as you can see in Figure 14. The be-goals that are represented in the personas and scenarios of use hand the designer with inspiration on the 'how' to interact using the system. Different tools, as we will further explain, are applied but first tested with the user flows. The user flow navigates the user from the starting point towards a successful outcome through a set of steps, where the technologies and the interactivity using low-fidelity tools is applied and tested (See Figure 15).

Our interactive system, as it was previously presented by the name RAUX (Tasoudis and Perry, 2018b) is the front-end interaction of a Remote automotive UX system. It is designed to support the various tasks of the UX design process. The tools introduced with this interactive demo demonstrate the mitigation of previously mentioned automotive domain deficiencies.

The front end of the system supports the automotive UX designers on:

- The understanding of the challenge.
- The preparation for research.
- The gathering of research inspiration.
- The search for meaning.
- The framing of opportunities and
- The storytelling

THE TASKS THAT CAN BE COMPLETED BY USING THE SYSTEM ARE:

- Identifying the available drivers out of a given database of registered participants. (See Figure 16)
- Observe the context of the interactions. (real-time 360-degree camera inside and outside of the vehicle.) (Figure 17)
- Get informed about car-related information, including heat maps, failures, and in-vehicle information systems' use.
- Synchronous and asynchronous communication with the driver/passenger. (Figure 21)
- Presenting Rich data experiences using interactive customer journeys. (Figure 19)
- Setting search agents to identify driving behaviour over time.
- Tagging video events when they happen. (Figure 20)
- Leave comments for other team members to see. (Figure 20)
- Sending and receiving from the drivers/passengers' inspiration material, including photo snaps, videos, audio, and illustrations. (Figure 18)

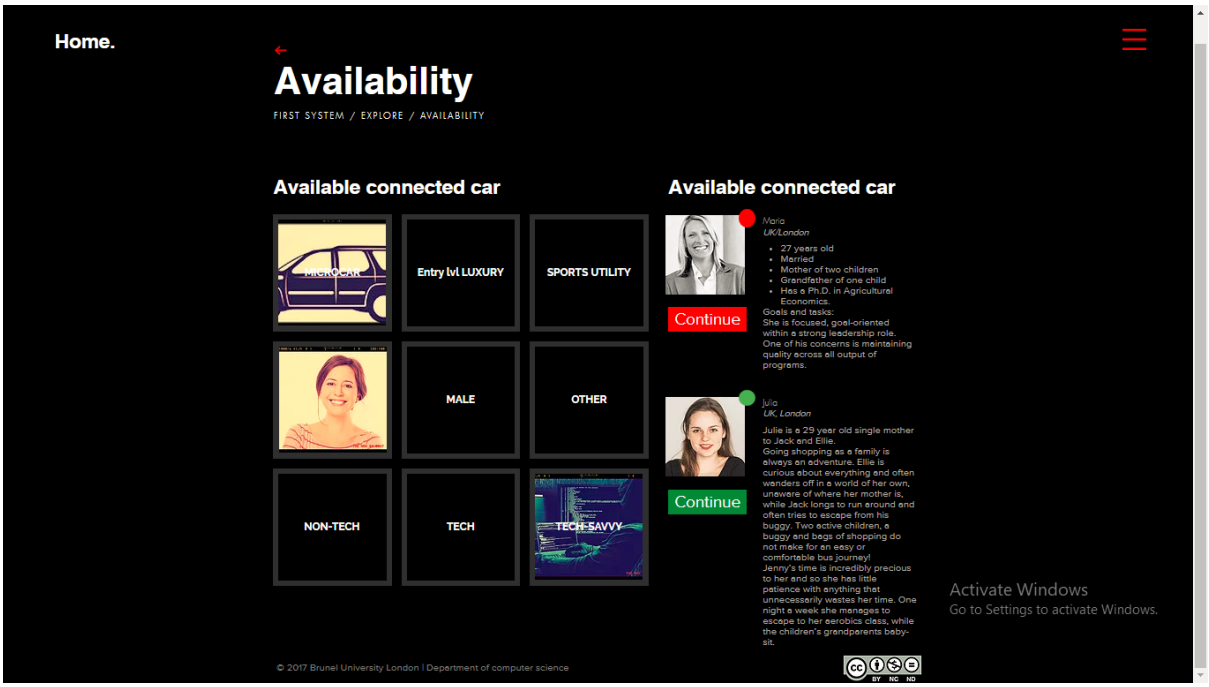


Figure 16: In this image, you can see the availability of the participants with the selected characteristics, given the driving conditions or their state.

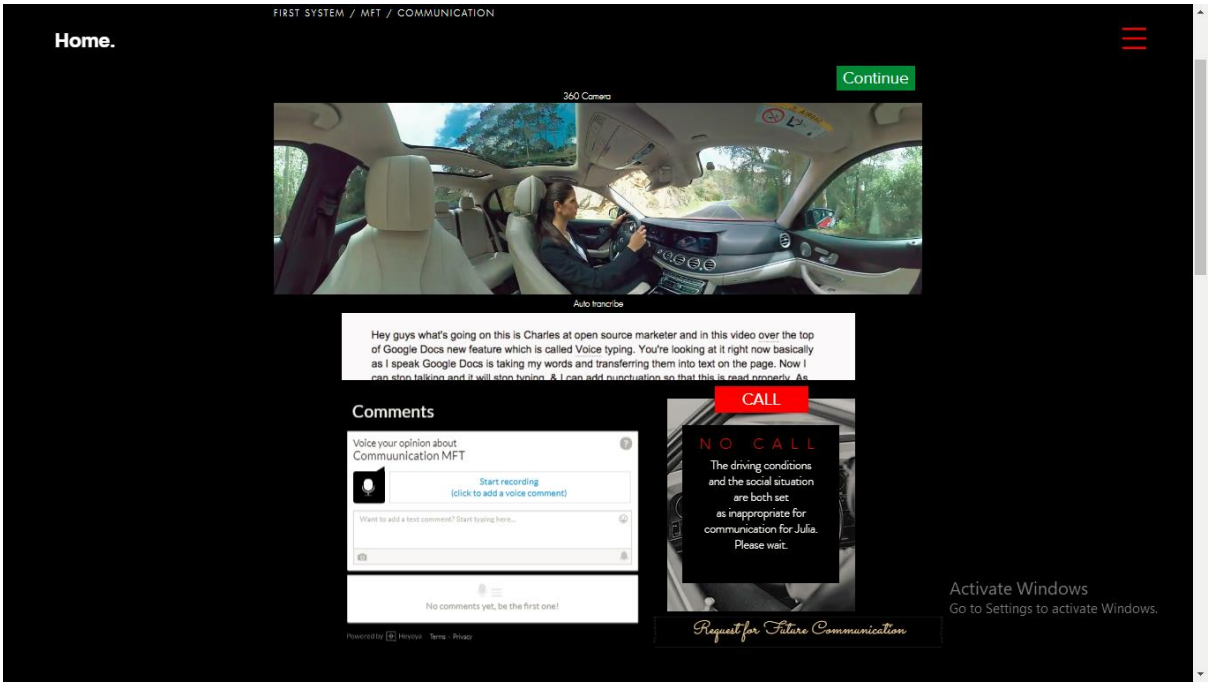


Figure 17: In this image, you can see the 360-degree view of the vehicle and some of the communication options available.

Figure 18: In this image, you can see the various ways of communication between the driver/passengers and the Automotive expert

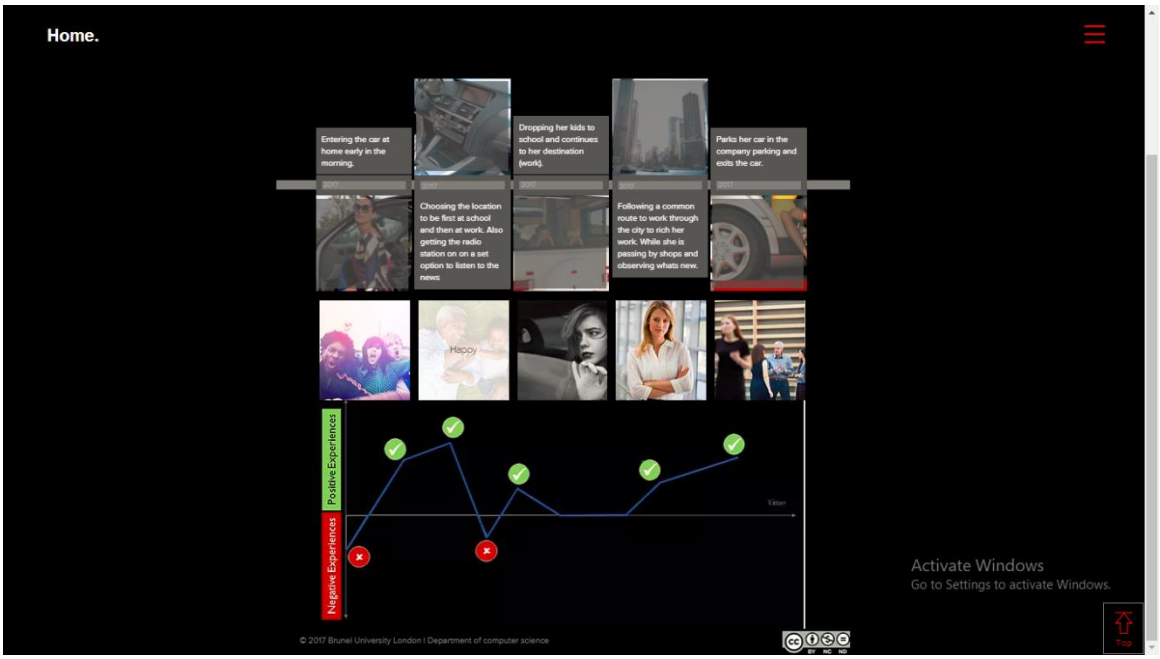


Figure 19: In this image, you can see the interactive customer journey presentation used in RAUX.

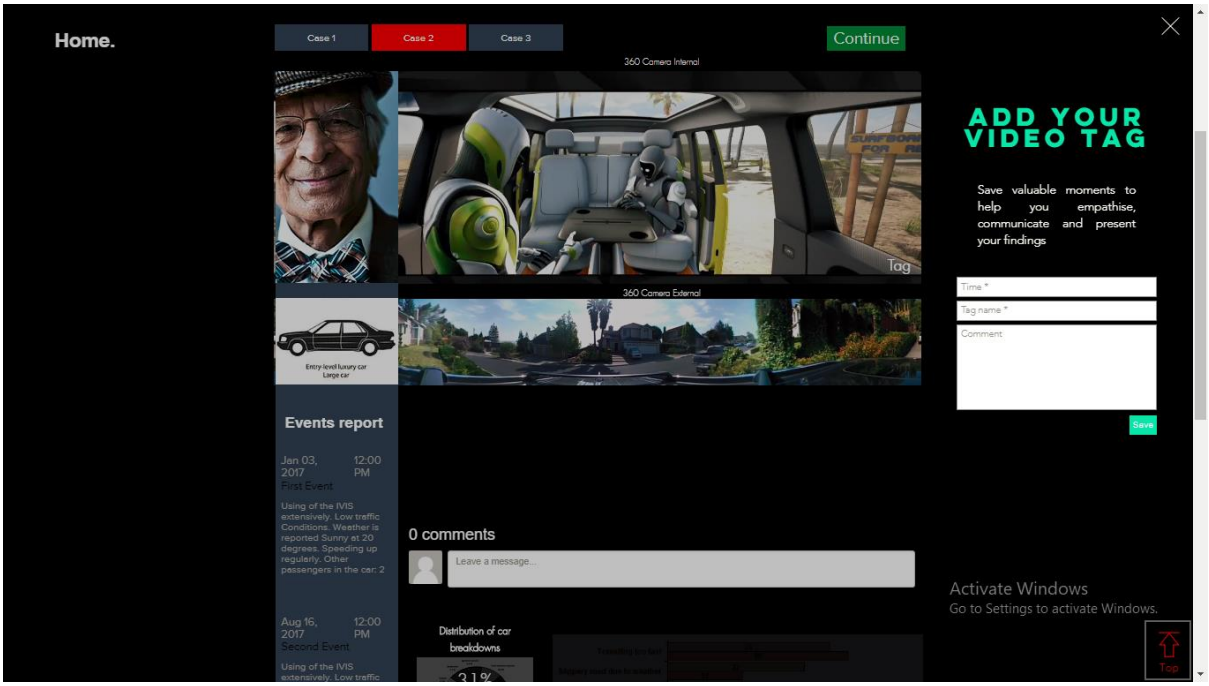


Figure 20 and Figure 21: Some of the functionality of RAUX includes tagging video of the internal and external 360-degree view, where necessary to use when analysing the data. RAUX communication tools including the conceptual model of archetypes, pre-defined Characters and communication styles.

3.5.2. PARTICIPANTS

We recruited 7 UX professionals (See table 19) from the special interest group of Automotive UI community. Our participants were recruited through a mailing list and from personal networks; we also asked each interview participant to refer to us anyone else who might be interested. The participants were either automotive human-computer/machine interaction researchers or automotive User experience designers. In most cases in the projects they have been involved, they were part of teams exercising both roles. The participants were very familiar with the state of the art technologies in automotive and especially the ones concerning autonomous driving. Most of the participants had acquired a PhD degree and were currently working in automotive projects. The participants were citizens of Either UK, Austria or Germany and had been involved in projects with companies including Jaguar-Land Rover, BMW, Rolls Royce, and Audi. Even though the recruiting process took less time than the first iteration, it was difficult to find more automotive experts, and we needed to travel to these countries to collect the necessary data. The fact that the participants are citizens of different European countries also enhances the ecological validity of our findings. Six of the participants were males, and only one was female in gender. However, this split is representative of the number of women in the specific community. The limited amount of participants is typical in qualitative studies of special interest groups, especially when co-designing activities are taking place which traditionally requires same-time same place communication. There is also the economic aspect of recruiting more participants and travelling to their remote locations to run the sessions. However, the collected data are richer; as a result, the analysis of even fewer participants needs more time.

Participant	Country	Gender	Age	Experience	Education	Familiarity with technology	Domain

a nt							
1	U K	Male	25-34	Seven years	Doctoral degree	I could teach others	Automotive HMI/ JLR
2	U K	Male	35-44	Ten years	Doctoral degree	I could teach others	Automotive HMI / JLR, Rolls Royce
3	U K	Male	35-44	Five years	Doctoral degree	I could teach others	Automotive HMI / JLR
4	A UT	Male	25-34	Five years	Doctoral degree	I could teach others	Academia and Automotive UX / Audi, BMW
5	A UT	Male	18-24	Two year	Master's degree	I could teach others	Academia and Automotive UX / Audi, BMW
6	D E	Male	18-24	Three years	Master's degree	I could teach others	Automotive HMI / Audi
7	D E	Female	25-34	Four years	Doctoral degree	I could teach others	Academia and Automotive UX / Audi

Table 18: The table reports on the details of the seven automotive user experience research and design professionals.

3.5.3. CRITIQUE AND CO-DESIGN PROCEDURE

The session took approximately 2 -3 hours, and as a good practice, an Amazon voucher was provided, to balance their effort and time. We asked the participant to read the research information sheet and the consent form for the study one more time since these were previously sent by email to them. We also explained a summary of the study to them and information about the time needed to complete and what will we need them to do in each of the tasks. Our setup (See Figure 22) consisted of a laptop connected to the internet running the online prototypes of the system, a sound recording and two cameras recording video footage of what the participants' interaction. For this session, we placed post-it notes, markers and other printed material, including personas, scenarios of use and tools, on the table.

We have prepared Semi-structured interview questions based on the findings of the first iteration. We have prepared between 1 to 3 questions for each one of the seven scenarios of use, comprising an overall 12 questions. Emerging questions based on the interaction of the participants and follow up questions helped us delve deeper into their needs. The participants were asked to read the personas before each session. Each scenario of use would fulfil needs and expectations of 1 to 3 personas since, in some scenarios, the personas are working together as a team. The researcher (facilitator) read each scenario of use out loud to the participants and then navigated through the interactive prototypes based on the scenario of use. The participants were asked to interact with the system when they thought it was necessary — having the facilitator going through the tasks and the participant repeating it when necessary was proved a very effective way since we were not concerned in measuring the efficiency of each task when the participant in navigating through (as part of usability testing). Our main concerns were that the participant would be able to

understand the scenarios of use and the tasks and critique of the cognitive model and the relevance of the interactions in the automotive context.

As we previously explained, we designed two prototypes to be used in the sessions and conclude with the participants that will help us in redesigning the prototypes to meet the contextual needs of automotive. The prototypes were functional for a significant amount of tasks, but generally, as a good practice, we tried to keep the interaction possibilities only based on the scenarios of use to save development time and effort. The above is also a good design strategy in new product development since a fully developed functionality that would later be proved not relevant and will need to be excluded would be a waste of time and effort for the developer/s.

While interacting with the system, the participants were asked to:

1. Evaluate the UX design goals synthesised during the previous iterations.
2. Validate the tools of the two online proposed prototypes.
3. Critique the scenarios and the interactivity of the interaction.
4. Redesign the remote UX design system.

Workshop process and timeframe	
5 min	Introduction
5 min	Freeform interface exploration
25 min 35 min	Reading and applying the Personas and Scenarios of use
25 min	Qualitative Semi-Structure interviewing
5 min	BREAK
20 min	Critique and co-design

Table 19: this is a table that shows the workshop timeframe and the activities undertaken.

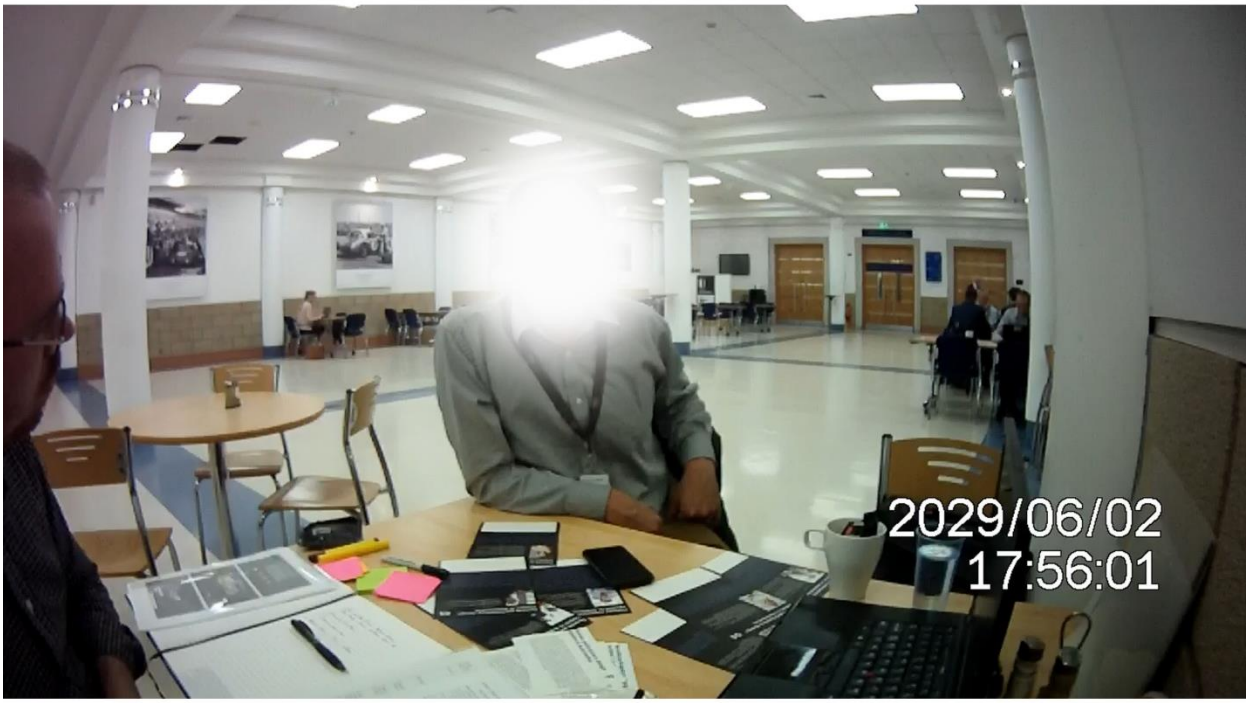


Figure 22: The setup of the second participatory workshop with automotive UX researchers and designers.

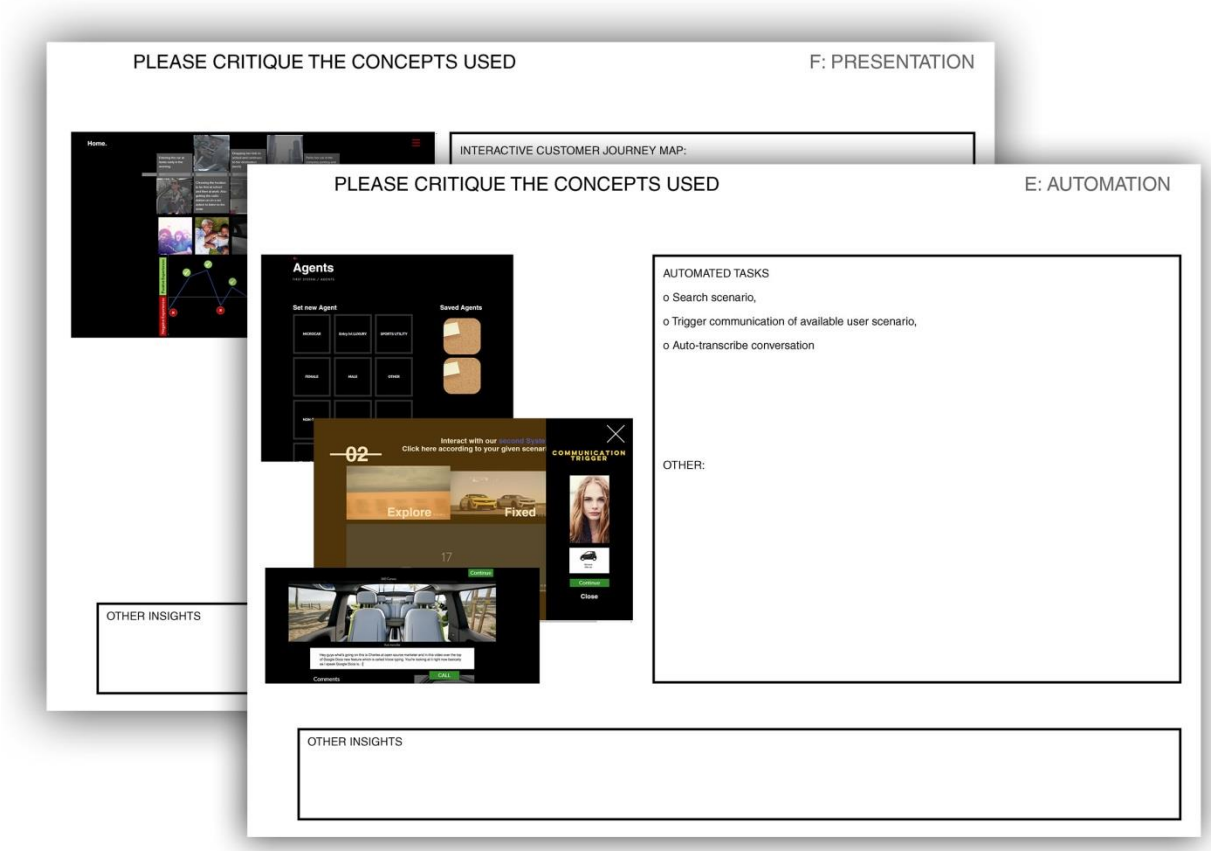


Figure 23: 'Critique and co-design A3 papers' illustrating the capabilities of the technology and the specific tools of the two prototype systems presented.

The last 20 minutes of each session, the participant were asked to summarise their thoughts on the design of the system. Critique and co-design material (See Figure 23) was provided as a platform for them to identify the best tools of each prototype system and exclude the ones that are not relevant, or the automotive context limits them. The participants were asked follow-up questions for the supportive tools and interactivity that they have chosen as more effective. The participants found the process quite effective, and some expressed their interest in applying it in their projects. Only a few participants used the break, and no participant complained about exceeding the time. On the contrary, some participants were proactive and very verbal in their communication even though they knew that the time of the workshop was exceeded.

3.5.4. DATA COLLECTION

We observed the participants while interacting and answering questions. At the same time key bullet points of their ideas, suggestions and thoughts were written down in the research notebook to support the analysis later on. Video recordings with sound were collected for each session and transcribed later on. A second camera and a recording device for audio-only monitoring were used to back up the primary recording devices in case of the battery, internal storage, and quality of recording issues. The above proved to be as a life-saver strategy in many cases. For this second part of our studies, we were collecting data from 7 individuals from 3 countries. The research took place in various locations and throughout 5-6 weeks for recruiting the participants, organising, and running the sessions in an individual

research effort. The result of this effort was, 45 artefacts, approximately 17 hours of video and audio to be analysed and 13000 words of written transcripts. These resulted in 167 affinity notes over four days of analysis working 6-7 hours per day on the wall. Previous research (Lucero, 2015) indicated that it takes approximately double the time of the videos to generate affinity notes which means for 45 minutes of video it would take 90 minutes for the affinity result. Thus, in this study, even though working individually for the data collection and analysis, the estimated time does not exceed the expectations. Research ethics training and approval was previously given to the researchers. All information, including what we discussed during the conversation, the qualitative interview and video recordings, is kept confidential (private) within the research team. No one outside the research team will have access to information which could be used to identify the participants. The researchers removed any information presented here, which could identify the participants' name so that the data we keep is anonymous. In our academic publishing efforts, our study report, do not mention any names or other identifying information.

3.5.5. DATA ANALYSIS

For the data analysis of this second iteration, we are using the modified version of the affinity diagramming method presented in previous work by Lucero et al. (2015) Their process consists of four stages: creating notes, clustering notes, walking the wall, and documentation. Although all the literature references characterise affinity diagramming as a team process, previous research (Harboe and Huang, 2015) reported much affinity diagramming work that was done entirely by one person working alone, and several others where one person worked alone for part of the process. Furthermore, as they explain some findings differ from previous descriptions: some diagrams take longer and use less hierarchy than prescribed, and people occasionally work on affinity diagrams by themselves (if only for part of the process). Woolrych et al. (2011) argue that such variations are a universal and necessary fact of doing HCI works and that we should reconceive rigid methods as flexible combinations of "resources."

Previous researchers (Klemmer *et al.*, 2001) expressed a strong awareness of the tangibility of the paper notes and the physical manipulation of them. Many-valued this aspect highly and even saw it as one of the most significant advantages of the process. They also pointed to the size of the working area and spatial awareness as essential benefits. They are highlighting that physically ordering in the spatial world facts and things creates opportunities for unexpected conclusions and understandings.

Lucero et al. (Lucero, 2015) conclude that despite the pervasiveness of new technologies, paper remains a critical feature of work and collaboration (Luff *et al.*, 2004). Luff et al. (2004) discuss some of the tools of paper that seem critical to human conduct. Paper is mobile as it can easily be relocated and juxtaposed with other artefacts, and micro-mobile as it can be positioned in delicate ways to support mutual access and collaboration. Paper can be annotated in ad hoc ways, allowing people to track the development of the annotations and recognise who has done what. Paper is persistent, according to Klemmer et al., (2001), retaining its form and the character of the artwork produced on its surface. Besides, paper allows people to see its contents from different reading angles simultaneously, and it can become the focus of gestures. Following previous research, we agree that the affordances of paper have played a key role in our practices with affinity diagrams, including our preference to use physical paper to digital alternatives, as well as to manually write notes on sticky notes.

The process starts with the evaluation and critique of the prototype. We transcribe the complete footage of the video recordings while we also add notes and highlight valuable insights. We use colour coding and commenting to give labels to our quotes coming from the participants. Each evaluation and critique session lasted between two and three hours. As a result, we end up with 14 to 21 h of video to analyse, both from observations of use during a task and from the semi-structured interviews during the session. Our affinity notes include handwritten text, but also drawings and annotations on top of the participants' artefacts. The number of affinity notes can vary. Interpretation sessions with two or more researchers can produce 500 to 2500 notes, depending on the number of interviews, their duration and the level of detail captured. It usually takes researchers (Holtzblatt et al. 2005) twice as much time to write affinity notes as the length of the videos. We gathered 167 notes. Digital affinity notes are typed on personal computers, and then printed on paper, and each note is individually cut with scissors. In an attempt to provide a similar function and feel as sticky notes, we first placed the notes in a six office table setting to mitigate the gravity limitations that we had to cope without the handwritten sticky post-it notes.

Holtzblatt et al. (2005) stress the importance of getting a dedicated team room for the duration of the project to avoid wasting time finding another room, packing up materials, and relocating halfway through the process. Thus, we booked and prepared the HCI lab room in our department and indicated that there is work in progress that must not be interrupted or relocated. The room provided us with the right space for setting up the table and the wall surfaces. The lab room is approximately 20 square meters which were right for our setting, but if the notes were more than 250, we would need another space. Previously, at our first iteration, we used the glass walls of a smaller room since the room space was not enough.

For the number of researchers analysing the data, we are following the original KJ method approach, which was conceived for individual use of one individual collecting and analysing the data. The research purposes for this decision include time efficiency, lack of experienced researchers in a particular method in our department, and lack of time for training other researchers. Also, when building an affinity wall to analyse prototype evaluation data, the note taker who created the affinity notes is already familiar with the data since he has seen the videos for all sessions which makes the clustering and findings more relevant to the research study. Despite the seemingly structured way of analysing the participants' critique and interaction observations, when going through the data (i.e., the semi-structured interview questions of the participatory sessions), we avoid as much as possible using the interview questions to structure the data. Instead, we let overarching topics naturally emerge from the data as a good practice indicated by previous researchers (Lucero, 2015).

Starting by spreading all the notes in the six-table setting (Figure 24). We are using colour coding to identify the participant to whom the quote belongs to; therefore, we try to have an equal spread of different participants across the table setting. We start by reading the notes of one corner and pick notes that raise important issues concerning the prototype and begin forming rough clusters. Once a couple of clusters have been created with a few notes, we tried to search for relevant ones to build upon the cluster and enhance our argument. Clusters with a few notes below them are initially named and labelled with a green note. These clusters are, in turn, grouped into more abstract groups labelled with pink notes.

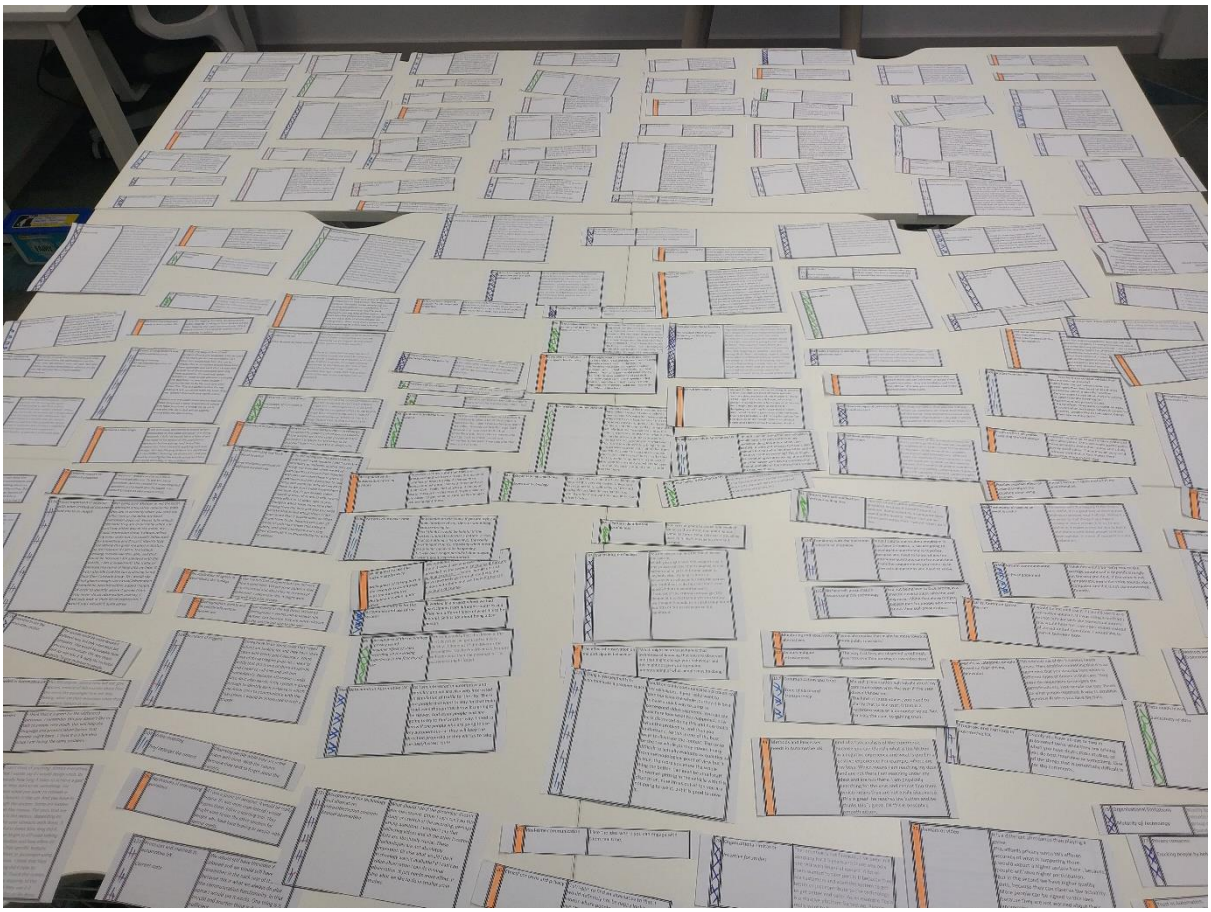


Figure 24: This figure illustrates the first steps of the affinity diagramming methods incorporated for the analysis of the collected data from automotive UXers. The quotes of individuals are assigned to a colour to differentiate and spread across the six tables.

By observing the clusters and the big picture will then concentrate on communicating the emerging clusters, checking if these clusters fail to cover some essential general topics, and identifying overlapping clusters that could potentially be merged (Figure 25). Similarly, clusters may be merged, moved to a different location, or can altogether disappear. Pruning the wall thus includes merging clusters, arranging the cluster hierarchy, and removing notes (and clusters) from the affinity wall.

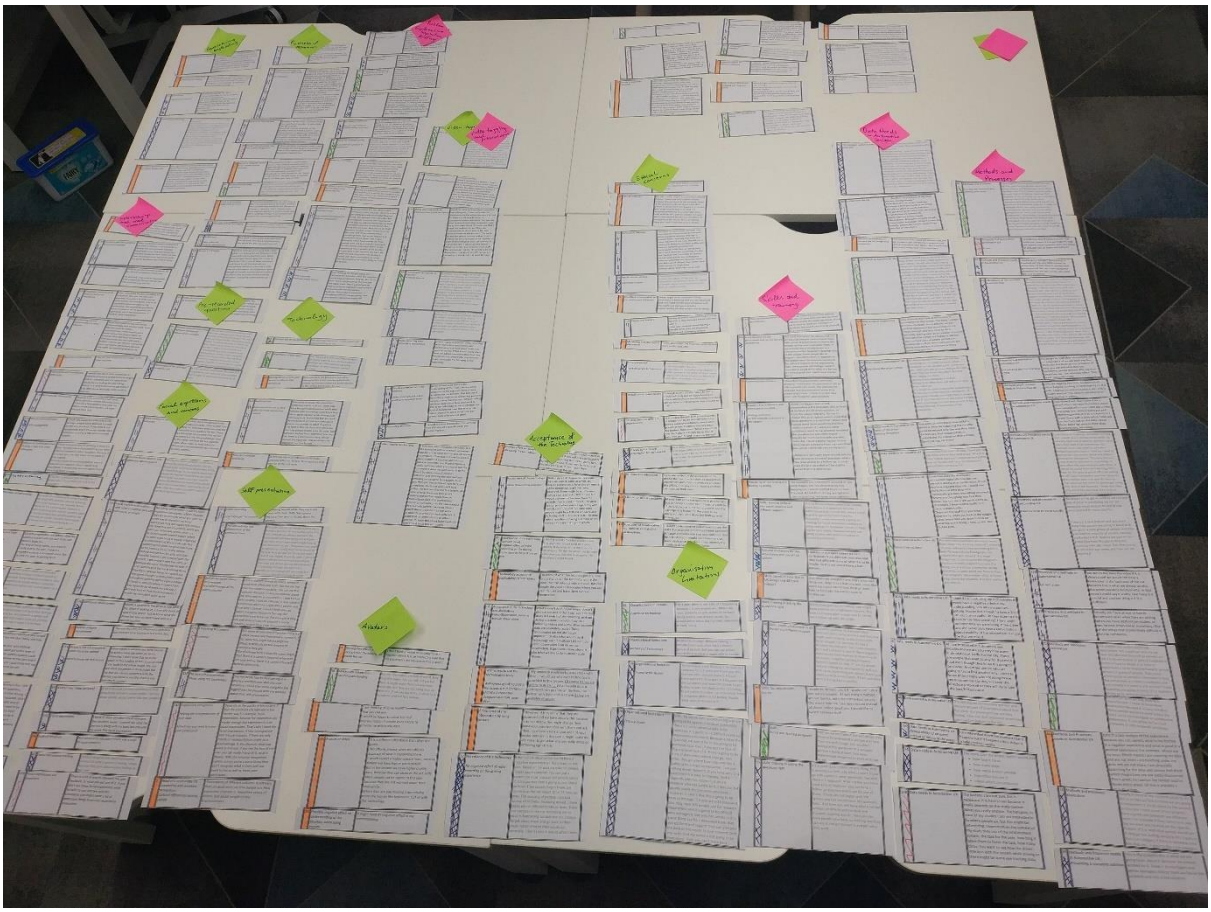


Figure 25: This figure illustrates the initial grouping of the quotes based on meaning. The categories including more posts are represented with pink colour and the ones with fewer posts with green.

For some of the more significant clusters, we defined a tentative cluster hierarchy among the notes to help us with the storytelling. On the one hand, fixing a hierarchy this early on in the process tends to limit the bottom-up nature of the process. On the other hand, shifting panels around late into the process to define a hierarchy (Figure 26) can have a detrimental effect. Social and spatial awareness of the affinity diagram is an integral part of building a cognitive model of the data (Harboe et al., 2012; SCUPIN, 1997). We then check that every green and pink note (Figure 26) still makes sense within the hierarchy. For each label, a succinct user statement describing the issue that holds all individual notes together is written on a large sticky note.

Figure 26: Final grouping and hierarchy of the quotes to interpret the meaning based on the findings. Three main categories and seven sub-categories help us structure the data and present a meaningful, actionable outcome for the development of the system.

The process took us four days in a row, spending 6-7 hour from work each day. Affinity diagramming can be a mentally demanding activity (Holtzblatt, Wendell and Wood, 2005), primarily when it is carried out for three to five days in a row. Natural breaks such as lunchtime or taking a coffee, but also an unrelated meeting can provide much-needed time for the mind to rest and think about something else, other than the ongoing analysis.

Another particular use of affinity walls for interaction design which previous researchers have developed over the years (Lucero, 2015) is to count the total number of notes and the number of people that raised an issue. Counting the total number of notes allows us to check how frequently the participants mentioned an issue or topic. When creating the final affinity wall hierarchy, the overall note numbers for each pink and green label provide us with an additional way to prioritise one topic over another. Special care should be taken to identify if a category with a large number of notes consists of one or two people mentioning the same issue repeatedly. Similar as for usability testing (Martin and Hanington, 2012), we also count the number of people that raised an issue. That is why using different note colours comes in handy as we can glance at a category and quickly get a sense of how many different people mention a specific issue. When doing this, we can quantify our (mostly) qualitative findings. Opening statements will usually accompany a qualitative finding highlighting statements or thoughts that the majority of the participants agreed on. Quantifying allows us to report our qualitative findings later in Figure 27.

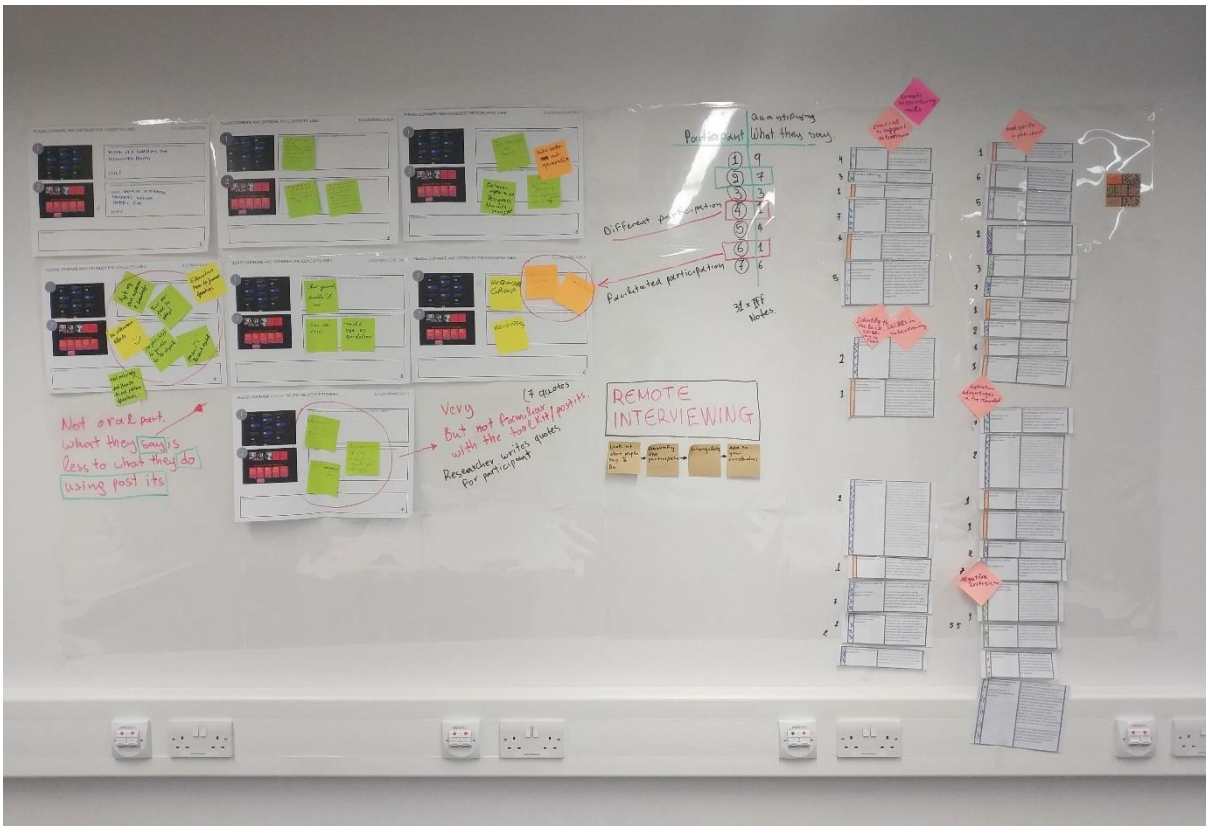


Figure 27: Quantifying the data collected and connecting them with the artefacts to make the most out of our data.

For making a digital version of the affinity diagram, we took (high-resolution) digital photographs to capture the final wall and to write it down on a computer word document. Keeping a digital record of the finalised affinity wall allows sharing the results across sites. Picking relevant user quotes, ones that capture the essence of what participants tried to tell us, will play an essential role in communicating the main (positive and negative) findings of the study to different stakeholders, improving existing designs, and further disseminating the results (e.g., publication at an academic conference)(Lucero, 2015).

4. CHAPTER FOUR: FIRST ITERATION FINDINGS

In this chapter, we present the themes of the first iteration based on the needs of the participants when interacting with a remote UX design system. We describe their importance, and we translate them into UX goals. We identified the themes based on the development and validation process and what the participants said did and made during this process. The process of developing and validating the system's wireframes also identified numerous areas where future research is required. Using the knowledge gained from this study will provide insight into what researchers might look for and what they might see when studying remote UX design systems in the automotive domain. We collected digital audio and video data of the workshop and analysed the transcripts and the field notes using coding and thematic maps. We coded repetitiveness of a phenomenon or a participant's opinion, commonalities, relationships with other participants' views and actions, and patterns of behaviour. Grouping and naming the themes, we prioritised the participants' meanings and identified participants' values that need to be fulfilled when we design supportive remote UX design systems. Although most of the themes express non-instrumental hedonic or eudemonic values, some themes are instrumental and pragmatic. As a result, the findings are structured and presented in themes to examine the role of a set of values that we identified in this study and to develop a remote participatory UX design system. The first theme explores the role of intrusiveness, emotions, and behaviour, followed by usability and information architecture and their impact on the effectiveness of our system. The third theme presents the value of the quality of communication and the fourth theme designer's empathy about their end-users. The last themes examine the role of context and the preference of the participants concerning the communication medium of our system. Below, we present the needs and how they relate to the UX goals based on our analysis. After analysing our findings, we conclude in ten UX needs, including, privacy, efficiency, effectiveness, engagement, naturalness, ease of use, information retrieval, self-image awareness, politeness, flexibility.

4.1. PREFERED TECHNOLOGIES TO CAPTURE EMOTIONS AND BEHAVIOR

The first theme that emerged was Intrusiveness. Even though some participants were more enthusiastic about the various technologies that we provided as stimuli, the majority expressed a general mistrust of the effectiveness of using emotion recognition technologies to support design. The fact that we cannot rely our perception of a persons' emotions relying only on facial recognition and the fact that emotions can be affected by different factors when users are in social settings led designers to a mistrust of the technology. Additionally, even though the participants understand the possibilities of the technologies as mentioned above, ethical considerations such as privacy and safety were expressed as they see themselves as potential users. Thus, we avoided incorporating face tracking and similar technologies in the scenarios of use of our system based on the following findings:

P1: "*For safety purposes*" "*You can see children inside the car, and the passengers are not properly protected*."

P1: "*This kind of information does not attract me. For the same concern. Privacy*."

P5: "*I am not sure what one sees in your face is what you feel; I think there is a discrepancy there. It is really difficult to understand emotions just from the facial expressions*", "*my facial expression can be affected by so many factors*."

On the contrary, the behaviour of the users in the vehicle was more important for the designers than emotion recognition. The participants suggested alternatives, less intrusive

methods such as observation, empathy building, and technologies such as video or audio monitoring:

P6: "*I would probably like to see him. If I were doing the interview remotely, I would like to see how he reacts to the questions that I ask and to different situations*."

P6: "*If you have a 360 view of everything around, you can see the behaviour*."

P7: "*You can design a car based on emotions, but you can also design a car based on demographics and behavioural (aspects). If someone is eco-friendly and likes nature, I could design for them, but I cannot do the same with emotions*."

The participants provided evidence that other technologies are more useful in designing for experiences. More specifically, technologies such as video or 360-degree view of the environment are suggested. A possible explanation for these results is that the context of the person interacting in the car is more important than the individual and can generate insights or inspirations for the design of the new automotive experiences. Even though the designers avoid monitoring facial expressions through technology, paradoxically they would like to see the users interact with their environment and want to observe their reactions. This preference might be a result of their need to identify cues such as frustration, confusion, or unexpected usage, which show a hidden or latent need of the observed user as we mentioned previously in this paper. The fact that designers empathise with the observed users since they are drivers themselves can explain this reaction. Therefore, ethical considerations of private information lead them to decisions of mistrust of specific communication mediums in comparison to the rationale of the media richness hypothesis (Kock, 2005). Medium richness hypothesis describes the preference of the people interacting with media as a decision based on the quality of interaction where the best quality is attached to the more technologically advanced media. Ethical considerations are influencing the decision of the media selected in remote UX design more than media richness theory hypothesise.

4.2. THE PREFERED SYSTEM'S INFORMATION ARCHITECTURE

Regarding the information architecture of the system, participants had various useful suggestions and ideas, and many usability qualities were highlighted as necessary by the participants. Although some of the participants wanted to include all the possible information they found on the system's toolkit, most highlighted the need for a minimalistic design approach. Thus, participants avoided redundant or complementary components regarding information content and architecture:

P1: "*You want punctual information really direct, visual maybe audio I think is really effective*."

Even though the hierarchy of information was generally not considered essential, participants grouped content and brought essential components in the front of the interaction, avoiding a loose interaction with no hierarchical structure. Even though sometimes the complementary information occupied most of the free space of the basic-screens, participants mainly followed the rule of 'bigger equals more critical', and they enlarged the more critical information to occupy more space.

Moreover, the participants highlighted the need for a flexible design that adapts to their needs each time they interact with it. Immediateness is another quality that the participants stated as crucial for their interaction. Finally, Information retrieval and ease of use were reportedly found to be crucial for our system, with the participants being concerned about the

mental effort needed to use the interaction and the possibility of forgetting information and missing essential findings throughout the process:

P6: "*I don't think there should be any hierarchy in the position of the visual systems. If I am blue sky and I don't know what I am doing, I would choose this hierarchy though*."

P1: "*With emoticons, you have a question and a list of emoticons that the driver can reply immediately*."

P5: "*Maybe what is very useful, you can star it, and it can get down to 20 per cent. If you think it is important and you like it and not want to forget about it, why not?*"

The designers preferred flexibility in the way they are going to use their tools as part of the system. The need for exploration and experimentation is fundamental in the early stages of the design process, and that could be one explanation about their preferences. Another explanation is that they do not have a predetermined set of scenarios, but they depend on the observation to identify the behavioural patterns of the users. It seems possible that the designers need some initial time to grasp the interaction scenario, identify the preferred contextual information and then decide on how they want the system to support them accordingly.

4.3. CONCERNS ABOUT THE QUALITY OF THE EXPERIENCE

Participants expressed concerns about the quality of the communication being affected by 'trust'. When the system supports them in communication with the driver/passenger, the used technologies must support a trustworthy communication interaction for both parties. They generally believe that when there is a lack of trust, the goal of the designer is undermined. Accordingly, they propose a more natural, transparent and socially present communication to mitigate the feelings of mistrust to them and the system by the passengers/drivers:

P7: "*If there is no 'point'(the participant here is referring to a common point of view) between you and the user, It is going to go downhill from there because you will never understand each other, that should be established. Building trust is the first thing. I want unstructured (interviewing) for the same reason*."

P8: "*Having audio of another person or me for self-presentation issues does not make much of a difference. If it wouldn't be my voice and it was somebody else's, I don't want it to sound artificial. That is a very bad idea. I prefer a terrible natural voice than an artificial one*."

Participants are also concerned about the quality of communication affected by self-presentation issues. Their appearance can affect the level of engagement with a communication interaction that is going to take place. The same effect also works vice versa, i.e., when people are distracted by the image that the designer communicates towards them and change their responses and behaviour accordingly:

P5: "*I don't want to be good looking in case they are looking at my face, and start thinking about other stuff rather than design. We don't need to have the same interaction every day. We can have different types. We can see each other today. If I am not presentable. If I have an initial video, it can work and then you can have another type of communication*."

P12: "*They cannot see the designer. Because the answer can change, if I see your facial expression, then my next answer is going to be different. For example, you are asking me how*

is research going, and I am responding I didn't do my literature review and you are laughing. Your next question if you ask me how often you see your supervisor, I might say every week."

Finally, the participants feel that a structured form of communication feels like a duty, and a preferred semi-structured manner will give them more feedback. On the bases of instantaneous communication and face-threatening acts, they are also concerned that they may lack the skills to provide high-quality communication and that they need to be supported by the system to achieve the levels of quality that are expected by this kind of qualitative conversations with people:

P9: "*People react in a way you react towards them. If you yell at someone, they will probably yell back at you. The driver is going to see you sometimes. If he is going to make signs, you can see him. Human beings respond to the way they are being treated. I would strongly lean on that the designer should be trained and experienced*."

P11: "*Unstructured (communication) needs an experienced researcher*."

The results here are in agreement with those obtained by previous studies about the self-image of people using remote communication technologies (Park *et al.*, 2014; Shalom *et al.*, 2015). A possible explanation is that the participants are trying to protect themselves from an unexpected situation and at the same time to protect the quality of the insights gained by the interaction with the driver/passenger through the system. The fact that they do not want their presentation to affect the interaction shows again empathy for the people with whom they are going to be interacting.

Building trust and maintaining engagement is again expressed as a desire here by participants. The medium that can serve these needs of the designers is presumably the most useful as well. It is worth highlighting here that the effectiveness of the medium in use is not a primary concern of the designers.

4.4. THE USERS ARE EMPATHISING WITH THE DRIVER'S SITUATION

On many occasions, the participants expressed empathy with the user and explained their decisions based on the experience that they would like to have if they would be the driver/passenger instead of the UX designer in this two-way interaction. Their values and their company's values (when applied) lead them to a definition of the appropriate interaction. They are concerned with the perceived safety, comfort, naturalness, politeness and the feeling of being valued or any possible frustration that the drivers or passengers will experience during this interaction. The participants consider it essential that the drivers find themselves in control and that the communication medium that they are going to use is appropriate for the situation. So, for example, they reported:

P4: "*Create an environment where they feel safe because it is a radical change*."

P9: "*Structured feels like a duty. If someone is relaxed, he or she tells you more. A bridge between being polite and having all the information you need*."

P12: "*Unstructured questions allow a better user experience because people like their opinion to be heard*."

As shown, participants highlighted the need for the naturalness of communication, prioritising the sense of more informal and natural communication. One of the participants' claim provides a possible explanation: the insights are going to be more in-depth if the person feels

more relaxed. Another explanation is that they are already "walking in the driver's shoes" and feel that they would not like a cold closed and structured interaction.

4.5. INTEREST IN LONG-TERM CONTEXTUAL DATA

Participants generally expressed the need for contextual data that they can relate to, at the time when the driving experience takes place. Participants describe that the place and the environment also shape the experiences of people and are equally important. Participants find the social context of the drivers to be of great importance to a deeper understanding of the situation. Finally, long-term patterns of behaviour are thought to be of help to designers in identifying opportunities before they delve into a more in-depth understanding of the situation. Thus, we incorporate this understanding in our design of the system based on these insights:

P5: "*You need to know if its rush hour in the morning and you have to get your kids to school or if it is a bit later in the day*."

P8: "*It goes back to the personality depending on different things. With the personality, If you have your girlfriend in your car or someone you care about, you might be driving a little bit more carefully, but then if you are with your first date, you might want to impress her and drive more dangerously. And you might want to identify a pattern based on that*."

P6: "*Otherwise, how can we improve the commodities of this family here maybe you need data that are collected over a few months*."

The majority of participants agreed on longitudinal behavioural data and supporting rich contextual information as a source of inspiration for the design of new automotive experiences in autonomous cars. A possible explanation is that they want to design for long-lasting, meaningful experiences in comparison to momentary hedonic experiences (Mekler and Hornbæk, 2016).

4.6. PREFERRED COMMUNICATION MEDIUM

The primary communication medium was also a concern for the participants. Video is generally considered a vital medium towards the understanding of emotions and behaviour. In such a manner, the participants' video technologies are suggested to capture behavioural patterns and to achieve more in-depth communication with the user. Video of the internal and external environment can give a deeper understanding of how people experience driving:

P7: "*That is why I want the video. The reaction of how he is sitting, the reactions. The pattern that leads to a personality, because if someone is constantly doing something, it leads to a personality*."

P11: "*The external camera is important because we can see how he is reacting based on the environment. Sometimes he is feeling bored and sees the other way*."

Furthermore, some of the participants suggested a two-way video interaction to communicate transparency and build trust among them. However, one participant expressed concerns about the importance of the video on the driver's side, basing his argument on the attention the video requires from the drivers. Many of the above qualities, such as recognising the feeling and the level of personal involvement in the communication are also expressed for only audio communication. Finally, they found text, gifs, and emoticons to be exciting means of communication but as an additional medium and not the primary medium due to the limitations in comparison to the video or only audio.

Building trust and maintaining engagement is again expressed as a desire here by participants:

P2: "*I would use the voice because with the voice, you can perceive the feelings as well.*" "*So if you use emoticons or text other than your voice could be less personal, so harder to build trust*."

Additionally, participants added characteristics of utility to their decisions choosing the most appropriate medium for convergence (better at engendering mutual understanding, Rhoads, 2010).

4.7. THE UX NEEDS OF THE USERS

We analysed the qualitative data under the above main themes and extracted the UX design needs. Some of the needs that UX designers want to be supported at include trust and empathy building, privacy and self-image, and holistic and behavioural long term understanding of the user as we later explain. Our results indicate that the designer's goals are to achieve a deeper understanding of the situation and map insights on feelings and long-term behavioural patterns.

However, the literature suggests that designers don't trust the effectiveness of using face tracking technologies, emotion recognition, and psychophysiological techniques (Mandryk, Inkpen and Calvert, 2006), due to technical and ethical considerations including privacy and safety. A holistic design result is also one of the participants' main considerations. The majority of our participants prefer a deeper understanding of the situation choosing holism versus reductionism and contextual data as previously defined by (Roto *et al.*, 2011b) to design for the new automotive experiences. Identifying the behaviour of the users in the vehicle and their experience over time (see, for example, Karapanos *et al.*, 2009) was more important for the designer's aims than identifying emotions. An interesting finding is that UX designers want to design for emotional experiences (Desmet and Hekkert, 2007) but not to draw inspiration by these insights since they perceive that they don't reflect the overall experience. The majority of the designers are not primarily interested in momentary emotions and agree with the notion that it is the long term user experience that, matters (Roto, 2007). Therefore, mediums, including video and audio for observation, empathy building, and communication are perceived as more effective and less intrusive forms of interaction. Previous researchers (Tonetto and Desmet, 2016) highlight the fact that quantitative data are more precise and are useful for attracting investments and convincing stakeholders about the effectiveness of design decisions. Some of our participants also preferred a combination of the two.

Our participants agree that trust in communication is important and that it is achieved when communication is natural, informal, transparent and high in social presence. They also expressed that the lack of a specific set of skills will result in an impolite, unnatural and/or ineffective communication, hence a non-trustworthy interaction. As previous researchers highlight (Kaasinen *et al.*, 2015) trust as an experiential issue has been included in earlier approaches, but rarely as the main objective of the design process. Trust has been an important factor in many e-commerce user studies (as we can see in chapter 2.3.1., page 32).

Another important finding was that self-presentation issues need to be addressed since participants are concerned about their appearance and how that can affect the communication or distract from the task of the design itself. In previous research (Park *et al.*, 2014) employees when teleconferencing, were more aware of others' status and reactions, thereby were more cautious of their self-image and behaviours. Our participants believe that

their self-image will affect communication behaviour and thus the experience itself. The designers empathise, with the end-user and they are supporting ideas that not only work for them but the end-user as well. Hence, the most compelling finding is that the participants believe it is important for the drivers to find themselves in control, valued, and interacting through the appropriate communication medium.

Previous work by Eckoldt et al. (2013) supports the notion that meaning and positivity are related to the fulfilment of universal psychological needs (an experience becomes positive and meaningful if it fulfils a psychological need) and explores the potential of an experience-oriented approach to design for interactivity in and through cars. Identifying these needs for design and evaluation purposes attracted the focus of automotive research measuring both momentary (Körber and Bengler 2013) and long-term (Kujala et al. 2011) user experiences. In this study, the analysis of our data led us to identify the following needs of our participants:

Privacy: Privacy refers to the avoidance of intrusiveness. We can achieve levels of privacy when the participants are using secure technological interventions that can mediate communication, and that can inspire the sense of being in control. People trust the interaction with the system when they feel in control of their privacy but without compromising the quality of the interaction.

Efficiency: Immediateness is crucial for the communication result of the system. As a result, we want the system to interact with the user quickly, on the spot.

Effectiveness: The majority of the participants lean towards a deep understanding of long-term behavioural patterns in contrast to data about the momentary emotional state of the participant. To support the designer's goals in empathising with the user and in achieving a deeper understanding of the situation, we want the system to be able to map the participant's feelings and behavioural patterns over time.

Engagement: A more personal and informal interaction. Communication which is going to provide us with more in-depth insights. We want the system to support the designer in achieving these levels of personal involvement when interacting.

Naturalness: An interaction that will feel natural to use. A technology that will be acceptable, thus enabling both parties to communicate instinctively. A naturalistic approach to the design of a system is one that supports a natural user experience.

Ease of Use: The most convenient and hassle-free interaction. We want the system to feel comfortable.

Information retrieval: To be assisted in avoiding information loss due to lack of memory as well as the system to store and retrieve data on the spot during the use of the system.

Self-Image awareness: The system supports different levels of self-presentation, supporting the designer in dealing with the situations of face-threatening acts in communication.

Politeness: The system supports the designer to interact only when it matches the situation, "at the right time" and in the right manner.

Flexibility: The system dynamically adapts its needs based on the situation of use, supporting the user with the right tools and interactivity.

Our participants' goals express their aim to fulfil specific needs, as Hassenzahl et al. (2015) explain. Our summative interpretation of these needs, based on empirical evidence drawn

from our co-design workshops, informs relevant theory in automotive design for experiences as we describe in chapter 4.7.1., 4.7.2., and 4.7.3. Furthermore, we suggest a formative interpretation of our findings in the form of UX Goals as actionable insights as we report in chapter 4.8. Each of these UX goals relates to one or more of the user needs that we present above.

4.7.1. EMOTION RECOGNITION TECHNOLOGIES

Previous studies on real-life driving by Dobbins and Fairclough (2017) have reported that the area of lifelogging has emerged as an application that is designed to measure personal data to support recall and self-reflection continuously. Emotions can be captured continuously and in an unobtrusive manner. In our study, the participants do not trust the effectiveness of using face tracking, emotion recognition technologies, and in general psychophysiological techniques (Mandryk, Inkpen and Calvert, 2006), due to technical and ethical considerations including false positives and effectiveness, privacy and safety. Even though the majority of our participants agree with the notion that it is the long-term user experience that matters (Roto, 2007), they are not primarily interested in momentary emotions especially coming from physiological measures. Thus, participants perceive mediums including video and audio for long-term behavioural observation, empathy building, and possible communication, as more effective and less intrusive forms of interaction.

4.7.2. UNOBTRUSIVE LONG-TERM BEHAVIOURAL RESEARCH

As we previously mentioned, researchers in the automotive domain (Dobbins and Fairclough, 2017) have established the need for unobtrusive research. Furthermore, in-situ methods such as the Experience Sampling Method and the Day Reconstruction Method are increasingly applied in longitudinal settings, as Karapanos et al. (Karapanos, Jain and Hassenzahl, 2012) highlighted, while retrospective techniques offer a cost-effective alternative to longitudinal studies. Our results are in agreement with the theoretical framework of unobtrusive behavioural research in the automotive domain. The results indicate that the participants need to achieve a deeper understanding of the situation and map insights on feelings and long-term behavioural patterns, in other words, behavioural research which avoids intrusiveness by limiting their interaction with the driver/passenger.

The majority of our participants prefer a deeper understanding of the situation choosing holism versus reductionism and contextual data as previously defined by Roto et al. (2011) to design for the new automotive experiences. Identifying the behaviour of the users in the vehicle and their experience over time (Karapanos *et al.*, 2009) was more critical to the designer's aims than identifying momentary emotions. An interesting finding is that UX designers are willing to design for experiences based on emotions as defined by (Desmet and Hekkert, 2007) but not to draw inspiration by detected emotions since they perceive that they do not reflect on the overall experience.

4.7.3. EMPATHY AND TRUST

Our participants agree that trust in communication is essential and that it is achieved when communication is natural, informal, transparent and high in social presence. They also expressed that the lack of a specific set of skills will result in impolite, unnatural and ineffective communication, hence a non-trustworthy interaction. As previous researchers highlight (Kaasinen *et al.*, 2015), trust as an experiential issue has been included in earlier approaches, but rarely as the primary objective of the design process. Trust has been an essential factor in many e-commerce user studies. Another important finding was that self-presentation issues

need to be addressed since our participants are concerned about their appearance and how that will affect a possible communication with the driver/passenger or distract from the design task itself. In previous research (Park *et al.*, 2014), employees when teleconferencing was more aware of others' status and reactions, thereby were more cautious of their self-image and behaviours. Our participants believe that their self-presentation can affect communication behaviour and thus, the driving experience itself. Even though we are designing for them, the participants empathise with the driver/passenger, and they only support/propose interventions that apply to all stakeholders of the system. Hence, the most compelling finding is that the participants believe that it is also crucial for the driver/passenger to find himself in control, valued, and interacting through the appropriate communication medium.

4.8. THE UX GOALS OF THE USER

A user experience goal (UX goal) is an actionable insight for the development of products, services or systems. It describes the intended momentary emotion or the emotional relationship/bond that a person has with the designed product/service/system, as Lu and Roto (Lu and Roto, 2014) described. The same research also highlights that, in multidisciplinary product development and marketing process, these concrete UX goals can be quite valuable since various stakeholder groups need to agree on what to design. Väätäjä et al. (2012) considered a UX goal to be good when it guides design towards a positive experience, helps in communicating objectives and is measurable. As a result of our study, we came up with actionable insights to communicate how to achieve a positive experience when designing for remote UX design systems in the automotive domain. These are UX goals, as presented below, that can inform the design of goal-directed personas and scenarios and the development of high fidelity prototypes. Designers use scenarios and personas to realise their users and their users' goals and place them in context. "A scenario is a concise description of a user using a software-based product to achieve a goal" (A. R. Hevner and Chatterjee, 2010) where the goals stem from the persona description. The prototype system or systems are then built based on the user scenarios of use.

The UX goals by themselves are general so as not to direct pre-defined design solutions. They only become more specific when connected with the needs that they fulfil and the context in which they need to be fulfilled: in our case, the automotive domain. Thus, we include the needs that must be fulfilled for each UX Goal in brackets, and we explain them in context. A list of the recommended UX goals when designing for relevant remote UX design systems in the automotive domain is presented below:

- Support contextual understanding (Empathy and Effectiveness).

Supporting the contextual understanding in the car is a need that was also previously highlighted by Meschtscherjakov et al. (2011). For example, given the mobility of the vehicle, the context of it is dynamic and can only be compared with that of mobile devices. As a result, the tools for understanding the context of a static home or office environment are not the same, and choosing the right ones will prove the effectiveness of the system. Since the form of transportation in this study is private, the car context is different concerning the social norms and relations among the passengers than when in a public environment. Building Empathy and Rapport as a need here differs from being able to afford it when in a public environment such as a train or even a library.

- Reduce the level of invasiveness of in people's lives with technological interventions (Privacy).

Reducing the intrusion in people's lives in the automotive domain is a UX goal that can be afforded with various interventions. However, given the fact that the car will need to be connected to the remote system to work synchronously, some of the interventions that were previously applied in asynchronous settings are not applicable here.

- Support long-term understanding of behavioural patterns (Effectiveness).

In mobility and more specifically in transportation, where the metaphor of the customer journey comes from, users' behaviour is identified by a sequence of events and not by an isolated moment as practitioners agreed. Support in identifying these patterns is a goal that will prove the system effective for practitioners when achieved.

- Operate even when the problem is ill-defined (Flexibility and Effectiveness).

In many cases, designers have no set brief for designing a new product/service or system. Setting the brief, in this case, in the automotive domain, requires flexibility to avoid the limitations that come with remote work. By being able to explore a situation without frustration or annoyance, the UX designer can effectively propose a design result. The system requires relevant tools to support the designers to achieve these levels of effectiveness and flexibility. We have previously highlighted that when designing for remote systems, the social context of the communication and the communication medium are of great importance, what is most important though is that the context has been found to influence the medium's perception and effectiveness. For example, even though telepresence is one of the most effective means of remote communication within the work environment, it might be neither flexible nor effective in a constantly changing mobile and private environment.

- Avoid redundant information at any interaction (Efficiency, Ease of Use, and Flexibility).

The automotive context includes many spaces such as the driver, front-seat passenger, and rear-seat passenger. As previously defined by Meschtscherjakov et al. [5] to capture the context holistically and gather insights, UX practitioners need to interact with a considerable amount of different data. The interplay between these data coming from these three different spaces should be usable and should fulfil the needs mentioned above.

- Avoid anxiety about uncertainty (Privacy, Engagement, Naturalness, and Self-image awareness).

Given the limitations as mentioned earlier, including the dynamic and private nature of the automotive context, a supportive system should avoid making the non-automotive expert practitioner anxious about the quality of his work when interacting with it. Fulfilling the needs as mentioned above, is crucial for the practitioner to interact smoothly and gather fruitful insights.

- The feeling of intelligent interactivity (Efficiency, Ease of Use, and Information retrieval).

Intelligent interfaces are applied in many domains. Tools for this UX goal should be standard in relevant systems. However, the availability of these tools does not mean that there is no need to fulfil these needs in the automotive context as well.

We learn that these UX Goals, excluding the increased privacy concern and the support of long-term behavioural patterns, are not exceptionally different from what we see in other domains where remote systems are applied. This result welcomes opportunities to apply state-of-the-art practices and technologies from other domains for the implementation of the remote automotive UX system. We further recommend the design of compatible systems using the suggested UX Goals and their evaluation by automotive user experience researchers and designers which will shed light on automotive organisation challenges for the adoption of such Research and Design Systems.

5. CHAPTER FIVE. SECOND ITERATION FINDINGS

5.1. DATA NEEDS IN AUTOMOTIVE UX

The participants criticise the possibilities of our system, indicating that they are generally satisfied with the amount of data that the system provides them. They even exclude some data provided by the system that they consider redundant. They propose additional contextual data that can be possibly valuable for their understanding of the driving experience and the behaviour of the drivers and passengers.

The majority of the participants agreed that the video is critical to their understanding of the context. The addition of the 360-degree camera was reported by one participant as a very effective medium to disseminate a decent amount of information about passengers' behaviour and their interaction within the vehicle. Two participants indicated that the car events as presented in the system are beneficial since they need to know if a critical situation happened. Other data supported by the system that the participants found important are demographics and the use of the in-vehicle information system. According to one participant, subjective data are inevitable since, without them, there is no progress in the design cycle. Therefore, actionable insights like a customer journey are more useful in this case.

P1: 'It is resource-rich. I have got videos from the participants, got comments to respond and direct interaction with them. I don't see any major things that I may need here. '

P3: 'You are going to start with that, and you are going to get to one of these anyway. Without the video, you are not going to be led anywhere. So, you need the context anyway.'

P2:' The 360-degree camera view will def. give a decent amount of information about how the driver the passenger how are they feeling, what are their responses when they use a certain feature in the car.'

P1: Just looking at the top three. Would be demographics events and in-vehicle info system. Just because they are more relevant to the vehicle but also to the user.

P7: 'I am interested in not the moment that it happens but if it happens often. When it is safety-critical mostly.'

P1:' Just looking at the top three. Would be demographics events and in-vehicle info system. Just because they are more relevant to the vehicle but also to the user.'

P2: Its always better to know whom you are designing for. It is better to know which category you are designing for. Whatever you select, you get to know the participants what they like what they don't like and then design for them. Having more categories is better. Maybe how often they use the car or how they use it for. It is easier to understand what people want if you are to select multiple categories. If you select female you might have 5 people, and if you also add savvy you have one, and what you design for that one person, it has more chances of applying to both categories.

P3: The interactive customer journey is more than video. You 've done some of the work for your colleagues. Just presenting them with 74 hours of raw footage you 've thought about it. It is more subjective. At some point, the designers have to be more subjective or else the designers are sitting around not saying anything; at some point, you have to trust the designers' observation skills. It is one step above the research. It is a lot quicker and concise.

P2: This is the problem; this is what we are going to do about it because we already worked on it. Show it to managers and senior managers telling them we found this problem, and this is the solution.

Three participants expressed a desire for physiological measures like facial expressions, where they are looking at using eye-tracking and tone of voice to relate with emotions that would help them validate their insights. As a result, they need data coming from a camera that is facing straight in front of the driver. Some of the participants are genuinely interested in data that would indicate the skills of the driver, such as speed and keeping the lane. These are argued as being of great importance to them in every case.

P2: The camera and the emotional expression and the tone of voice. That would be useful as automation. I think eye tracking, tone of voice and facial expressions are essential because these are the subconscious reactions that people have to questions. For example, where people initially look when you ask them something, it says if they know they answer if they don't of it they know it but don't bother about answering. You ask me something about something that I need to recall; apparently, I look at the sealing. If you don't have this information and if you only have a video outside the car. You will miss this information. These technologies are already there and analysing the tone of voice is also important.

P3: I suppose I would like to see more of a face. When I watched videos before I 've seen videos, We will often have a setup where we have a face, video of the screen the interactive part, three or 4 different cameras and the one I end up using most is actually just the face camera and at the end, I am not so interested in what is going on on the screen but the expressions, interest or discuss or anger or whatever. That's the most interesting thing for me, and actually, you can get a lot of that from audio but its good to see the face as well. The upper body helps as well, but I' d rather see that from the front, not from the back. I also want to see the eyes when the eyes are kind of dancing around, and I cannot see that here.

P1: How often do they look at this screen in comparison to that screen. The time and the number of times. Duration. Some people use eye-tracking equipment, but sometimes it is not robust enough, and they need to do it manually. Having data within reason. You cant trust data like people are happy or sad, but you can have data of where people are looking more often. How many people are doing something or if only one is doing something specific?

P7: You want to understand how skilful a driver is. How he is pushing the throttle could be related with the way they drive. Battery use, fuel consumption, to understand the character of the driver. Sporty or regular driver. As I am interested in automotive and mobility and we are also very interested in the simulation of traffic for the city. There are people that want to stay for that main road even though they know it is going to be slower. And other people who are going to try to find another way. I need to know if the people who are going to use my autonomous car they will keep the direction proposed or they will try to take the best/fastest route.

P4: Contextual data like dashboard information, especially how fast the person is driving at a specific point. It tells you how engaged they are. I would also really like real-time map data. Technically you have everything you need. Where are they going how fast they move. You can see if the participants act differently if there is little traffic or if there is more traffic. These are the staff that you need afterwards when you look at the middle video, every time you want to look at what the guy is doing; I need to see how fast he goes.

And some others more on usability data informing them about the interaction of the user with the system. These include use of the system, such as how long it takes, how many

steps and or how often it is used. A participant explicitly referred to the value of audio data to capture dialogues concerning usability issues during the interaction.

P2: The more data, the better. Smth I would add

how long it takes

how many steps

how many button presses

how often you use it

under which circumstances

P4: -Are there any contextual data that you are missing already?

Audio from the car, when there are passengers, then you need to see if they are talking about a specific function.

-Do you want to see what they are saying or what they are listening to?

Again there are privacy issues.

-No problem. They gave consent already.

Conversation exchange. When it comes to novelty, people like to talk about things they like, or they don't.

P4: I think if I am not using the technologies, it would have a negative effect on my understanding, less information I am getting. Maybe just enough to have a 360 camera but no audio. Do they listen to the radio, or are they swearing? There might be something we are missing. If the driver and the passengers have a conversation about the usability of the interactions, it might be that we miss it.

Even though most of the participants agreed that the data provided by the system supported them in identifying the users' situation and context, some of them found some of the tools redundant and some of the data not crucial for their needs. Almost half of the participants expressed their concerns about the location tracking data and their value in their work. Even though they think it could be potentially interesting, they highlight that they had never tracked the location of their participants in their studies. When that was necessary, they would instead ask them retrospectively. Two of our participant explicitly referred to the external environment data and the external 360-degree camera as a tool that has no use in their research and design work.

P3: I never had that sort of data. I tend just to ask them where they tend to go. Where is their typical journey? I suppose seeing that one on its own will help me understand where they are going but.

P1: I am not very mindful how I can show the visited location and external environment and make them useful. If we are talking about an off-road vehicle that would be interesting. But if we are talking about the human factors of the car, I would pick them out. Will it be a private car or a service car and who is using it.

P6: The battery, I am not sure this is necessary. It is hard to say because it really depends on the study context. What you really analyse. The hotspots, in most of my studies, I am not interested in where people go, but this might be interesting. Dependent on the context of my study they use of the infotainment system, the task for the user, how long it takes them to finish the task, how many clicks. You want to see how the driver interacts with the system while driving so there might be some eye-tracking data.

P1: I am not very mindful how I can show the visited location and external environment and make them useful. If we are talking about an off-road vehicle that would be interesting. But if we are talking about the human factors of the car, I would pick them out. Will it be a private car or a service car and who is using it.

P3: The external 360 is not useful; it does not add something to me. The external doesn't add a lot your understanding.

5.2. AUTOMOTIVE UX METHODS AND PROCESSES

Participants highlight their current research and design methods in automotive, and they criticise a specific tool used in our system based on a group of methods that they don't find useful. The majority of them indicate a similar process of research and design and discuss the lack of exploratory investigations in automotive (No new ground, autonomous, electric, gap).

5.2.1. METHODS

Our participants explicitly referred to their current research and design methods to support their arguments. The majority of our participants reported that they mostly use interviews and surveys as their main methods of eliciting information from users. They are using common UX scales for the evaluation of the experience in the car such as Attrakdiff, Panas, and UEQ. They are asking about the feelings associated with driving and automated tasks and measuring distraction momentarily or after the interaction with the systems. One individual emphasised on the value of being in the car observing, video recording, and interviewing, when this is possible as a valuable method, while another one preferred focus groups using the vehicle as stimuli. Another participant explained how some more modern UX tools and techniques like card sorting and card video games could be used in automotive. Two of our participants were particularly interesting in the tasks of the drivers and the passengers. They expressed the usefulness of task analysis using detailed examples, and they referred to the needs of measuring and evaluating task completion and times of use of a specific feature in the car.

P5: Usually, you have an eye or two in automated tasks while they are driving when you have destruction studies, or you do post-interview or something. One of the things that are potentially difficult is for the comments.

P6: We always do that after observations, we run an interview, and we ask how they feel. There also has to be an interpretation of what you see and what they say. Sometimes people behave differently than what they say. The interview effect. They want you to like them.

P5: We would still have the video if it is allowed, and we would still have a researcher in the back seat of the car because this is what we always do plus the communication functionality. In that sense, I would say it works. One thing is if it is crucial, and another thing is if it is sufficient.

P7: I mostly use a standard focus group, a standard survey, very little related to active users. It has to be in a room with prototypes of the cars. I am asking questions about cars. So you are using the cars as stimuli.

P4: I use PowerPoint. But I came from a school where we have illustrations move them around tell a story. I also use a video card game. You analyse video you pick interesting points of it as a snapshot as a single frame with a description. Later you can lay them out on the table, group them. More for analysis more than anything else, behaviour.

P1: Kind of a task analysis of the experience, because you can identify what is the friction in a negative experience and what is good in a positive experience: For example, where are my keys; Which means I am reaching my desk and are not there I am reaching under my desk and are not there. I am physically searching for the keys and cannot find them, which means they are not easily discovered. This is great, he reaches the button, and he thinks this is great. Ok, this is possibly a smooth action.

P2: I can't think of anything. Almost everything that I would say if I would design smth. It is basically how long it takes to achieve a goal when they start to do something. For example, when you want to activate a certain feature in the car. And you have to go through the system. Some are hidden deep down the menus. The ones that are deep down in the menus, depending on how often the user interacts with them, it would be useful to know how long did it take for the user to get to the off-road setting or off-road information and how often do they interact with that specific feature. That sais that the driver or passenger using only 30% of the features. I think that they only use it but how long did it take to activate it or de-activate. Touch the screen, start the counter. For the majority of the pass takes 30 seconds, and they use it 3 times a journey, something has to be done.

They also expressed a negative criticism over the value of a group of UX methods. A participant explained why this did not work. A tool used in our system incorporating these methods was described as ineffective by the majority of our participants who agreed to exclude it from our system or re-design it.

P5: I do something like this when I want active user input because I don't have the possibility to understand what they are doing. For example, when we asked the participants to record their experience with adas, we asked them to give us some comments and also if possible, to take photos and annotate. Why did we do that? Because we don't video record them all the time. But if I am already video-recording them that would require a lot more effort to sit down type in your thoughts which takes more time than saying them out loud, and also you need to take photos and attach them. From the experience that is usually quite an effort to get them to do. Because you have all levels of tech-savviness that taking a photo with their smartphone or using their Bluetooth is an impossibility for a lot of people.

P6: It is good to have space where you have an exchange between participant and designer, but I think you can't really answer your question with this because it is only space, maybe open to doing something different , the system is not providing you. Adding some other staff. At the moment as an empty space which might be maybe not used because they don't know how to use it.

P7: The section could be understood in a different way, not only inspiration but complains. That would be valuable cause you can communicate this very clearly and you can take it & apply the technical aspects. To give incentive to people.

P3: I don't see if you are getting anything out of that. You can get all that out of the video. Having only just images from there idealised self 4 hours later I am not going to trust that information, because the majority of car journeys are very mundane, they are quite boring. And maybe someone goes back home and say oh my god I look quite boring, how can I make the designer think I am a really interesting inspirational person. So I'm not really going to trust. I will trust what really happened. I know about contextual inquiry and some staff done with diaries and colleagues, but car journeys are quite boring and what happens is what happens. I don't know if you can get inspired by going to the supermarket every day.

P5: One could re-design the inspiration section as purely auditory. When you have the users speak up loud while they interact with something. Sometimes they like to speak up loud while driving a car, not everybody. Something that we could do would be to just prompt them on to give us a comment on what they did is this light or this interface that comes up and says, please explain your decision. You tell them before head; whenever you see this there is a microphone here, please explain the situation. That would be the inspiration section for me.

5.2.2. PROCESSES

The majority of our participants agreed that there are not many car companies who got the resources to proceed in exploratory studies with no set research or design brief. The typical cases in automotive are to know which features they are developing or the purpose of use of the vehicle or which is the target group of users they need to design for. Based on a 'go find out' how this idea is going to be implemented for our product and our users' process strategy in which a set brief is handed to the professionals.

P3: Who is paying these people? What is the job and are they getting paid by a manufacturer. I need to know their motivation because it is very rare that these people would be given a blue sky black check to investigate an automotive experience. It can either be for a car company or and academic university.

P3: You won't find a lot of car companies who got the resources to start with a blank sheet. It's a better approach to do that. The only car companies that I know by this stage they already know which feature they are developing. Whereas this is a stage before that to find out what the problems are in peoples lives.

P1: Will it be a private car or a service car and who is using it. What is the purpose and how many people are using it. Some people want to use it because they are lazy driving to the grocery store, others because they want to push the vehicle to the edge.

P2: Usually, in most of the research projects its: this is an idea go find out how we are going to implement it. So its closer to the second. In this case, I think some of our projects have a good split between our different users. For example, If they come to us and say we want you to work on this specific feature. If it is smth that people would use if they go out surfing camping etc., it goes in the x car category if there is someone who has dogs etc., it goes to the car category.

Almost half of our participants refer to situations where the company sets the target group of users, with only a few exceptions where they have an entirely new target group of users. Agreeing with that statement, one participant adds that the company wants focused research on a specific target group based on the car they bought or on a common characteristic of their users. The same way a third participant refers to his personal experience with the exploitation of target groups of particular interest. The opinion of the special interest groups was included in the design result.

P2: The experts are in the marketing department. We usually go and say we have this idea and they tell us yes we can sell it to these people or give us feedback in terms of how to design it or how to implement it to be targeted towards certain people or group of people. They know which group of people is interested in that. But sometimes it is smth completely new, and nobody has done it, and we don't know how they are going to react. It's a question of letting us go to whoever one and ask.

P7: For Audi A8, the question would be for people who bought the BMW 5 series, and they compare the target group. In this example the question is, we want to have the opinion of people who bought a specific category of cars, and people with specific characteristics, like people who are earning 500 000 euros/year and so on. Then we have a specific target group based on that definition.

P1: I am not really interested in brand-driven innovation in this stage because I am doing research. I fell this would be in a later stage. You need to be aware of the population dynamics before you go and brand the experience. I am currently applying 'inclusive design'. You see the population as a spectrum of capabilities, hearing, dexterity etc. and you need to investigate the whole space, and then you apply branding in the solution.

There are also two of our participants reporting their experience with a set brief and problem space but not a fixed target group of users. In that case, starting from general to more specific, you need to define the differences between this target group and the rest of the users. As a result, there are some cases with a set brief, specific features of a product, and they are trying to understand how they work with different demographics.

P2: We always try to get as wide as we can and then if there is something we are not expecting we go deeper to that group. (from general to more specific). If there is a new feature and you don't know how people are going to react to it, you go to a wide group of people, and then you find the majority of people reacting positively to that feature are part of the group that they like sports they are businessmen age range. Pick that group, which is the age range, and how can we expand it.

P3: Whereas this is a stage before that to find out what the problems are in peoples lives. Any business does that because they suppose that you want to do the research because there is going to be a new feature or a new design and the second in the best way of doing it. I might have the feature or the thing in mind, but I want to explore it from all these positions. Especially female male. I filter through all these things.

One participant recognised the advantages of the exploration of new segments and new target groups as a new process. Another participant welcomed the opportunity of targeting a group of people for inspiration, reporting it as an exciting idea. Choosing the target group based on specific characteristics saves time and effort based on another participant. However, the individual is also concerned about losing valuable time and resources in case the agent gets a target group that does not help to answer the research and design questions.

P7: I am thinking of a target group of a company for a product. And the company wants to gain valuable insights. But if you don't have a target group, then you get the bigger view. That's a good way to have a customer segment and be more focused on the functionalities.

And then the product could reach a completely different target group than the company could have expected.

P1: The fact that they narrow down whom they are looking into before they see who is available at the moment, is already like having an idea who their users are for the problem, which is ok if you want to take some more inspiration from a specific group.

P7: The agents are a helpful functionality because it means less work for me. So less effort for me as a designer. If you have the wrong agent that would be fatal for the whole process. If you have the wrong people selection, then I will have to wait again for another group of people.

5.3. SUPPORTIVE TECHNOLOGY

5.3.1. VIDEO TAGGING

There is a general agreement that video tagging is a beneficial tool, especially in combination with the 'customer journey mapping' presentation tool. However, the professionals raise concerns about

- the circulation and presentation of data and the ethical limitations of circulating the data.
- Also, the skills in observation required to reach a professional conclusion
- Some of them propose solutions that they use already for circulating but not for the observation skills.

The above concerns could be the reason why the facial expression technologies as we see below are so welcome as a supportive tool among Automotive UX professionals.

All our participants were positive about the video tagging tool. The majority of our participants were able to identify Video tagging as an excellent idea to save time. Given the fact that all this work has to be held manually at the moment, the participants think that the tool is going to save them both time and effort. Two of the participant mentioned the need to have a function that saves the video of each tag, 5 seconds before and 5 seconds after to add some more contextual information to the situation happening. This way, it could serve as a video post it too.

P1: I like the tagging function. An automated video tagging. Looking in front looking on the side. Tagging the video automatically. This is mostly manual. You need to spend a lot of time looking at videos.

P5: I liked the video annotation function. It is like transcript software which, wherever you are at the video section, you can leave a comment. Then you just need to click on the comment, it expands, and you can leave a comment. And if you program it really well then when you click on the comment it does not jump exactly to the point but plus, minus 5 seconds.

Between you noticing the spot and you pressing pause some time passes. So if you then put the comment right here, and somebody starts the video, will miss either the first word or the first letters, of what it has been said they won't understand so they would have to manually go back. The professional transcript software puts the timestamp a few seconds before. I want to make it smart there to conform to the same standards as other research software. I want to

communicate with other people. If I have this smart functionality, I don't need to do this extra step.

P3: The video tag is a very good idea. As a designer, I don't want to look at all the video. A good idea. Someone who is a designer don't want to look all the 70 hours. You want the tags to be there. IF you click on them, you can 5 mins before 5 mins after and what happened just before and what happened just after. That would save me a lot of time. Communicate that more easily to colleagues. For example, in my work recently, where we had a participant who had a lot to say. The video was 1 hour and 30 min. If you can use the tagging thing. If I had a way of tagging instead of the post it. Then get the video and at the end when the manager said, can you summarise that just with the press of a button.

The majority of the participants found the combination of the video tagging and the customer journey beneficial and especially when it is combined with the UX curve, it turns into a time saviour tool. Two participants agree that video recording with interaction possibilities is more than sufficient. The same two participants suggested more specifically interactivity to connect the UX curve with the event happening on the video as very useful.

Video in combination with the customer journey to present:

a. The out of the ordinary occurrence or the repeated pattern.

b. The video segments of importance to illustrate the context, and

c. to make it possible to share with others

P6: If you can make this customer journey and this UX curve here and also you have videos to prove the single situations. It is a lot of work to do, but this tool can facilitate because if you do it by yourself, it is a lot of work.

P5: I think it does in a sense. Video recording with interaction possibilities with participants is, in most cases, more than you can ask for. What I don't see is how the added communication function would add any meaningful supplement here, same with the filtrating at the beginning. What I found a bit weird is the redundancy of this tool. I have linear progress on the top, and I have linear progress on the bottom. This tells me if something negative or something positive occurs, it even has the possibility of telling me how negative or how positive it is. This is not informative; what interests me is what happened here that is so great. What I expect to see is what I can get when I click on the event itself.

P6: If you can make this customer journey and this UX curve here and also you have videos to prove the single situations. It is a lot of work to do, but this tool can facilitate because if you do it by yourself, it is a lot of work.

P4: Customer Journey: I think it would have a benefit. I never tried to share it this way. When it comes out of the ordinary occurrence. There was an event that never happened before. It was only once. But it was important

If I can present the usual behaviour over time, or the repeated pattern, that would lead to the out of the ordinary occurrence.

Or even for the positive because you can compare, What happened before with what happened after.

P5: could certainly communicate a problem to my colleagues. If you want to communicate the whole journey, it is best to have a quick way to jump to corresponding video segments.

You can say look here look what has happened, now he is distracted doing this, and now that's what the problem is, and then you understand. So this is one of the best ways to illustrate the context. This UX to be the whole journey makes it very difficult to actually evaluate UX qualities as from the methodological point of view, but it is true, the more you know the whole thing, the better. Can even be small staff. The woman is getting in the vehicle with this disposition, nine times out of ten you are not going to use it, but it is good to have it.

P2: The system with the tagging of the time is very useful. It is a good way of sharing your findings or proving your findings. Makes it a lot easier to find things if you have a comment about minute 3.15 or 15 min within it, it makes it easy for you to find it and share it with other people to share their opinion. In terms of research, it is not redundant.

However, one participant mentioned that the way they need to present differs between industry and academia. Posters and customer journeys are presented in production, which makes this tool relevant, but data in papers are presented in academia, which would exclude.

P6: In academia, the goal is to present papers, in comparison to the industry where you always make presentations, PowerPoint presentations. Customer journey maps, big posters, huge ones. When it wasn't for the client, and it was only for us, then it was only post its and images on the wall.

A snapshot of the available data would be a useful addition to have for circulation reasons. A participant explicitly refers to the need for validation of his insights based on the video recordings and highlights ethical concerns about the circulating of the data outside of the team

P3: I suppose the only thing you can add another line of boxes, is the snapshot of the data. Each one of those would say 40 miles per hour, raining. Just a snapshot of what is going on, 8 am, this is coming from the vehicle. A snapshot of the circumstances like a scenario. It is what is going on for the driver. A very good way of indicating what is going on, on a single statistic. If you know, they are going to be on a highway. These are for your colleagues to communicate and maybe later generate.

P1: Me and 2 other people are working at project A then I cannot get hold of these people because they are busy at the moment. There is this urge for me to ask them what this person is doing there is he happy or is he sad. But I might not be able to do that. If I am designing something for a particular client and I want to ask a person outside the team, this is not possible, and this is a limitation for the quality of the result. This is an ethical thing, and I don't know the answer to this.

P1: A tool to support you in defining if there is a case. You are presenting something you think there is interest to other designers. Because if it is only you, you don't feel comfortable with the validity.

If we had a shared understanding of what is positive and negative, then it would help everybody. It would only become better if you show it to other people.

P1: I would prefer another pair of eyes to see the data. For example, sometimes I think someone is happy, and someone else may conclude that he is frustrated. I would like someone else, some assistance in order to help identify the problem space more efficient.

P1: Maybe with some background in psychology, but generally another pair of eyes to validate. If the people are in the same project and the participant is happy for the video to be analysed, then I can share the findings with colleagues.

The solution to this problem is proposed by another participant who suggests circulating solutions rather than raw data, actionable insights like video personas and scenarios rather than raw footage of videos. Even though, the same participant highlights that in an industrial setting is not only the fact that there are limitations to the people who have access to data but also to the people within the same team that is not trained to understand these data.

P2: If there are structured information instead of raw information. If they give me information like personas which are based on people. So you don't actually see the data you see the results. Showing a video of somebody doing something to people that are not trained to pick up certain some ques on their facial expression or their tone of voice. If they are not trained to pick up on that, they have different opinions. Customer journey: As a presentation method, I don't know, but as a tool that you might want to bring up discussion with other people. For example, if I had a timeline like this and I had the video attached to it, and I picked up one of those negative experiences, and I wanted to share it with my team, I might be getting different opinions based on that. If I am an expert and my colleagues are experts as well, you pick up on something you discuss it, and you come up with a conclusion. If I am and they aren't, it might be a conflict. If it's a formal presentation that nobody gives to you as a question. It is like information that I found this since I am an expert it would be helpful, but for discussion, unless everyone is going on training for facial expression analysis or voice analysis or whatever, I think it might not be very helpful because people are going to give their opinion instead of something scientific.

5.3.2. FACIAL EXPRESSIONS

Most of the automotive experts subscribe to the idea of real-time observation or facial expressions recognition in the car to support research and design.

They generally do not observe self-presentation concerns from participants since the participants forget the existence of a recording camera relatively fast.

However, they mention many

- Ethical concerns and
- Technical limitations

That they are aware of when applying these tools.

Overall, they are positive about the maturity of the technology.

The majority of our participants agree for the need for a front-facing camera to collect data of the driver and or the passengers. What the users might be doing, what are they looking on, and what their expressions are being reportedly valuable information. Almost half of the participants agree on the importance of the facial expressions in addition to the users' comments and the physical actions of the person to define the experience of the person.

P4: In some cases, this is not going to give me their facial expression. If that is what I am looking for. Whenever there are using the real mirror and situations like this, there is a thread for

commenting that you can comment just life. The good thing is that in the video, I will have the best possible angle when I want to know what the drivers do. I would probably do 2 cameras for each position.

P7: Maybe a camera to the driver to see what the driver is looking at, a from the point of view of the driver. Just to know what the driver has seen or could have seen in a special location.

P7: I think if I have the face, I could interpret the situation easier. I cannot see what the person is doing with his body but not with his mind. The facial expressions.

P6: There is a lot of ways to interpret the user feedback, or what you get out of it. If you don't see these facial expressions while he talks to you and see only the comments, you might lose a lot of important things from user experience evaluation.

P6: Depends on the quality of the system, if also the emotions are replayed in the correct way, for example, facial expressions. Because for the experience this may be enough, but the experience is a lot about expressions. That's why I need the facial expressions. It helps to empathise with the participants if there are only robots or representations might be a disadvantage. It also depends on what you want to find out. If you see the face of the user, you can really interpret it, what it means. With this emotion recognition system using a camera sometimes, they can't recognise what is there, and you need to see as well or know your participant.

A participant reports that even though the facial expression does not always reflect the state or the user, it is an indicator of something occurring and then with further investigation, you can extract valuable information. However, another participant completely disagrees that facial expressions by themselves cannot indicate an emotional state.

P5: Not being sure whether or not the facial expression adequately reflects the state they are in currently which you can't say other way or the other my facial expression does not always fully reflects the state they are in currently which you can't say either way or the other, my facial expression doesn't always reflect my inner state, but it is usually influenced by something, and If I can't identify that something this gives me good indicators, so for instance if I am in the vehicle looking outside like this, and that could be because I am annoyed with the vehicle, I am annoyed with the traffic or because the sun is shining into my face. If I can identify that the sun is shining to my face, then I already know. So I would say that given enough contextual information I should be possible within a good margin of error to identify where it comes from. You never do an observation and say, I will only look at their facial expression. I would say I wouldn't quite agree.

P2: I kind of disagree that facial expressions cannot tell what a person is feeling, simply because they give subconscious feelings in this case.

Avatars are distant from naturalistic understanding 86 and almost half of our participants agree that they might harm the professionals understanding of the situation since they do not appear as explicit or accurate data. Although a participant argues that they are less intrusive given that they are not raw video data. They would prefer real representation communication if the participants are willing to share such data. In any other case since the avatars have no proven adverse effect on the driving experience and while being he would subscribe to it as a technological intervention since it is an exciting idea and people may be more willing to share their data this way. Finally, two participants find the purpose of

interchanging among the two different technologies more appropriate for taking advantage of them according to the situation.

P1: It might have a negative effect on my understanding.

P7: Observation is valuable, but there should be trust in what the other person is observing. I don't think that an avatar could be that explicit or that accurate that I can build in the whole image. You can see what the person is doing inside the car, but you cannot connect it with the person you know in real life, there is not that much context.

P1: 'The way that they are observed is definitely less intrusive than looking at raw video data.'

P1: I am missing the accuracy of the footage.

I am thinking of some recent technologies that you can use.

I would be happy to choose the real representation if people were happy to provide me with this data.

P1: 'I don t think it would necessarily have a negative effect. It is an interesting idea that the passengers are represented as avatars.'

P2: Having the option between these two, it would be useful based on what you are trying to get out of your experiment. If this is about the feelings. If you need to know how people are feeling inside the car, you need their facial expression, but if you need to know the difference between what people put in the car and when. You need to know how often they use it. you don't need to see their facial expression.

P1: 'However, if they know that they are observed, and we have already this possible artefact of how this might change their behaviour, why not chat with them and ask them: Can I really look at you and not your avatar because in this case, it might make my life easier to get what you are really doing or achieving right there.'

P1: It is a different affordance than playing a game.

This affords privacy when this affords accuracy of what is happening there.

I would expect a higher update here because people will have higher participation.

But in the second we have higher quality data because they can observe the actuality.

More people can be signed to this idea because they are not worried about their anonymity.

Which data are you missing? I am missing more human-like behaviour. Cut off with this technology.

The majority of our participant explicitly report based on their experiences that users are forgetting about the cameras and the fact that they are being observed after a short amount of time. Almost half of the participants also agree that using the remote system would mitigate the self-presentation issues of the user when a physically present professional is in the car with them. Besides, the system gives the professional the ability not to intrude when the user does not feel comfortable interacting. Other participants don't find the more significant part of the intrusion of privacy in the physical presence of the professional but whether to have a camera or not inside the vehicle.

P6: For some people, they know that there is a video camera, and they behave normal, but for some, this might have a negative effect. It depends on the amount of incentive they get. The challenge here is that the users forget that there is a camera because whenever the user knows there is a camera, they will behave differently.

P4: Observing people while they are in the room with them. With the camera because they tend to forget about the camera.

P3: I think it would affect the drivers on the first day they can get used to it very quickly. It depends on the driver or the passengers. Maybe the driver can be more self-conscious than the passengers. The passengers might forget.

P2: I don't think observation would have a negative experience on the drivers of our cars. Based on my past experience, people forget about cameras. You can put a camera in a car you can tell people about it. On a journey that is going to last about an hour. They usually forget there are cameras in the car about 10 to 15 minutes max. The majority of people, I am not saying all of them, including myself. I have taken part in different trials or tests. There are cameras in the car recording me or what is happening outside the car. People forget about them and go back to their usual habits of what they would normally do. I don't think it would affect them.

P1: If you are limited by the availability of the people, then you can ask them to assess their experience when they are available and have this offline. This way, you can have a bit more participation from users.

Most of our participants are aware of the limitations of the technology. Two of them explain their concerns and the boundaries for this technology to be applied in scale. However, the majority of our participants agrees that the benefits of these technologies outweigh the limitations including privacy technological maturity and community of users and they are trying to come up with solutions to mitigate the privacy limitation.

P1: 'What might be an issue here is that awareness of knowing that you are observed, and that might change your behaviour and this might not give you a genuine understanding of what people may be doing." 'I struggle to find an alternative to that. I would definitely not be happy looking at videos where people wouldn't know that they are observed and have given their consent to that.' Of course, they might want to take account of privacy consents, like this person is talking about his family.

P2: 'My tendency would be to cross-check with them. I would use whatever technology is provided by the system. Of course, if they are willing to do so.'…. What I would do is to retrospectively go through the field, the videos with them and ask them if they are available of course.

P2: With the whole data protection, big organisations are going to be against it because potentially, there is a lot of personal data to be collected. It is going to be difficult to get big organisations behind it. Because a lot of the data that are useful for us are going to be personal data. Even if you get the face of the customer out of it. There is going to be a lot of data about where they go, how often they go where they stop, and this is going to be a large conversation. I am just talking about research. If you have only 3-4 customers, it is easy to manage. And it depends who has access to it. And it depends who has access to it. They are 3-4 people inside

the company who have access to it, that's fine this is going to be easy to manage. If there are 5-10 thousand and they have 300 people just for the research department, and it is going to be difficult who manages it and who has access to it. I guess there can be a dedicated team that you go to them and suggest they can give you the data or the result. In your consent form, you write that my name is not going to be mentioned. Then you can't traceback.

Some participants are building on the idea of the avatars and recommend more available road data as an alternative and a gamified platform to motivate people to take part and create a community of users. Almost half of the participants are mentioning the maturity of the technology in terms of how expensive it still but they are also highlighting the fact that the investment is not going to be lost in case of a technology failure since you can have the same research without the system just with more effort.

P4: Having an avatar, I wouldn't find it crucial. But this is also because I haven't worked with it.

I also can't imagine myself having a benefit other than the emotional attachment of keeping privacy.

P2: You cannot track people from an avatar or a 3d visualisation but you

If you track my car and you put a tracker in 3 other people In the research department. If you put it in front of my close friends at work, they can identify the person.

P1: 'Some alternative that might be more tolerant more public road data.'

P1: However, I would be happy to have avatars or voice alterations if this will make participants more willing to share their video and a fully eponymised video. There may be very valid reasons with that. If this makes them subscribe more to this idea.

P7: You could also search for drivers that are driving a lot, and you could connect them with a kind of gamification to motive the people for the most inspiration facts. In my opinion, this is serving better as a complains section because it depends also on the people. Some people like to support, and others don't. It depends on the people what the outcome is going to be, either it is more on the engineering side. Some people will willingly support you others would think, what is in for me if I have a good idea. I want some money for it.

P2: The incentive is not financial, I 've been to X company for 3.5 years, and there was only one test with financial reward. A lot of them wanted to take part in it because they are customers and want the system to get better or just contribute to the technology to get better and safer. As an example, Tesla is a massive platform for testing. People really want to be part of it.

P3: For a start, there is not a lot of it happening because it is very expensive. Unless you have someone to split, the screen of forward-facing drivers' faces drivers' hands. You would prefer more, but the most important is front-facing.

P2: Mostly technology. Because having a remote communication with a decent group of people that you can say what I found from my test is applicable to people.

P5: What should I do if the passenger doesn't give me consent. Either I say I can't do this study or I switch off the recording, perhaps asking questions. I wouldn't say that collecting videos and all the other location data are absolutely crucial. These technologies are not absolutely important. Or else what would I do if the technology wasn't available? If I can't do video

observation, I can do manual observation. It just needs more effort. It also what we like to do in smaller-scale studies.

5.3.3. INTERVIEWING TOOLS

The majority of the professionals agree that it is crucial to support the interviewing of participants and prefer to have a draft script when they do it with their users. The majority finds a lot of applications and advantages at the generated questions, given that you don't trick the users that it is a real person and that the technology is at a level of smooth and natural communication. The most significant disadvantage of the tool is the naturalness of the follow-up questions. Moreover, there are still some professionals that they are entirely negative in the idea of such a device.

Most of our participants find interviewing important for their work. Most of the participants believe that to get what the users need, you have to talk with them and that by only watching somebody you cannot infer what is going on in their minds. Besides, pre-structured interviewing is reported by almost half of our participants to be the one they use and recommend among the interviewing techniques.

P4: -Why do you find interviewing useful; do you think it would work in your case:

Yes definitely. First make an observation with a hypothesis then go and see how they are using it, go and ask.

P3: I like this contextual data, but you don't know what this is unless you talk to the passenger.

P1: I like the idea where you can engage with them real-time.

P7: More appreciated for the user will be communicating with the user orally, more efficient would be written communication. I think that the users prefer to call and the designer wants to minimize effort, and if you are about to think something else than call, then it is written. I think to get the real voice of the users; you need to talk to them because they might say something between the lines.

P1: 'I definitely agree with the statement that only by watching somebody you cannot really infer what exactly is going on in their minds. You can definitely make some assumptions and have the first idea about their expressiveness. My tendency would be to cross-check with them. I would use whatever technology is provided by the system.'

P5: The part for the interviewing is fine. I still need to ask them directed questions, whether they are driving or after driving. I think the insight is already captured. Also, I think typing staff is not the right way to go since operating in level 3 I need to be careful when I make requests for their mental driving mode; there might be a mental driving mode up until level 4. Might be a problem legally to implement something like this or you need to safeguard it.

P1: I suppose I would use this as a more streamlined process. To use the same questions. And the second for more targeted questions and more specific scope. I do consult to have an elementary script.

P6: I would also like to have something in advance because it is also embarrassing to talk to somebody and not really know what you are looking for and talking about. It is hard to formulate questions if you don't know what you really want to find out.

P5: What I said to our student employee is you have 2 choices, a. we are going to develop the questionnaire together because you need to know where the interview questions come from and how from the requirements you come up to the actual questions you need to know.

However, interviewing runs the risk of being held by non-trained professionals, and this can lead to many unwanted results. These include leading the answer when using leading questions, not being familiar with the script of the interview, not being able to identify the cultural differences of the users being interviewed, not knowing how to frame and ask the right questions, being a non-native speaker. Some other participants add personal skills, such as being a positive person and being an empathetic person.

P2: In terms of microphone, it makes it a little bit more difficult when you ask someone. This is not based on any research; this is based on my own personal experience when someone asks a direct question about a certain subject they already pushing me towards an answer. And this limits people in terms of what they are going to say.

P3: Not too worried about the self-image. You have to be interested in people and how they use technology. So I wouldn't delegate the questions to a younger person a real starter. You need experienced designers to work with the script.

P7: I worked in a project where we had participants from different countries, and they had different ideas of what it is to be helpful. So it is not about being a bad person.

P1: 'Participants of different cultures. A software that can accurately say how people are. How expressive a person is. Repetitive shows of videos and asked people to rate expressiveness. '

P2: When they give you an answer, you might have a whole set of a different answer. You need someone who knows how to ask he won't mess up with the script.

P1: 'For example, you look overly agitated, or you seem happy. Are you experiencing this happiness? I would prompt them on how they feel. If I ask them if they are agitated then maybe they feel even more agitated.'

P1: I would be inclined to use it if I would use it as a non-native speaker. If I was using a method, I am not familiar with like contextual inquiry; this would help me. Use open-ended instead of closed-ended questions. I would like to switch between both

P2: If it goes back to me having a good day or having a bad day. If I am having a good day and I am happier asking a question, the participants will keep going and will give you more information which might help to get the answer to get. The answers you want as opposed to I really don't want to talk to this guy. How do you feel about the radio? Yeah, it was all right, it was ok, and then if you are happy with the conversation, you can say the radio was ok, but this can be improved. If I am going through this and I am a positive person you can get more info, but then you run the risk of going off-script.

P1: Text to speech cannot do that in terms of emotional affect and staff. You can ask the question compassionately; you can ask the question abruptly. I have perceptions about my voice and my pronunciation. I don't know who exactly might be affected. A masculine or feminine voice might affect people and how they respond. I would think you can adjust the presentation to the way the participants are behaving. For example, if they are well dressed, you can present a similar character to gain their trust in communication

Some participants mentioned some limitations that are mitigated with the pre-recorded questions tool provided in the system. The tone of voice and the level of how friendly and honest the conversation can appear relies solely on the mood of the professional when asking the questions, which is something that can be reasonably standard when the issues are pre-recorded. Asking the questions right is also something mitigated when a professional

interviewer pre-records them. Another advantage is 'inclusive design' and including people with special needs. Furthermore, consistency and replicability of the questions avoiding bias. Finally, supporting designers/researchers who are not very talkative.

P7: My self-presentation will totally affect my communication with the user if the user doesn't know me. The kind of these voices, you need to clarify that to the user, if that is a recorded voice or a computer voice. Not to trick the user to gaining trust.

P2: It's a good start. I think the one thing that is missing is a hierarchy kind of chart. If you go with opinion/ value questions. You klick there is a response. After a while, you know what kind of response you can have a follow-up question which can be one of these. If they are not happy with the system, you can recommend this question next. And then you will have after a certain amount of time to get the data and machine learning and AI., then you can have people who have no training, and they can use it and go through it and get what they want.

P1: If I was a junior UX designer, it would be really helpful. If I was more experienced, I would bypass them. Either a learning tool. They might want to use the other function for people who have hard hearing or people with special needs.

P1: I think that it is good for the (different) personas. I remember this guy doesn't like to talk to people very much; this will help the language and pronunciation barrier that people might have. I think it is a fair idea since I am facing the same problem.

Being able to set follow up questions and the communication naturalness of the tool are the only disadvantages being reported by the participants. Two participants criticised the tool negatively based on the naturalness of the communication, and the limitation of the pre-structured follow up questions.

P2: The disadvantage is that you cannot ask to follow up questions on top of that that are off the script. And sometimes people will give better information if you ask a follow-up question that it might not be there.

P7: I think this would be really new to the average people and it depends strongly on the way you do it. If the voice is not sympathetic and if the voice sounds like a computer and if it is not communicated fluently.

P3: If you go back and ask the question and then the passenger comes back and asks oh really, what sorts of things? You won't have an answer to that. The second seems all right. It is just like the lady to inform you have been in an accident. For a moment, you don't realize is not a real person.

I would prefer you to do it in person to be more genuine. Or even if the researcher watches the video, and then they ask them, even if it passed the moment it is more genuine than this. To do it properly and be more genuine, you need to do it in person.

P3: I am not so sure about pre-recorded questions because it doesn't sound so genuine. Being talked by a computer, they would quite quickly realize. I would be rather worried about that. I would rather do it live.

P5: Let's say you couldn't understand the problem. I would say, can you repeat that. And in the same way, you need to really get into what the participant is saying; you can't make blanket statements after everything they said. Apart from flattering the participant

P5: Unless the biggest fear of self-presentation is the language. Like Jan part of his fears are his pronunciation, so I think this would help him. For me to choose this as an option would mean that these questions are such that I know that I would need these questions and only these questions. If I need any other questions, I need to ask whoever recorded the questions or add

them myself. I require for me to be the only one who does this. This is a better option for me than just ask someone from my team help me, which I think will very rarely occur.

Unless you are super experienced, and you have prepared a tone of questions where you have prepared a follow-up. In each case, the pre-recorded will be slightly worse than the alternative.

5.3.4. PATTERNS OF BEHAVIOUR

Ux professionals found the pattern identification tool very promising, given that it saves them valuable time, and it can help them in targeting specific characteristics. The possibility of generalising their findings with a tool like that is welcome even though the tool itself raises some concerns like

- Informing the user about his behaviour
- Having accurate results coming from the tool
- Running the risk of over-reeling to the system and using only the suggested patterns.

Two individuals find interest in Episodic Patterns of behaviour for a specific journey, and they also highlight the fact that when we are looking at a particular pattern of behaviour that occurred during an episode, we could identify previous events that could have triggered this pattern of behaviour. Another participant emphasised that patterns of behaviour are beneficial for Longitudinal studies to evaluate experience over time, especially when smaller occurrences are happening that they are not significant if not many in size. Our participants agreed on the importance of such a tool, especially when having to deal with Big Data; the tool would save a lot of their time. Since we have many data, the difficulty in analysing them would qualify this tool of pattern recognition valuable support for them. Even though two participants expressed their need in setting triggers of interest themselves, another participant would prefer this to be automated using AI. One of the individuals also referenced similar tools for big data to match the behaviour of a driver with pre-existing patterns fed into archetypical personas of use.

P5: It is going to be a one and a half hours drive, give me a pattern when this occurs, if it is not a false positive, wait until the conversation is finished then call them and ask them that

P4: In a week or two weeks from now if you find an issue. You find something that you would like, and you want more of.

P4: Let us say these two are both negative experiences, but let us say that the event that came before led to that negative experience.

A time lime of events and compare the timelines and see if there was a previous event that led to that negative experience.

P4: It depends on the study. If you are trying a new interface of any short or something you are trying to. Yes, I think it would be helpful (if the system understands that a pattern occurs, that something is happening). Especially over longer studies, especially when there are smaller behaviours happening.

If it was over a longer period of time, maybe it wasn't good.

P3: You are not going to watch one week of video, so the automation pointing out some patterns. When the car is travelling over 70 miles/h maybe log that and present.

P2: It would be useful to have triggers if I could set them instead of having pre-defined triggers.

P3: It would be useful if you had some artificial intelligence to make sense of the events. I would add the face video. I would exclude the ab; it is unhelpful data.

P1: This reminds me of the travellers needs a survey. They establish something that it is an agent idea that you describe here, which is different types of drivers in that case. They were the dependent passengers the petrolheads etc. How people use cars. Based on what people reported. A way to establish agents is AI when you have big Data.

Three participants expressed their concerns about the findings of the specific tool and explained the way that a pattern could be generalised to more users when fulfilling two main factors. The results should be based on a sample size that represents the company's users to define that this is a general rule and the fact that they wouldn't trust the accuracy of the data if they weren't subjective.

P1: We might want to relate it with local agents taken from surveys and big exercises of asking people where they fit in the pattern effectively this might be by generalisation.

Because when I think of generalising, I think about it from an experimental point of view. To perform an experiment and you do it neutrally and explain it very openly so that you can reproduce it. In this way, its more reproducible or generalisable but maybe this is a different idea here.

P2: You are always running the risk of having too specific

Which you might have 500 people using it, and you can set the criteria applied to one person and might not be applicable to anybody else. As long as me as a researcher or whoever is using the system are careful not to do that and don't over-specify, I think it would be useful.

If you set of the criteria and you get 100 people fit into that group yes you can say we thought it would be a small group, but it is a fifth of our participants, so it is significant.

P1: 'That would definitely help me , but it has to be a very subjective kind of pattern. If there was a pattern that would say that the person is happy, I , wouldn't trust it. I would need more objective pattern. It would actually help me of not going through hours and hours of video to find something manually.'

P7: If more than one has the same characteristics, then it helps us to define that this is a general rule.

Ok, I have a significance, the same number of this group and this group can be connected to this specific characteristic. You generalise only based on one characteristic, But I would focus on the size of the characteristic.

One participant is worried about the dangers of professionals over-rely on automation and losing expert knowledge. Finally, a participant was particularly critical about the immediateness of the pattern identification and questions that will be asked to the users following the pattern identification.

P6: I think identifying a pattern is useful. I see the danger that the designers would stick then to the suggestions and the expert knowledge might be lost.

P5: A pattern of behaviour you put it something and then you think what I am going to do about it. Am I going to tell the guy, hey I just did identify that you exhibit this pattern of behaviour, is this when there are dangerous patterns of behaviour, and I want him to stop?

Honestly, I don't know. I can imagine that it works well if you ask them and they give you a better and more detail answer because they remember it. On the other hand, as soon as I call them,

I disrupt this pattern; I create an artificial environment by my calling them. Even though there is no physical presence, it is going to take their physical attention away from whatever they are doing.

So at that point, I am not in that pattern anymore. What I can do is ask them questions about what the pattern was immediately before that. There have to be some cases that I need what I am looking for, and they have to be cases with pretty good accuracy. When one of these triggers pops up, I need to verify that this is one of these situations, and I need to call him and ask him immediately. Because otherwise, I could also do it afterwards. If my system is good enough to identify each instance in which my driver tries to communicate with the taxi driver, I would be interested in such a trigger.

6. CHAPTER SIX: DISCUSSION

This chapter discusses the outcomes of our research, considering the different sides of our participants' perspective, which support or contradict previous literature in automotive UX design and remote communication. We discuss the implications of these findings and propose actionable insights and concrete design solutions to our problem. We further highlight unexpected outcomes and explain our results, commenting on previous interpretations of relevant work. We start our discussion with a comparative review of the results of our two iterations, and we describe the final system UX goals and tools. We discuss five UX goals by merging or excluding two out of the initial seven UX goals. This reduction is a result of the second iteration and their lack of importance for the automotive UX practitioners based on their identified needs. UX goals including supporting the context, reducing intrusion into people's lives, operating even when the problem is ill-defined, avoiding the anxiety of self-presentation, fluency and empathy in communication, and supporting the feeling of intelligent interactivity. Later we extensively discuss the methods we used to solve our problem and refer to previous research practices in relevant problems informing the state-of-the-art methods in participatory design. Finally, we discuss essential findings concerning remote design, trust and privacy and highlight their relevance to other domains.

6.1. SUPPORTING CONTEXTUAL UNDERSTANDING

In user research, the two main activities are observing and interviewing participants (as seen in Figure 28). User experience researchers are interested in accurate information about people, their tasks, and their needs, and, since interviews are not always accurate, observation can have greater value. Observation of human behaviour is an essential element of most user-research, including usability testing, contextual inquiry, naturalistic observation, shadowing, covert observation, and participant observation. The main differences between these methods are the location of the observation, the amount of interaction with participants, the proximity to the participant, and the participants' knowledge of being observed (Ross 2018). To achieve unobtrusive results, practitioners use a variety of tools (Six, 2017). Furthermore, in UX research and design, UX researchers need to share their inspiration material, data or insights using synchronous or asynchronous communication tools. Sketches and discussion of the ideas

can be supported using a combination of tools such as Google Drive or InVision and Skype or Zoom. The simplest solution is to ask team members to sketch on their own, then take photos of their sketches and share them on Google Drive or InVision, so everyone can see them while discussing the problem via Skype or Zoom. To understand the problem of interviewing or communicating orally, a variety of Web conferencing tools, including WebEx, GoToMeeting, and Zoom, can support UX designers. Finally, screen sharing is more effective than any shared drawing tool. Just as UX designers come from a variety of backgrounds, they like a variety of different tools that they use when designing user experiences.

Figure 28: Remote automotive UX systems support in UX research and design by observing; interacting with synchronous or asynchronous data concerning the context of the car; and communicating in real-time with the passengers or the drivers.

Automotive researchers use remote observation techniques initially applied in the mobile phone domain since similar systems in the automotive domain are not fully developed to the extent that supports both UX research and design. Previous researchers (Wilfinger *et al.*, 2013) introduced toolkits that use Android smartphones to offer a low-cost, manufacturer-independent and scalable in-car agile prototyping and research environment. CarDaT (Car Data Toolkit) enables researchers to gather data on human behaviour and designers to create novel context-aware interface solutions remotely by combining available remote data, smartphone sensor data and other car generated data. Even though these toolkits are not part of a complete system proposition which also supports interviewing, as a fundamental part of user research, they can still support or even replace observation and the identification of behavioural patterns of drivers or passengers. Only a few attempts have been made to extend previous remote systems, foreshadowed by Carter et al. (Carter et al. 2007), by providing real-time video and automotive data with the ability of designers to directly interact with a driver through speech and in-car interfaces. WoZ Way (Martelaro & Ju 2017), for example, allows designers to watch the real-time driving experience via high-fidelity video and audio, and also simultaneously receive meta-data about the drive. The designer can also ask questions by using a text-to-speech messaging system or remotely triggering custom in-car screen and electromechanical interfaces.

Previous research in contextual systems design (Bauer and Dey, 2016) highlights that system designers need to be aware of the relevant combinations and characteristics of context

before they apply an intelligent system in the real world. In our study, many practitioners expressed an interest in data that would indicate the skills of the driver, such as keeping the speed limit and keeping the lane. The same data have been previously collected in studies that are concerned about the safety of drivers and their primary and secondary activities with new technology in the vehicle (Liu & Wen, 2004; Sodnik *et al.*, 2008; Weinberg et al., 2011). The practitioners additionally collect some standard usability data about the interaction of the user with the system, including the task completion time, the steps that are required to reach a specific function, and the frequency of use. We conclude that UX designers in the automotive domain are mostly involved in safety studies and are still limited to the human factors and usability understanding of the experience collecting 'instrumental' measures including speed, steering, street-finding task, and task timing. The nature of their studies might be the reason why most Automotive UX practitioners suggest the need for validating their insights on observed emotions using physiological measures, including facial expressions, eye tracking, and tone of voice. Paradoxically, we do not find many studies that explore the non-instrumental needs of drivers even though they identify emotions as something vital to the experience.

Supporting the contextual understanding in the car is a need that was also previously highlighted by Meschtscherjakov et al. (2011). The social context of the vehicle and the dynamic character of mobility add to the complexity of the in-vehicle context. The social norms and relations among the passengers are different in the vehicle context than when in a public environment. Also, the car is moving to change location, and as a result, the context and the driving behaviour can be influenced by triggers coming from the external environment (sunny/rainy, city/countryside, a road with traffic/a quiet alley). Building Empathy and Rapport as a need here differs from being able to build it when in a public environment, such as a train or even a library. We previously explained that different individuals, or even the same individual at a different time, may experience technology in entirely different ways, and that is not easy to capture in rationalist models. Rationalist models abstract in a way that excludes particular circumstances, perhaps the very conditions that turn out in practice to be most salient (McCarthy, 2004).

The majority of our participants agreed that the video is critical to their understanding of the context. Moreover, the 360-degree video (See Figure 29) was reported in our data as a very effective medium to disseminate a large amount of information about passengers' behaviour and their interaction within the car. Video footage, therefore, helps identify the in-vehicle situation holistically. In both of our prototype evaluations, the UXers think that a holistic design result is also one of their primary considerations. The majority of our participants prefer a deeper understanding of the situation choosing holism versus reductionism and contextual data to design for the new automotive experiences. Previous research describes how 360-degree video and Virtual Reality (VR) technology can be a tool to evaluate UX (Rebelo *et al.*, 2012). Robelo et al. argue that VR can be used in two ways. Firstly, to gather insights on the users' needs and expectations. In this case, the users' behaviour is evaluated during the interaction with products and/or environments with accurate control. Secondly, on UX evaluation with the use of user-centred design (UCD) approach. In this case, the users' emotional reactions and/or behavioural responses are evaluated in controlled VEs. They also highlight that the main advantage of using VR is that it offers the means to monitor the interaction, adequately contextualised while granting ecological validity. Some of the most significant drawbacks of the technology are the ethical considerations which are influencing the decision of the media selected, and the quality of the audio that comes with the 360-degree video technology. It is essential to highlight that participants express their interest in the audio recording of a conversation for analysing the content to extract usability related insights. The ethical considerations of the 360 video technology are based on the same argument that

would exclude any sensor or technology tracking sensitive data. Even though the professionals explain that participants forget about the existence of a camera very fast, the ethical considerations are still a drawback for the adaptation of these technologies by the industry.

Even though many participants expressed concerns about the location tracking data of the system, most of the participants agreed that the data provided by the system supported them in identifying the users' situation. Some of the participants found some of the tools redundant and some of the data not crucial for their needs. Although they find location tracking interesting as a source, they highlight that they had never followed the location of their participants in their studies. When that was necessary, they would instead ask them retrospectively. Two of our participants explicitly referred to the external environment data and the external 360-degree camera as a tool that has no use in their research and design. It is essential to understand what the context is for the automotive UX designers and since the majority of the automotive UXers are reluctant in using location as the context for privacy reasons this will affect the design of a system that supports contextual understanding of the in-vehicle interactions. As we highlight in our review of previous work (chapter 2.2.1), previous research in context-awareness in mobile computing is focusing on location (Hazas, Scott and Krumm, 2004). Schmidt et al. (2000) discuss some examples of context-aware systems some of which are using radio frequency (RF) and global positioning system (GPS) to determine the users' location, while others described by Schilit et al. (Schilit, Adams and Want, 1994) adapt according to the location of use, the collection of nearby people, hosts, and accessible devices, as well as to changes to such things over time. A system with these capabilities can

examine the computing environment and react to changes to the environment (Schilit, Adams and Want, 1994). Schmidt et al. (2000) regard

Figure 29: Contextual data provided to the UX designers to support the mapping of the situation.

situational context, such as location, surrounding environment or state of the device, as implicit input to an interactive system. They are using the term "situational context" to describe implicit interaction fragments. In line with Schmidt et al. (2000), the interactions in the vehicle can be characterised as direct, explicit interactions from the user (e.g., a user manually indicates current context parameters such as time pressure, psychophysiological state, availability, and current interest in certain types of information) or indirect implicit interactions based on the situational context (e.g., automatic data monitoring, HCI monitoring, and sensor-based perception). Based on this model we identify that the fact that automotive designers are interested in the location of the drivers (Figure 29), but they cannot have their implicit interactions based on situational context using sensors or monitoring because of privacy means that the drivers have to indicate these parameters including location, availability, and current

interest manually. Explicitly specifying context hands the user a sense of control over the system and provides contextual data that may not be otherwise available. However, a system that relies too much on specific context will put a heavier workload on the participants (the drivers/passengers are the participants on our system) as they must provide a more substantial amount of information to the system, requiring a more complex user interface and a more

significant number of manipulations which may interfere with the user's ability to focus on their primary tasks which can also distort the driving experience itself by applying our system. Conversely, a system that emphasises implicit context frees the participants from tedious data input operations, but requires the system to monitor data and perform reasoning to infer contextual information. This requires a significant a priori effort to develop compelling user state and contextual classification models. As we can see in previous work, other researchers (Fridman, 2018) are using implicit context to determine many activities in the vehicle and support in building effective, enjoyable, and safe autonomous vehicles. Fridman (2018) previously used computer vision to detect driver glance region, cognitive load activity, hand, and body position. Furthermore, location tracking is already used in many applications of handheld devices to make our everyday life more comfortable. As a result, users are used to sharing their location data to take advantage of many affordances. Even though cars in 2019 are using many sensors, automotive designers are still very concerned about the privacy of location data of the vehicle and their passengers.

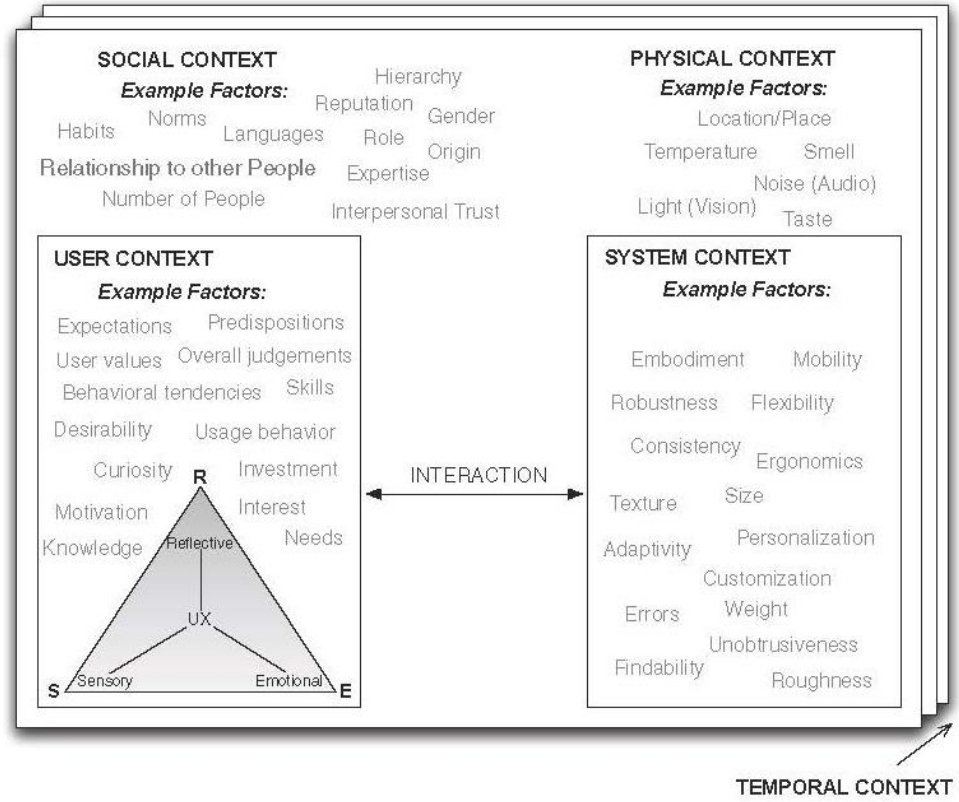


Figure 30: Contextual User experience figure. Context characteristics for vehicle experiences (Roto 2006)

Design in context seeks to overcome the problems identified in traditional ethnography such as time scales, lack of structure in the work model and usability of the ethnographic record as a design document. Previous work of Christian Doppler Laboratory on contextual interfaces (Grill *et al.*, 2010) defined UX as 'the user's sensory, emotional and reflective response to the interaction with a system in context'. The context here refers to the interrelated conditions in which something exists or occurs. They agreed with the context definition of Roto (2006) and applied their context characteristics in vehicle research and design including user context, social context, physical context, system and temporal context as we can see in Figure 30.

Traditional ethnography is useful to understand how people incorporate things into their daily life, how people interact with products and services in their lives and to map the authentic

behaviour. Observing people in the real world is particularly useful in the early stages of a project, as you can gain deep insight into the scope of the problem and the context in which it exists. Learning about what is going on can help you create realistic rather than idealised products/services. It also helps in understanding the emotional values people connect to in your product or service. Although ethnography is very well respected in the HCI field, user-centred, participatory design and co-design methods, by involving people in the design allow designers to both take advantage of ad-hoc solutions developed by individuals and refine them into products or to identify problems that users have assumed unfixable.

In some cases, an observation may not be enough, and as a result, the role of users in the design process is changing in HCI and Psychology. As we have previously explained a conversation with users about products in their possession that they 'love' or 'hate' reveals that emotional connections to products can be related as much to the giver of the product as the product itself (Thomas and McDonagh, 2013). In consequence, maybe empathy is "our intuitive ability to identify with other people's thoughts, and feelings – their motivations, emotional and mental models, values, priorities, preferences, and inner conflicts" (Thomas and McDonagh, 2013) but communication is the design component that unveils the actual situation for which designers design.

Furthermore, methods, which involve users in various enacting activities, are vital to the design of artefacts, because patterns of behaviour, attitudes and personal motivations on the part of users are notable factors in shaping the design and use of artefacts and gain access to more than the observable (see figure 8). Consequently by using our methods and projecting our findings to the new context categories of Roto et al. (2011) which is based on the model (See Figure 31) of Jumisko-Pyykkö & Vainio (2010) we can come to conclusions about what our participants perceive as a useful contextual characteristic to support them in identifying and mapping the in-vehicle experience. We describe them below:

Firstly, the majority of our participants were positive about the tools of the system that provide them with relevant information about the task context. Task context is essential to the automotive UX designers since they were particularly interested in the tasks of the drivers and the passengers, and the surrounding tasks concerning the user's interaction in the vehicle. They also wanted to validate their insights with supportive technology, to collect physiological measures, including facial expressions, eye tracking to monitor where they are looking at when performing the tasks, and tone of voice to relate with emotions that would help them validate al their central UX insights. Task context is also associated with the demands of the entire situation upon one's attention. The automotive UXers criticise the 'car events' tool as beneficial since what they need to know is if a critical condition happened. Our participants also find helpful any context for usability evaluation as part of UX, including the use of the system, how long it takes, how many steps and or how often it is used. A participant explicitly referred to the value of audio data to capture social dialogues concerning usability issues during the interaction. Previous studies have identified the need for physical and system-related data and advanced tools, including CarDaT (Wilfinger *et al.*, 2013) to support the design of user experiences in the vehicle. CarDaT combines smartphone sensor data with data sources like OBD-II as well as other readily available remote data (e.g., weather). This data and the provided connectivity enable researchers to gather data on human behaviour and designers to create novel context-aware interface solutions.

Even though most of the participants agreed that the data provided by the system could support them identifying the users' physical context, some of them found some of the tools redundant and some of the data not crucial for their needs and giving considerably less

attention to physical context than task context. The majority of the participants agreed that the video is critical to their understanding of the physical and social context highlighting the need for a view of the front of the participant and that will be strategically placed to capture as much of the environment as possible. However, almost half of the participants surprisingly expressed their concerns about the location tracking data and their value in their work. Even though it can be valuable, they highlight that they had never tracked the location of their participants in their studies; instead, they would ask them retrospectively when necessary. The UXers also unexpectedly find the external environment contextual data redundant, and they explicitly refer to the external 360-degree camera as a tool that has no use in their research and design work.

Only a few of our participants were interested in capturing the social context of the interaction in the vehicle as defined by Roto et al. (2011). This finding describes that the majority of the participants focused their attention to other contextual elements than the other persons' presence in the vehicle, their characteristics and roles, the interpersonal interactions and the surrounding culture that influence the user's (drivers) interaction with our interactive system. The few participants who are interested in the social context, are mostly interested in how the user (driver/passenger) behaves when sharing the vehicle space with others in the car. The participants were not interested in drivers interacting with technology but rather to the human to human interaction in the vehicle. For example, there are many events in our life that we share the in-vehicle space with other passengers, including friends and family. These events were of interest to our participants. In this case, the addition of the 360-degree camera was reported by a participant as a very effective medium to disseminate information about passengers' behaviour and their social or private interactions within the vehicle. The difference between the UX designers from the first iteration and the automotive UX designers from the second iteration is that the UX designers, describing their need for long-term understanding of the users' experience, mentioned the temporal context many times.

The fact that most automotive UXers are interested in the task context could be because most of the current automotive UX practitioners are interested in the factors that can distract the driver from the primary task (driving) and lead them to a harmful situation of dangerous driving behaviour. The difference with this traditional approach concerning safety and the safe driving experience is that in autonomous vehicles, the attention is not on the current main task, which is driving but shifted to the secondary tasks. The question here is whether the contextual needs of automotive UXers will remain the same on an autonomous vehicle or will they turn towards social and temporal context that the currently overlook. The main reason that automotive UXers ignore location as part of the physical context at the moment is not because of autonomy, but because of privacy issues. UX Designers cannot use the location of the car as context if the driver does not give consent, and even in the case of full permission, the technologies used to communicate these data should be secure so that they will not be bridged.

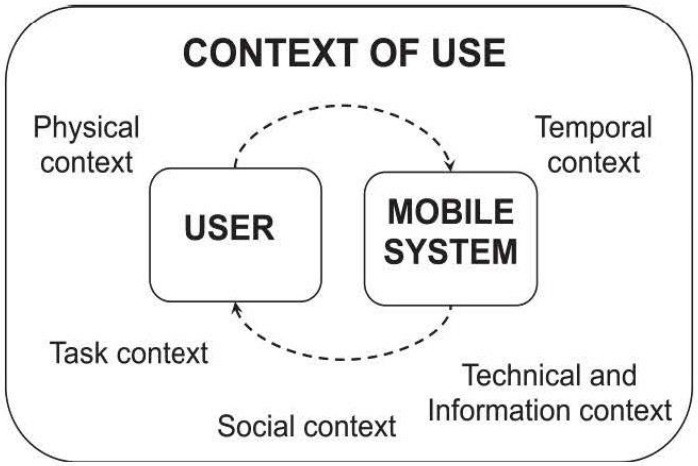


Figure 31: Context of Use in Mobile Human-Computer Interaction (CoU-MHCI) framework (a simplified version of Jumisko-Pyykkö & Vainio (2010))

Dealing with mobility anywhere, anytime is a concern of our participants and one, which we tried to address through some tools. Our two iterations of design and evaluation helped us describe and implement the most relevant and supportive tools based on the participants' needs. We explain video observation and real-time tagging tools in the following section.

6.1.1. VIDEO AND TAGGING TOOLS

Our participants agree on the value of interactive tagging of the real-time video recording of the in-vehicle experience to indicate the possibility of a happening or an about to happen phenomenon. The tagged video could be used either to support a design argument or to recall a situation in the vehicle in data analysis. It was reported to save time and effort of the design process. Interactivity was also proposed to enhance this tool. A function that saves the video of each tag, 5 seconds before and 5 seconds after, would be useful to add some more contextual information to the situation happening (Figure 32). Participants suggested that this way, the tool could serve as a video post-it tool which was described as an interactive video where you could add keyframes the moment something is happening and illustrate it with a post-it note. Also, the fact that these videos can be used to be included in an interactive customer journey and presented to colleges makes it an even more attractive to the automotive UX practitioners' tool. Video in combination with the customer journey was suggested to be used to display the out of the ordinary occurrence or a repeated pattern, the video segments of importance being used to illustrate the context and to share insights with others. Here we can highlight the success of the tool (Figure 32) since the pattern identification, and contextual mapping is the original reason why we implemented it based on the UX goal of supporting the understanding of contextual data effectively. Even though most UXers found the tool very useful for their work, there are two limitations to this tool and practitioners highlight them.

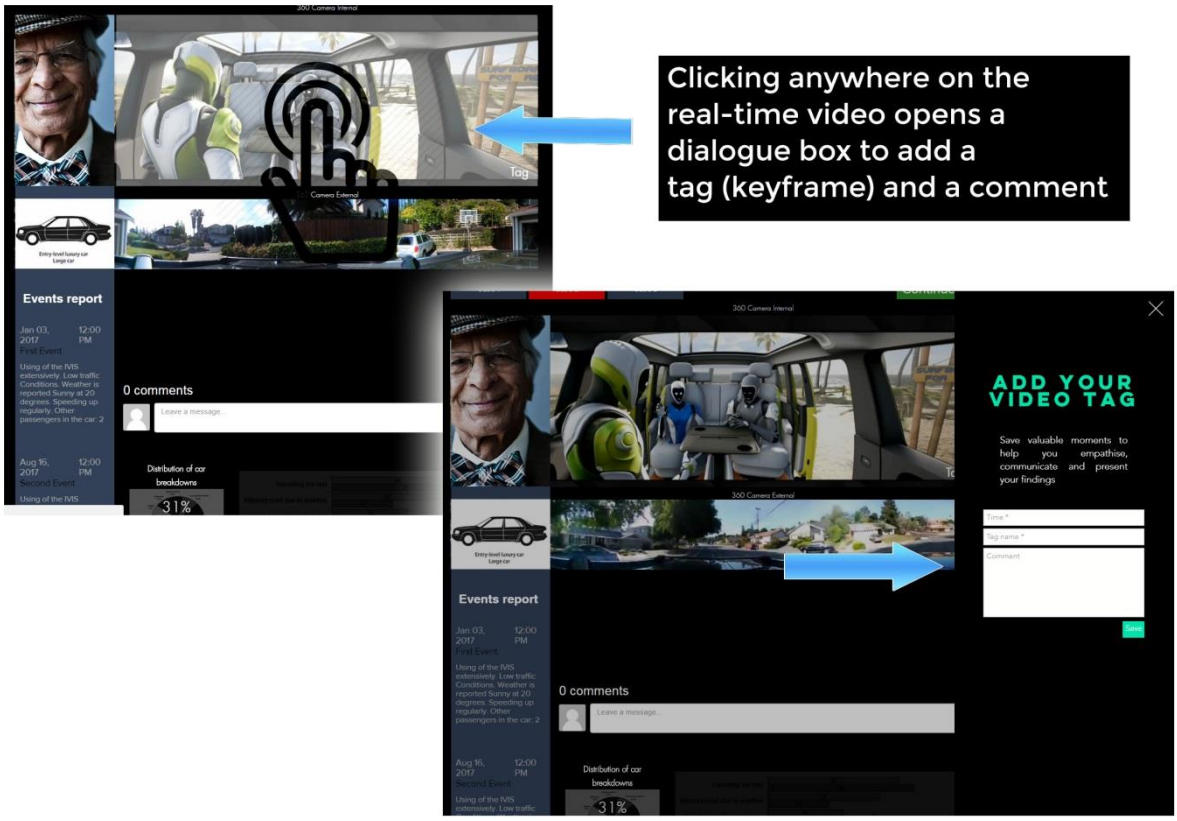


Figure 32: Interactive tagging tool. It supports in saving a possible phenomenon or an occurrence identified on the real-time video, momentarily to recommend UX design interventions.

Firstly, the circulation and presentation of data and the ethical limitations of circulating the video data to colleges who are not part of the team. An automotive UXer explicitly refers to the need of validation of his insights based on the video recordings and highlights ethical concerns about the circulating of the data outside of the team when an expert opinion of a different discipline is necessary. As the practitioners described it, the approvals for the ethics are only for one group, and the deliverables are expected to be already in the form of an artefact and not of collected data. Circulating raw data to anyone outside of the team would be against the privacy standards of the automotive companies, and therefore the group is limited to the expertise of the members of the team and not of external partners.

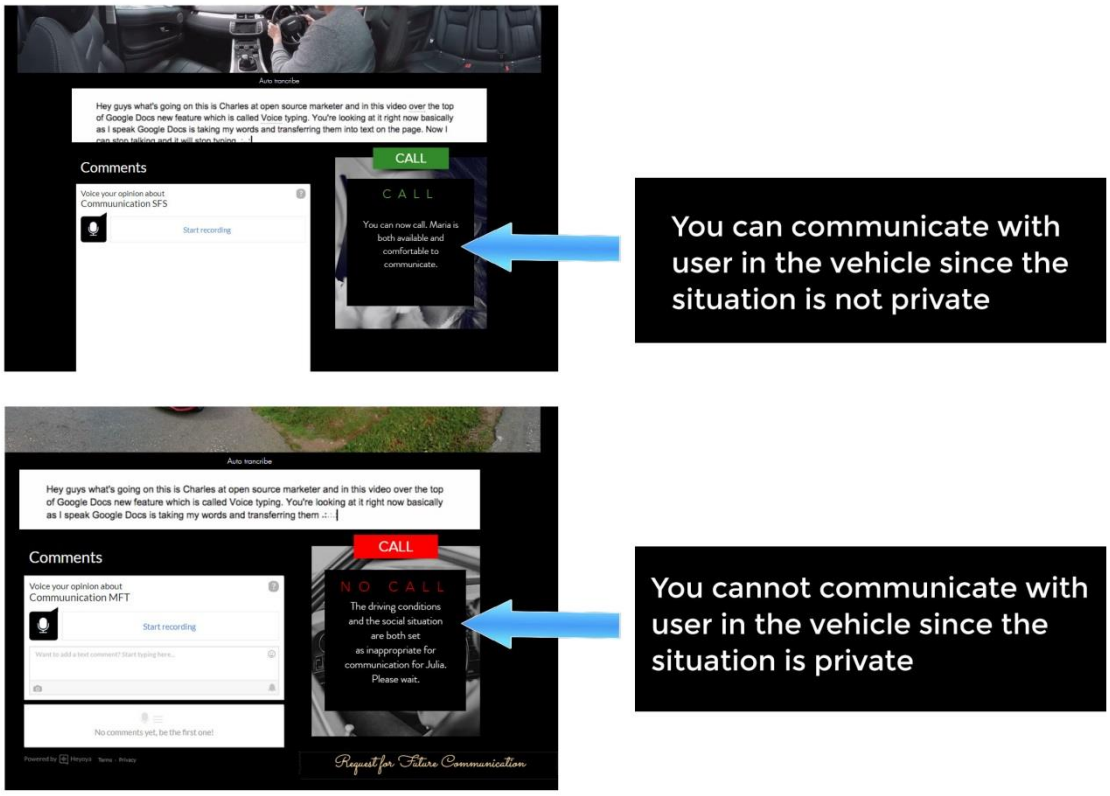
Secondly, observation and identification of a phenomenon or patterns of behaviour is a skill that needs to be acquired by the members of the UX team. Designers and psychologists have been trained in the past in empathising and identifying the behaviour, non-verbal cues and emotions and translating them into design results. Computer scientists and engineers though are not likely to be trained with the skillset for emotional recognition or empathising. In this case, they would either need individual training/guidance or supportive technologies to confirm their findings before feeling comfortable into proceeding on a design result. Some of the practitioners proposed solutions, for making circulating possible, that we include in our design, such as videos with avatars instead of users, but no answer could be offered for the observation skills other than 'training' or 'work only to be assigned to experts.' Finally, the video is covering the need of most UXers for context identification, but the physiological measure was also reported as a need mostly by the automotive UXers, as we will analyse below.

6.2. REDUCING INTRUSION INTO PEOPLE'S LIVES

One of the most important considerations that the UX designers raised was that of monitoring people. On the contrary, the majority of the automotive UX practitioners subscribe to the idea of real-time observation or facial expressions recognition in the car to support research and design. The automotive designers report based on their experiences that they do not observe self-presentation concerns from participants since the participants forget the existence of a recording camera too fast. The only reasons why these technologies are not implemented on a large scale are the technical limitations of applying expensive technology and ethical constraints.

Based on the data collected in the first iteration, UX designers would avoid monitoring facial expressions, tracking the eyes or use other technologies to collect physiological measures. UX Designers did not trust the effectiveness of using face tracking technologies, emotion recognition, and psychophysiological techniques, due to technical and ethical considerations, including privacy and safety. Conversely, the majority of the automotive UX designers agreed for the need for a front-facing camera to collect data of the driver and the passengers. Almost half of the automotive UXers agreed on the importance of the facial expressions in addition to the users' comments and the physical actions of the person to define the experience. Also, our first data analysis showed us that the majority of the designers are not primarily interested in momentary emotions and agree with the notion that it is the long term user experience that matters (Roto, 2007). Therefore, mediums, including video and audio for observation, empathy building, and communication, are perceived as more effective and less intrusive forms of interaction. Contrary to this line of thought on our second iteration with automotive UXers it is proposed that even though the facial expression does not always reflect the state or the user, it is an indicator of something occurring and then with further investigation, users can extract valuable information.

Figure 33: Privacy call wall. Implicit and explicit context to inform the availability of the user and prevent the UX designer being intrusive in private situations.



Preventing intrusion by blocking any communication with the user when the situation is set as demanding by the system, or when the user has set the situation as private (Figure 33) had a positive response by the UXers recognising the importance of such tool. As previously explained, the tool could use either implicit or explicit context to set the situation to private and inform the automotive UX designer.

Even though in the first iteration, technologies such as avatars, which can mitigate the privacy issues, were described as promising, they were criticised as distant from naturalistic understanding by the automotive UXers. According to Media Naturalness theory (MNT) (Kock, 2005) using modes of communication that veer away from natural communication is likely to put an extra burden on the brain as our brain has been designed for that type of communication. Almost half of the automotive practitioners agreed that avatars might harm their understanding of the situation since they do not appear as explicit or accurate data, although they are less intrusive. Alternatives to the 'alien-like,' as characterised by the participants, avatars were recommended. We recommended high definition anthropomorphic avatars replicating human behaviour in the vehicle for that reason (Figure 34). Some automotive practitioners are building on the idea of the avatars, and recommend more available road data as an alternative and a gamified platform to motivate people in taking part and create a community of users. Our participant proposed the idea of interchanging among the two different technologies as more appropriate for taking advantage of the situation since avatars have no proven negative effect on the driving experience and since more people may be willing to share their data this way. Overall, they are positive about the maturity of the technology. It is worth highlighting recent efforts to use an avatar as a medium called "invisible-to-visible" (i2V) introduced at CES 2019 by Nissan.

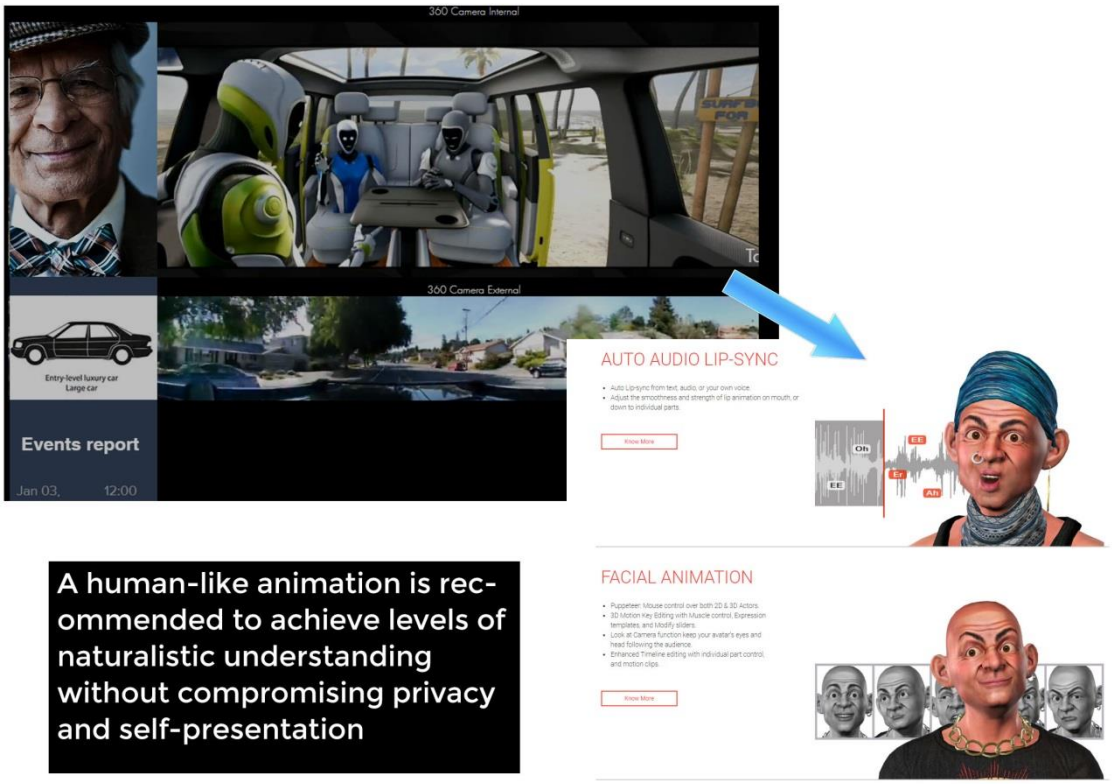


Figure 34: Human-like avatars instead of 'alienated' avatars to achieve a naturalistic real-time result.

6.3. OPERATE EVEN WHEN THE PROBLEM IS ILL DEFINED

Automotive UX designers expressed their concern about the lack of exploratory studies and described that many companies do not prefer exploratory studies that need active participation in context since they are not many companies who have the resources to proceed. On the contrary, there are many situations with a set target group of users, car category, and the characteristics of the users. Only a few previous studies and workshops are exploring the in-vehicles' interactions in context with the most recent of them exploring autonomous vehicles (Pettersson & Ju, 2017; Martelaro & Ju, 2017; Jordan, B., Wasson, C. and Roth-Lobo, 2015; Eckoldt et al., 2013).

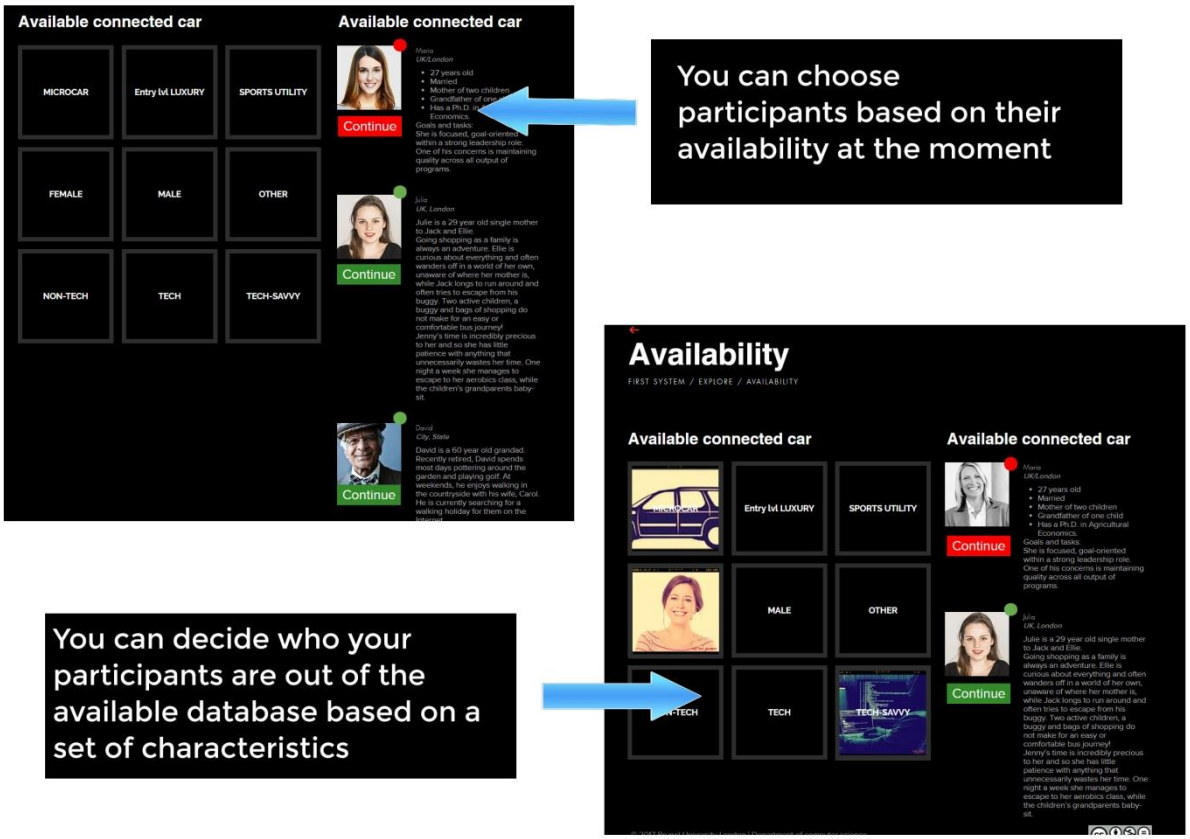


Figure 35: Tool to support exploratory studies without a pre-structured target group and problem space.

The majority of our participants reported that they use interviews and surveys as their primary methods of eliciting information from users. They are using standard UX scales for the evaluation of the experience in the car such as Attrakdiff[1], Panas[2], and UEQ[3]. They elicit the feelings associated with driving and automated tasks and measure distraction momentarily or after the interaction with the systems. They express the usefulness of task analysis using detailed examples, and they refer to their needs of measuring and evaluating task completion and times of use of a specific feature in the car. We suggested exploratory studies in our system introducing tools that let the UX designer navigate through different users with different characteristics, and decide on the target group based on a database of users (See Figure 35).

The automotive UX designers expressed a negative criticism over the value of a group of UX methods that were previously suggested by other UX designers in the first iteration. The majority of our participants in the second study referred to a specific tool used in our system incorporating these methods as ineffective and agreed to exclude it from our design. The participants highlighted the differences between academia and industry, and they explained why they base their design decisions on the form of the result which differs in academia and the industry. For example, posters and customer journeys are presented in the automotive industry, which makes this tool relevant, but in academia, they would exclude that and would present raw data.

6.4. AVOID ANXIETY ABOUT SELF-PRESENTATION, FLUENCY AND EMPATHY IN COMMUNICATION

Automotive UXers find interviewing important for their work, arguing that they cannot rely only on observation. A semi-structured interviewing method was reported as the one UXers use and recommend among the interviewing techniques. The majority of automotive UXers would prefer to have a draft script to ask the questions. On both iterations, the UX practitioners described the communication limitations and their need for a natural, transparent and socially present communication to mitigate the feelings of mistrust to them and the system by the passengers/drivers. The automotive UXers think that the insights will be more in-depth when the users feel more relaxed. As a result, they would prefer a more informal and natural communication. The UXers prefered a naturalistic communication, and even though they like the idea of automated questions generated by the system, they would prefer to be able to communicate and not have to 'lie' to the driver/passenger, pretending that they are the ones asking the questions. The majority finds a lot of applications and advantages for the generated questions because you do not 'lie' to the users and also the technology is at a level of fluent and natural communication. The most significant disadvantage of having an automated questions tool is reported to be the naturalness of the follow-up questions, and there are still some professionals that are negative in the idea of such a tool.

[1] http://attrakdiff.de/index-en.html
[2] https://onlinelibrary.wiley.com/doi/pdf/10.1348/0144665031752934
[3] https://www.ueq-online.org/

However, interviewing manually runs the risk of being held by non-trained professionals in interviewing because teams in automotive UX include engineers and computer scientists, and this can lead to many unwanted results. These include leading the answer when using leading questions, not being familiar with the script of the interview, not being able to identify the cultural differences of the users being interviewed, not knowing how to frame and ask the right questions, and being a non-native speaker. Some UXers even include personal skills such as being a positive person and an empathetic person. Also, some other limitations that can be mitigated using the automated questions instead of asking manually, including the tone of voice and how friendly and honest the question is for the driver, relies solely on the mood of the professional when asking the questions, which is something that can be standard when the questions are pre-recorded. Pre-recorded questions are also characterised for their consistency and replicability avoiding the bias of each UXer asking the questions, and are described as supportive to designers/researchers who are not very talkative.

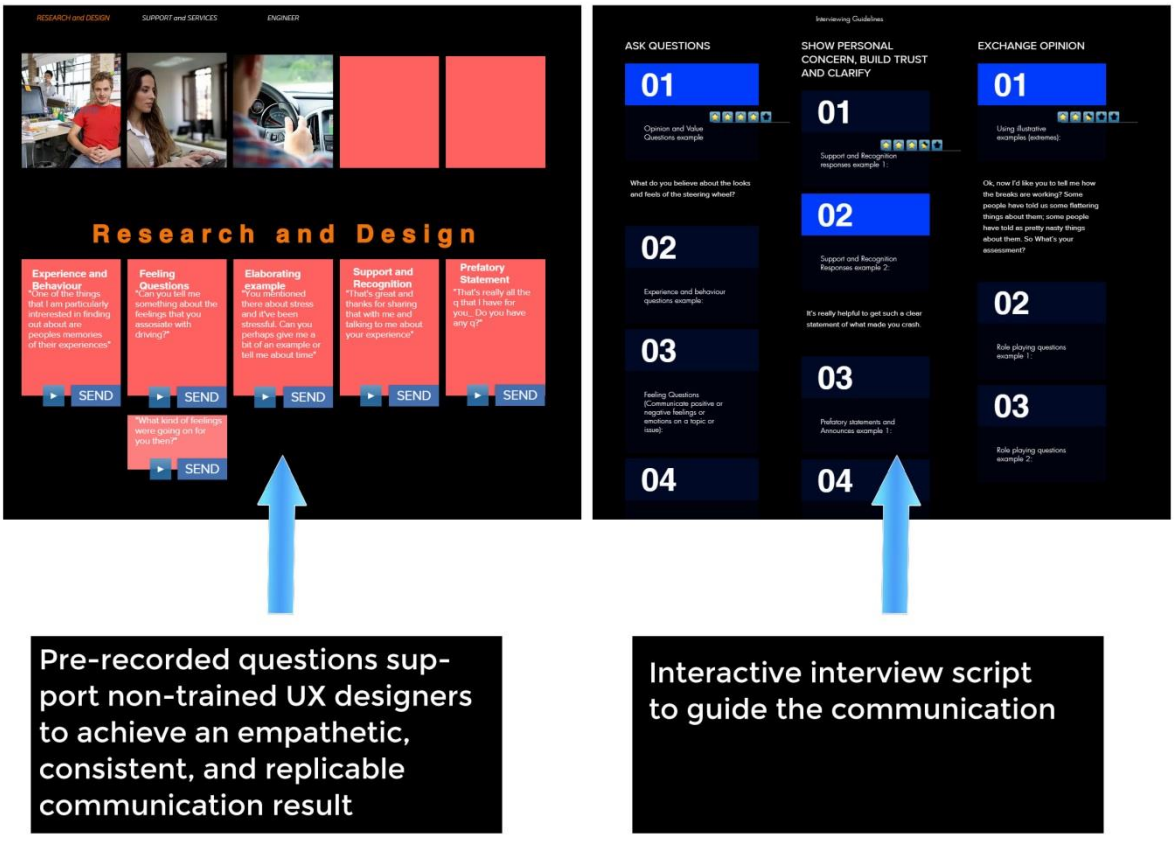


Figure 36: Interactive interviewing tool. It supports various communication activities that are necessary for UX research and design.

The introduction of these tools (Figure 36) can drive the path towards the design of UX design specific conversational In-Vehicle Dialogue Systems. However, these systems typically do not have much dialogue capability and, in most cases, focus on single-turn question-answers (Q&A), and straightforward actions, which based on our results is something important in building rapport and trust (see also Weng et al. 2016). As a contrast, text-based chatbots from Facebook, Google, and others make use of dialogue technologies in automating services via Messenger, bypassing the dependency on speech technology. Besides their current limitations according to Weng et al. (2016) future, voice-enabled in-vehicle assistance technologies will be influenced by increased automation in driving, with independent sensing and artificial intelligence capabilities and the increased vehicle connectivity to online IPAs, with driving-related services enhanced by traffic infrastructure and sensor advancement. In

many commercial web applications, artificial intelligence is used to provide help and navigation services to users via chatbots. Chatbots, including Eliza (Weizenbaum 1966), are using a Rogerian psychology interview model in which the psychiatrist is drawing the patient out by reflecting the patient's statements at them. Even more advanced chatbots can use deep-learning to train on databases of movie dialogues or Twitter conversations.

6.5. FEELING OF INTELLIGENT INTERACTIVITY

Our results indicate that in both iterations, the designer's goals are to achieve a deeper understanding of the situation and map insights on feelings and long-term behavioural patterns. To accomplish this goal, UX professionals found the pattern identification tool of our system an auspicious addition because it saves them valuable time and it can help them in targeting specific characteristics of users (Figure 37). The possibility of generalising their findings with a tool like that is welcome even though the tool itself raised some concerns. The concerns include, informing the user about his behaviour can change the users behaviour, whether the results provided by the tool are accurate is vital, and running the risk of having professionals who will over-rely to the system and use only the suggested patterns resulting in losing expert knowledge.

When having to deal with Big Data, our participants agreed that a pattern identification tool would save them a lot of their time. Since we have many data, the difficulty in analysing them would qualify this tool of pattern recognition as a valuable support for them. For example, when UXers are interested in identifying episodic patterns of behaviour for a specific journey they highlight that looking at a pattern of behaviour that occurred during an episode and can locate previous events that could have triggered this pattern of behaviour. Some UXers expressed their need in choosing the triggers of interest themselves to

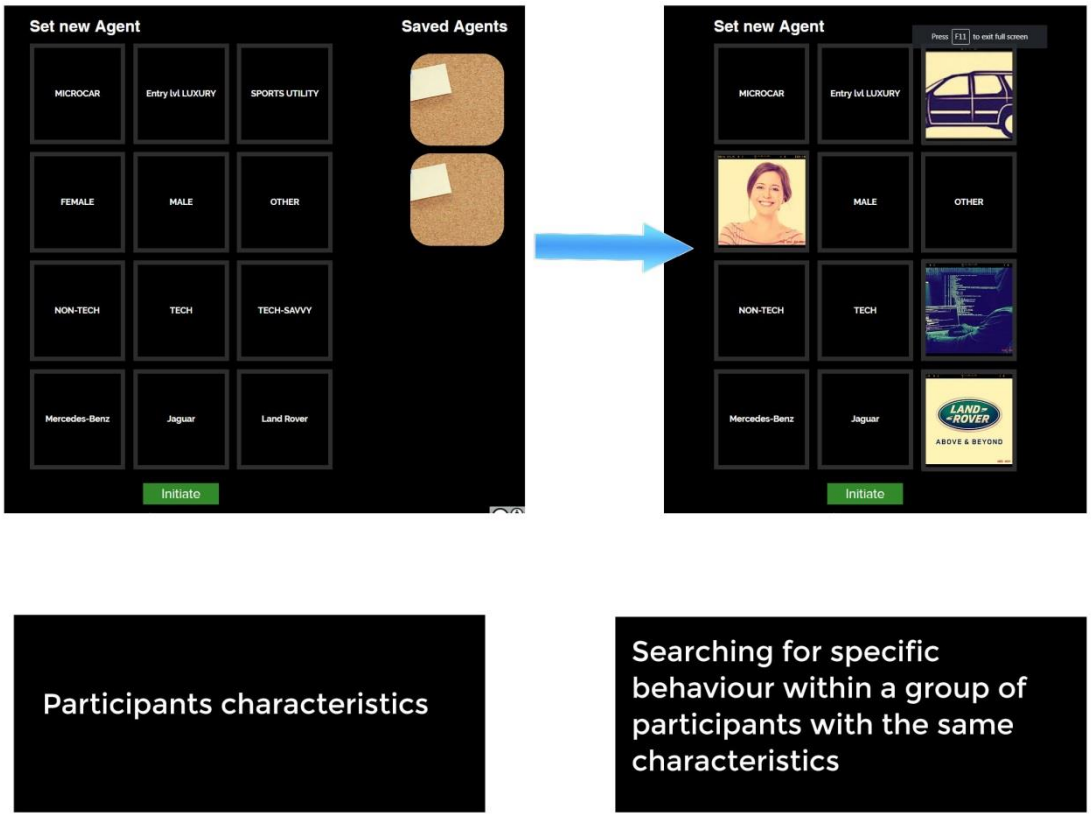


Figure 37: Exploration of the target group based on participants' characteristics

find out if there is an occurrence, while others would prefer this pattern identification to be automated using AI. Patterns of behaviour can be beneficial also for longitudinal studies to evaluate experience over time, especially when smaller occurrences are happening that they are not significant if not many in size.

Many participants have also expressed their concerns about the tool and the possibility of generalising the findings offered. They suggest that the findings can only be generalised when the sample size of the participants represents the customers of the company to argue that what is observed is a general rule. There were also concerns on the immediateness of identifying the pattern and asking the questions following the pattern identification. How efficiently can the UX designer proceed to an interview when a pattern occurs is a question left unanswered.

6.6. METHODS IN PARTICIPATORY DESIGN

Participatory design methods occur from generalisations of empirically-based experiences on how to conduct Participatory Design. In participatory design, a method is not a protocol, but it provides general guidelines that must be carefully selected, adapted and appropriated to the specific project and situation at hand. Thus the Participatory Design method concept should be interpreted broadly as a 'methodology' or 'meta-method' as a set of principles of a method which in any particular situation has to be reduced to a method uniquely suitable to that particular situation' (Checkland 1981, pp 161f). In the past we can see examples of participatory design methods including ethnographic, contextual inquiry, envisioning future solutions, card games, semi-structured conferences, collaborative prototyping, translators, storyboard prototyping, video prototyping, theatre for work impact, mock-ups, co-development, low-tech prototyping, and customisation (Muller and Kuhn, 1993). Methods in the participatory design include guidelines in terms of tools, techniques, and principals. The guidelines are recommendations for how to carry out the design process. For participatory design methods, this typically includes, 1) which type of users to include, 2) how to involve users in core activities, and 3) how to resolve conflicting views on the functionality and/or form of the products (Simonsen & Robertson 2013, pp 119). Since the contribution of the later was extensively covered by our previous section on UX goals and tools, the additional contribution of our study presented in this section is the guidelines on how to carry out iterative design research using participatory design activities.

According to Visser *et al.*, (2005), the researchers are applying these methods to generate the questions and not to ask the questions themselves. This way, in contrast to conventional methods of user research, including questionnaires, these methods lead the researcher to directions that he or she is not in control with the aim of identifying the blind spots. These methods are problem framing and solving methods and supported us in collecting many valuable data in this study. Applying these methods, which lay a relatively high degree of initiative with the respondents, it was possible to find out tacit and latent knowledge about people's experience as Sanders & Dandavate (1999) had previously described.

UX design in Automotive as in HCI, in general, is interested in the inspiration design and evaluation of the lived in-vehicle experiences of drivers and passengers but are mostly limited in traditional methods to conduct research and design. Previously many researchers highlighted the need for a new way of designing for experiences. One of the reasons for this need is that UX designers are given the task of designing for semi-autonomous or autonomous vehicles without having users in a real context. The design science paradigm has its roots in engineering and the 'sciences of the artificial' (Simon, 1996). It is fundamentally a problem-

solving paradigm. Natural science research methods are appropriate for the study of existing and emerging phenomena; however, they are insufficient for the study of "wicked organisational problems," (Rittel and Webber, 1973) the type of problems that require creative novel and innovative solutions. Since self-driving cars are still not operational for civilian applications in most countries designers and researchers can only deploy generative techniques (Karlsson and Pettersson, 2015), methods of enactment (Pettersson and Ju, 2017), Wizard-of-Oz method (Meschtscherjakov *et al.*, 2016), participatory prototyping workshops (Tasoudis and Perry, 2018a), learning from other domains (Meschtscherjakov *et al.*, 2018), create design fictions of future scenarios (Sadeghian Borojeni *et al.*, 2019).

With generative techniques, participants are asked how their imagined journeys with the self-driving cars would be like. As a result, qualitative data are generated in terms of the user's collages, drawings and narratives. Both enactment and generative techniques point towards possible ways of probing into the future without time taking and expensive prototypes. In Wizard-of-Oz methods, Wizard-of-Oz autonomous vehicles are designed to simulate the autonomous driving experience, and participants are asked to participate in sketching, conceptualising prototyping, and activities that address constraints and potentials of autonomous driving. Our study argues that in automotive participatory prototyping can considerably support the development of new novel UX design solutions using tailored toolkits to the automotive to actively involve users in prototyping their desired interactions with autonomous cars and their interactive systems. As we describe in our research, the workshops do not aim at the design of a low or high fidelity prototype but to gain access into explicit, observable, tacit and latent needs of the participants through the design activities. We are learning from other domains where automation is already established, including Aviation, by incorporating relevant guidelines to the automotive. Finally envisioning scenarios of potential futures involves automotive UX researchers, designers and practitioners from different disciplines, cultures, sectors, communities, and backgrounds to envision the potential of autonomous vehicles. Participatory prototyping can include non-experts in the specific domain but experts in another domain to share expertise and transfer knowledge by innovating. However, designing for autonomous vehicle experiences isolated by the real-life user context is a task that falls into a concept of designing for memorable experiences and staging events and interactions. Many methods in the past tried to capture the user experience, but any attempt to isolate this experience from real-life events makes the user experience design irrelevant. Co-creative design and Participatory prototyping are methods, which can, in comparison to other methods, actively involve real users in real-life settings to design for experiences in the lived context.

Research focus has moved from the memorability of the staged events to a concept that is no longer selling memorable experiences, but to a construct that lets the customer live all the moments of the relationship with the company in an excellent way, even beyond their expectations (LaSalle & Britton, 2003). Furthermore, Prahalad & Ramaswamy (2004) propose the customers-company co-creation of unique experiences. Their paradigm suggests that companies provide artefacts and contexts that are conducive of experiences and which can be adequately employed by consumers to co-create their own unique, experiences. More recently, Ramaswamy & Gouillart (2010) argue that many enterprises may not be comfortable with the co-creative design. In their book, they describe that the designers in firms like to focus on an endpoint when designing a product a service a system or any other engagement platform. They argue that co-creative design, in contrast, starts with people who are seeking experiences that are meaningful and they desire. They argue that people often cannot articulate beforehand what these experiences are, because they have, by definition, never "experienced" them. People typically discover what is meaningful to them through

visualisation and dialogue. Thus, the enterprise must give them tools that help them on these fronts (and thereby help the enterprise). The future design of the engagement platform will need to incorporate both the "lived" experiences of participants and their imaginative skills, stimulated by the tools and knowledge provided by company designers. In co-creative design, the company designer and co-creator interact collaboratively and creatively in two-sided fashion (through transparency, dialogue, and access) in contrast to the conventional sequential back-and-forth of design testing and feedback.

6.6.1. NON-EXPERT PARTICIPANTS

We propose an approach in which including a different type of users, based on their domain expertise, in various iterations played an essential role in the innovative character of our results. In our study, we recruited UX designers/researchers that are not qualified as experts in the automotive domain in the first iteration and UX designers/researchers that are eligible as automotive domain experts. We recommend this approach on fields that previous work shows that are traditional in their practices. We support the idea of not fixating on preconceived views of what are the right methods and tools based on opinions of the Domain experts but also recruiting non-domain experts to be able to identify insights of the state of the art of practice and project them into the domain-specific needs. To achieve a state-of-the-art result and an innovative outcome, we wanted to avoid traditional thinking, or recreate existing, or obsolete solutions since the system itself aims to provide support not only to expert users such as automotive UX designers but also to general UX designers. Our conversations with designers inside the automotive industry suggest that the industry is exceptionally traditional regarding the methods and tools used to design and evaluate interactions in comparison to other domains. This is also emphasised on our second iteration findings which report that automotive domain experts criticise a specific tool used in our system based on a group of methods used by non-automotive UX designers and they discuss the lack of exploratory investigations in automotive.

An issue with the participatory design is the long-term perspective that may be required in some projects to come up with a solution that reaches into the future. In some domains, a participatory design result may indeed need participants who can envision more radical transformations of our daily lives (Bratteteig and Wagner, 2016). Moreover, the people who use a product now will not necessarily be the ones who will use the product in the future. This tendency needs consideration when selecting the pool of participants for a study (Visser et al. 2005, pp 125). Previous research highlights that we need to push more for 'vanguards' and 'early movers' among people rather than for representativity and most significant common denominator arguments to achieve robust IT systems (Bødker and Zander, 2015). As a result, it is recommended to proceed to this recruitment technique but only when the domain experts exhibit a lack of innovation in initial conversations or when previous literature emphasises on this lack of innovation.

Furthermore, recruiting participants from various domains instead of a particular interest group can widen your pool of participants but requires more effort and different tools to involve and engage them in participatory design activities of a different domain. In our study, we placed the artefacts created with non-expert users in context later in our second iteration of design and evaluation. This second iteration included the comparison of the knowledge previously provided by non-expert users with the situational expertise of domain experts. We recommend this practice when, as previously mentioned, the domain experts are mainly traditional on their practices, and an innovative result cannot be based on their current

practice. However, a critique of the innovative artefact based on the contextual limitations in the second iteration is why the domain experts need to be involved.

6.6.2. ACTIVELY INVOLVING NON-EXPERTS

Previously we explained why involving non-expert participants is essential; furthermore, we also recommend a guideline on how to actively involve participants that are not domain experts in core activities. Part of our participatory design activities is 'educating' the participants about the domain. Generative tools (as we describe in Chapter 2.2.) are also used to help untrained users (non-designers) to imagine and express their ideas about how they prefer to live, work and play in the future (Sanders and Stappers, 2008) using sensitising material which is handed to the participants before the sessions. The materials and the process we are using in this study are tailored to educate the participants in the technologies of the specific domain and support them in co-designing a solution using relevant state of the art technologies. On the contrary, the process of designing our material and processes as a technique can be applied to any other domain with equivalent actionable results since it does not rely on the domain. The techniques typically explain how to carry specific activities as part of a method (Simonsen and Robertson, 2013a). Traditional user study techniques, such as interviews, observations and focus groups, uncover explicit and observable knowledge about contexts. Sanders (1992) introduced 'generative techniques' to fill the gap of gaining knowledge about what people know, feel and dream. The use of these projective techniques provides a view to revealing future states of people. These techniques can reveal tacit knowledge and expose potential needs. Tacit knowledge is the knowledge that people can act upon, but cannot readily express in words. Latent needs are those that people are not yet aware of, and demands that become realised in the future. In our study, we are inspired by previous work applying techniques that require the participants to construct artefacts, including generative tools, cultural probes or context-mapping techniques, so that we plan and execute participatory prototyping workshops and co-design the artefact with the users.

Most participatory design techniques include a toolkit designed to support the user in the creation of the artefact. For example, cultural probes (Gaver, Dunne and Pacenti, 1999) are small packages containing material for expressive exercises, such as cameras, pictures, collage words and colour pencils, which researchers sent to people instead of questionnaires. They include small exercises for the participants, which are then given to the designers as sources of inspiration. In generative tools, as in probes, respondents are sent workbooks with little exercises in preparation of a group session. Context mapping also uses a sensitising package consisting of short activities to prepare participants to access their experiences. More interactive techniques, such as workshops, card-sets, persona displays can be used to enhance the design team's understanding for, and empathy with users and they follow right after the sensitising step. Bringing these interactive techniques at the forefront of the design process while excluding the sensitising step was a strategic decision for this study. We do not argue against the importance of sensitising, but when it comes to envisioning and designing future systems that do not exist at present we need to generate new knowledge, and not only to confirm (or disconfirm) existing knowledge which derives by the current experiences (Stappers, Sleeswijk Visser and Keller, 2003). This needs, in our opinion, to be an artefact created in collaboration with the designer/researcher who facilitates the exploration of the research space. The researcher, in this case, is using the artefact as a means, not to answer precisely framed questions, but in the case that generating the questions themselves is part of the technique of co-designing the artefact. The practice of co-design has become commonplace in participatory design practices wherein participants and designers/researchers work together

to envision environments for future use in various situations (Maceli and Monica, 2016). Co-design activities are also known as co-operative prototyping.

In contrast to traditional prototyping, the co-design techniques not only provide a prototype that conveys requirements but also allows users to experiment with different work scenarios, thereby learning for themselves how the available technology can best support their work. The available technology and the design task scenarios can be communicated even to non-experts by the preparation of a toolkit to use in the participatory activities. Thus we designed a toolkit tailored to the needs of the automotive design context to succeed in involving non-expert users in the design process. Even though we try to apply participatory design approaches as early as possible in the design process, we recommend that the primary tools designed to be used in the participatory design process are carefully selected based on previous literature in the state of the art research and technology of the chosen domain.

6.6.3. THE TOOLKIT

The toolkit we designed succeeded into actively involving participants and proved to be very useful not only to the design of the artefact (the low fidelity prototype of the system) but also to our understanding of the methods that the participants want to use, the needs that they want to fulfil, and the ways they are willing to meet them. Tools are real instruments supporting the techniques. According to Sanders & Stappers (2008), "*Users can become part of the design team as 'expert of their experiences,' but for them to take on this role, they must be given appropriate tools for expressing themselves.*" *Collages* (Sanders, 2000), paper prototypes, artistic toolkits, games, low-tech prototypes (Bødker et al., 1993) and questionable concepts (Vines, Blythe, Lindsay, *et al.*, 2012) are some of the tools that researchers previously used to support their techniques. Our toolkit could be described as a set of technology surrogates illustrated in paper to be used in a collage. Ultimately the collage represents a low fidelity prototype (wireframe) of the working system. To build mock-ups, wireframes, diagrams, and flowcharts, UX designers use software solutions including 'Axure' and 'Justinmind prototyping'. They need to drag and drop elements from the software's built-in libraries. They can also use their library of elements. After they drag and drop items, they can then customise them using fills, gradients, line styles, and text formatting. As we described earlier, the participants were provided with three blank printed papers resembling the three primary screens of the interaction and a library of available technologies and interactions printed in paper format (cards of low-fidelity paper illustrations).

We designed the toolkit to help the participants get informed about the available technologies that they can use, and gave them the possibility to make their combinations exploring the design space. The cards were easy to move and re-arranged and did not limit the participants to decide where to place them in the final wireframe. The participants were also allowed to make changes to the size of the card by marking the area they would like it to occupy on the empty wireframe printed screen. The post-it notes and colour markers proved valuable when participants wanted to add a design element to the wireframe or explain an interaction. The fact that the participants were designers lead to a rich wireframe design and helped the design process of this study.

This toolkit also helped us, the researchers, in three ways. Firstly the content of the wireframe collage is anchored in what people know and thus can contribute to our knowledge about their needs, desires and how they want to fulfil them. For example, participants would not use specific technology for their wireframe if they know that it will not work for them from experience, and they would also explain their decision. They would place the paper surrogates

in a way that pleases their interaction intuitively and would explain the reason for their decision providing us with the knowledge that we would have missed if we only had a set of pre-structured questions based on literature. Secondly, in line with previous research (Sanders & Dandavate, 1999; Sanders, 2000) we also found that collage techniques work better for non-designer than for designers because the latter make collages which 'speak for themselves,' whereas the former give elaborate explanations of the reasons behind their collage. As a result, the participants are pro-active in explaining their design, and that makes it easier for the researcher to collect data and generate new knowledge. Finally, the toolkit in presenting both information and inspiration, to give freedom of interpretation and provide direction, to stimulate ideation and argumentation for the next iteration. The second iteration involved automotive UX researchers and designers and not all designers are skilful researchers, nor do they have time to analyse the data. Even though we have interpreted the data in our first iteration, analysis reports tend to provide generalising, abstract conclusions in which much richness of the data is lost. Moreover, research results are often formulated for a research audience, not for a design audience. The toolkit helped us reporting on actionable insights and towards the development of the artefact.

7. CHAPTER SEVEN: CONCLUSION

7.1. OVERVIEW

The purpose of this study was to examine the previous work in UX design in the era of driving automation, to determine the goals of the UX designers who want to design for in-vehicle interactive systems, and to apply the right methods to develop a remote design system to support UX activities informing both theory and practice.

In this study, we have defined the needs and UX goals of UX designers when designing in-vehicle experiences. We compared the results of the first iteration with the second iteration needs and UX goals of automotive UX designers and the limitations they face when designing and evaluating in context using different methods and tools. After two iterations of design and evaluation using participatory design and co-design activities, informing the design of our system and providing a critique of our design decisions based on our participants, we produce both formative and summative results.

7.2. SUMMARISE FINDINGS

In this study, we answer to our research question "how can a Remote Participation System support, context-aware, in-situ, participatory design in automotive?" by designing and evaluating our interactive system and reporting on the artefacts. Answering this research question in this study based on our findings is a design task that requires shaping artefacts and events as Boland & Collopy (2004) previously described. Therefore, we asked the domain experts to criticise the novelty and innovativeness of our artefacts by involving them in participatory design activities. As a result, our research is extending the boundaries of current scientific knowledge, addressing essential problems in remote UX design systems informing theory and practice with our findings. Following our pragmatic epistemology approach, we explored implications including the participants' motivation to use the supportive technologies, the detailed interactivity of the system, and the system's architecture, allowing us to translate participants' (UX designers) needs into UX design goals that serve as actionable insights for the development of a relevant system-solution. We conclude on the design of a functional prototype of our system and a pragmatic interpretation of our findings to inform the design of such systems and answer our research question.

Some of our results on how can remote participatory system support, context-aware in-situ, UX design in automotive include functional prototype designs. The prototypes support the contextual understanding of the in-vehicle situation, reducing the intrusion of passengers in the vehicle, designing even in an ill-defined problem, supporting a fluent and empathetic communication between the passenger and the UX designers, and automate tasks to support the intelligent interactivity of the system. One of our significant theoretical findings is that in contrast to non-automotive UX designers, most automotive UX designers are ready to adopt technologies that use sensitive physiological measures including eyes, face, body tracking using cameras and computer vision. Our findings also suggest that as a general rule if consent is given, then the UXers would like to communicate and design with the passengers in the vehicle. In this study based on empirical data, we also report that automotive UX designers are collecting mostly task-related contextual data while leaving the social, temporal, and physical contextual data unexplored due to safety and security reasons.

This study advances our knowledge of remote in-vehicle design for experiences of autonomous cars, and there are several critical areas where this study makes an original contribution. We use a Design science research methodology to answers our research

questions relevant to human problems via the creation of innovative artefacts, thereby contributing new knowledge to the body of scientific evidence. As a result of our epistemological paradigm, we inform the body of scientific research by providing both theoretical and practical contributions as we describe in the following section.

7.3. CONTRIBUTION TO THEORY

Our work provides an original contribution to knowledge by describing how to design and execute participatory design workshops and actively involve non-trained users to cooperatively design artefacts in the early stages of a user-centred software development process. Our study helps in advancing our understanding of the state-of-the-art methods in participation and design and informs the body of knowledge on how to involve non-trained users in the early stages of the design process. Even though there is previous work in participatory design that actively involves non-trained users, the researchers already provide the prototypes to the users for critique and evaluation but not as early as our study describes.

We also discuss why involving non-experts in co-design activities very early in the design process using toolkits tailored to the domain of interest is valuable, and we extensively describe how to involve non-experts in these activities actively and inform theory. We inform HCI theory of the tailored tools that we developed to collect data on what users say, what users do, and what users make, and state-of-the-art methods that we applied for the analysis of the users' explicit, observable, tacit and latent needs. The participatory prototyping methods and toolkits that were developed in this study will significantly contribute to the body of scientific knowledge of co-designing of interactive systems. We inform the body of knowledge in participatory UX and HCI methods about the advantages of our methodological approach and the limitations of using it.

Furthermore, in automotive domain-specific research work, most of the previous studies examine the in-vehicle interactions of the passengers (in both conventional and autonomous vehicles) intending to maximise the safety of the passengers. In comparison to the most conventional approaches, we apply participatory design methods and tools to inform theory about the democratisation of innovation in automotive UX research and design. Intending to democratise automotive UX innovation, we applied state of the art design methodologies to develop a system that serves as a platform for non-trained UX designers and drivers/passengers to collectively come up with the most innovative automotive experiences. Consequently, the extension and revision of our system provide a precise and verifiable contribution in the area of the design methodologies and design artefact. Well-executed design and evaluation methods used for the utility, quality and efficacy of the system demonstrate the rigour of this study and contribute to the scientific body of knowledge.

7.4. CONTRIBUTION TO PRACTICE

Answering our research question, through design research we produce viable artefacts in two forms, a design framework of a remote UX design system in automotive, and a supportive Interactive system to inform the body of practical research. The design framework consists of the identified UX goals of the proposed remote participatory design system for the early stages of designing for in-vehicle experiences. The supportive, interactive system includes the functional prototype of the system and its front-end interactions in the early stages of the design process based on the UX design goals that we have previously identified.

Firstly, drawing on rich data, such as designer needs, wants, and feelings, our research informs the understanding of the practitioners UX goals, in the early stages of the automotive UX design in context. Therefore, the UX goals further enrich our understanding of the concept of remote democratisation of innovation in the automotive domain and how to support it. Our framework of UX goals is expected to feedback to the automotive design systems and processes with new insights that will enhance the understanding and implementation of the system. The proposed framework can also help the development of technology-based solutions to important and relevant problems.

Secondly, the system itself and the proposed interactions contribute to the body of scientific evidence as an implementation of the empirical data collected using rigorous methods of design and evaluation. This artefact reflects on the second objective by many rigorous cycles of design and evaluation. Design science research relies upon the application of rigorous methods in both the construction and evaluation of design artefacts. Low and high fidelity prototypes can serve in the early stages to iterate on the design and evaluation of the prototype system. Design and evaluation inform academic practice about the optimisation of the system and provides valuable scientific insights for future application. As a result of our iterations, we conclude to design implications and functional tools of our system including a video tagging tool that supports saving an occurrence identified momentarily on real-time video and a privacy call-wall which uses implicit and explicit context to avoid intrusiveness in private situations. Additionally, we propose a human-like avatar tool for mitigating privacy issues, and an interactive interviewing tool to support communication between UXers and the passengers of autonomous vehicles. Finally, our system deploys exploration tools, including a tool for searching participants' characteristics and target groups of people.

Finally, our second artefact (remote design system) is incorporating the most preferred remote UX technologies in the automotive domain based on empirical data. We provide a separate contribution to scientific practice on how these preferences on remote UX technologies differ between the automotive domain and other domains when designing remotely. As a result, our study informs the human-computer interaction and user experience research community about distant UX design.

7.5. LIMITATIONS

7.5.1. GENERAL LIMITATIONS

Our study focus is on the implementation of the system to support the early stages of the design process (Discovery an Interpretation) (Efeoglu *et al.*, 2013). Our artefact does not engage with later stages of the design process, although our study can be helpful to other researchers to explore systems supporting stages such as ideation, experimentation, and evolution of in-vehicle interactions. Furthermore, the thesis does not engage in the design and evaluation of a specific IVIS (Navigator/GPS) or an in-vehicle infotainment system. It is also beyond the scope of this study to examine the technical aspects of telecommunication technologies even though computer-mediated communication theory is essential to this study. Even though our findings are related to trust and privacy, our study does not provide us with a direction on the privacy of autonomous vehicle experiences and whether privacy will continue being a limitation in the context of self-driving vehicles.

7.5.2. SPECIAL INTEREST GROUPS RECRUITMENT LIMITATIONS

A significant limitation is the relatively small community of automotive HCI and HMI researchers. In our study, we recruited out of a pool of participants of communities, including automotive user interfaces community, and CSCW community, which focus on automotive studies and involve both academics and industry professionals. To reach out to these people, we had to recruit from three different countries. Even though the recruiting process of the domain-specific professionals took less time than recruiting UX designers in other domains, it was challenging to find automotive experts only in the United Kingdom, and we needed to travel to these countries to collect the necessary data. Most of the participants were males, and even though our overall split was representative of the number of women in the specific community, we must highlight the lack of female professionals in automotive UX research and design. The present study did not consider whether the low percentage of female participants affected the level of outcomes. The limited number of available participants is typical in qualitative studies of special interest groups, especially when co-designing activities are taking place which traditionally requires same-time same place communication. There is also the economic aspect of recruiting more participants and travelling to their remote locations to run the sessions.

For a design result in participatory design, as Simonsen and Robertson, (2012) highlight, the involvement of people in the design process itself, which was previously the responsibility of only the designer, hands them more control in determining the technologies they might eventually use in work or leisure. Participatory design as a group result has a collaborative outcome of at least two individuals that are expert or non-expert designers. In many instances, it can be a result of larger groups of people acting as designers. While, it may seem paradoxical to the untrained researcher that even though in our study, we recruit only one individual for each session, the outcome is collaborative. In design science theory, though and for the nature of design science, the researcher also acts as a designer to inform the body of knowledge through their designed artefact (Hevner and Chatterjee, 2010, p. 15).

Consequently, in participatory co-design both the researcher/designer (these roles blur) (Simonsen and Robertson, 2013, p. 91) and the participant, form a group and are acting as designers collaborating towards the creation of an artefact. Through our methods of design and evaluation, we argue that we have established a collaborative effort and a joint outcome reaching high levels of involvement of expert and non-expert users. Even though there are many advantages in larger participatory design groups in our study, there is both an operational and scientific rationale behind our decision for the smallest possible group of participants.

The scientific rationale is based on the balance between facilitating and collaboratively building on the participants' ideas.

For the nature of these studies the collaborative discussion between the researcher and the participant over several activities, that involve the participant in this dialogue and a collaborative outcome, can bring many fruitful insights in the design process. The participant does not need to reduce his ideas and designs because the researcher is only there to take part in the process by supporting, facilitating and building on the ideas of the participant. (Visser *et al.*, 2005, p. 14). The paradigm proposes that the role of the researcher is both of the facilitator and the co-designer building on the participants' ideas in a collaborative effort. In large groups, a large amount of diverse information is generated in one session, and without professional moderation, one dominant participant can influence the group. It is a common practise for a skilled facilitator in qualitative methods, including interviewing and focus groups

to equaly distribute the time among participants preventing a particularly vocal or dominant participant from coercing others to agree with his/her views (Breen, 2006). As a result, in order to make no sacrifices in the quality of our data, we avoided poor facilitation by minimising the group size of our collaborative outcome to the minimum. Facilitating qualitative research sessions in many other methods including interviewing, free elicitation, and Kelly repertory grid are commonly conducted as sessions with one individual at the time to maximise the amount of time spent with a participant and delve deeper. As a result, the findings are personalised and more detailed due to the time spent with one individual at a time. Adding to the dual role of the researcher, to achieve equivalent levels of quality and depth with other UX methods for our collected data, we applied our methods with the smallest possible group for each session.

As we previously explained there a many reasons to deploy participatory design including sharing control, sharing expertise and getting inspired to change (Vines *et al.*, 2013). In this study, our focus is not on the social phenomena between groups of people when collaborating achieving consensus or a community based participatory result. Our focus is on collecting a variety of different ideas, and designs, to frame the requirements and their interrelations based on a pragmatic epistemological standpoint. We argue that the smallest possible group principle is also a decision for design quality in our studies. To avoid sacrificing the design result, and even though there are many advantages in using participatory design extensive group sessions including the fact that more participants can react to each other's experiences which results in a global view of the context and various user experiences, group sessions of two participants including the designer were used as explained before, over large group sessions. We described that the system being designed is relatively new, and therefore it is 'under-constrained', that is when the unknowns outnumber the equations. Using large group sessions would have undercut part of these insights of each participant, and therefore, our design results would be of low quality and could lead in failing to address the research questions.

Previous research that actively involves participants in design (Sanders et al., 2010) highlight that by deploying these methods with one participant at a time, a lot of attention and time can be devoted to a participant, and this can bring out detailed information. Even though a participant can feel inhibited, because the session may feel as if a psychologist is testing him/her about feelings, experiences, and needs, Sanders et al. (2010), describe the importance of this methodological and recruitment strategy in terms of the outcome. They also add that probing, priming and understanding applications are best designed ´´individually´´ to be able to capture unique individual experiences (Sanders et al., 2010). We agree with this understanding. We apply our methods in line with previous work of Visser et al. (2005) who argues that the researcher is co-designing by facilitating and building on the ideas of the participant; thus the participant does not need to reduce his ideas and designs because of the researcher or of other participants with conflicting perspectives and can still have a collaborative outcome of two. This is not the result of large group collaboration methods that involve more than two stakeholders in many cases since there is the risk of killing many novel ideas, designs or end solutions to come to a consensus.

On the other hand, applying a non-participatory design result is not preferred because it would also reduce the collaborative outcomes of our research. Traditional methods and practices according to Simonsen and Robertson, (2012), rooted in engineering and natural sciences which are the origins of computer science, emphasise on step-by-step procedures and prevent creativity and cooperation between system designers and users. There are also disadvantages in this method applied in smaller groups of two people. The participatory result of bigger groups leaves the participants with a broader involvement since they are exposed

to more opinions coming from different stakeholders. The participants of a large group of participatory design sessions have a holistic understanding of the problems, and solutions and can empathise with more people of the group. However, this has a more significant impact on the design result in comparison to smaller groups, as explained before, which outweighs the advantages.

There is also a logistical rationale based on the goal of our participatory design study.

The main goal is to give control to the participants and the distribution of power in the design process or its outcome. Different methods are developed and deployed to achieve this result and include the design and application tools, techniques, and principles. Also, participatory design limitations, including recruitment limitations and time and location sensitivity, as explained below, dictated that we actively involved participants in smaller group sessions.

The question of how many people do you involve in each participatory design workshop is not the focus of the attention of participatory design results following this paradigm but the level of active participation of each individual is the primary concern of the method, and it is crucial to address it. Kensing and Blomberg (1998) argue that there is considerable overlap in the problems addressed by research in computer-supported collaborative work (CSCW) and participatory design (PD). They explain that CSCW is focused on understanding the requirements of the system under design when people work cooperatively. In this paradigm, people work is either an individual or any other type of collaborative work. Following this understanding, our work can highly contribute to the body of literature concerned about the participatory design activities and methods, but cannot have a considerable contribution on CSCW work which is mostly interested in phenomena including, joint authoring and distributed teamwork. Kensing and Blomberg, (1998b, p. 181) also want to highlight that '*While there is a discussion in the CSCW literature about how to construct productive relations between those doing work analysis and those designing CSCW systems, there is no explicit commitment to direct user participation in design.*' They add that in fact, previous researchers (Bentley et al., 1992; Hughes et al., 1993) have argued that it is too costly and logistically problematic to have users involved in the design. Thus, we chose to relate more to the participatory design result than the computer supported collaborative work, even though there is collaboration between the researcher and the user who are both taking part in co-design activities.

In this study, we are aware that many researchers incorporating methods and tools from CSCW are running participatory design workshops or sessions in teams or in large groups to mitigate the cost limitation of the participatory design practice, but their main goal and contribution is still participatory design to share knowledge on social networks or to give users more control over decision making which is not limited to the discussion between a large group and the designer but also the discussion between smaller groups. Supporting this argument previous PD results about the dialogue in participatory design (Kensing and Blomberg, 1998a) describe researchers involving individuals in the data collection by using semi-structured interviews, and arguing for the effectiveness of their PD results. Because we believe in the active involvement of participants in our study, we deploy different tools as explained previously in the methods section, and we are aware of the limitation of our work to contribute to the CSCW body literature. We recommend further work on applying our tools and methods to larger groups of participants and further reflective research on comparing the results between the small group and large group workshops and the team workshops.

Furthermore, our study and studies of the same nature are time-intensive and require a substantial amount of time. Recruiting professionals and not students, organising the workshops, and analysing the data depends on the participants' agendas which makes it demanding for the researcher when they are required to implement the studies within a short timeframe. Another limitation of the nature of our studies is that the empirical results depend heavily on the researcher's way of interpreting and analysing the extracted data. Interpretive research is often criticised by positivists (Kroeze, 2011, p 2) for the subjective influence that the researcher's interpretation might have on the findings.

7.5.3. OBJECTIVITY LIMITATION

An objectivity limitation should be highlighted for future researchers that believe that any attempt to remain unbiased is meaningful. In our research, the paradigm is that we did not attempt to remain 'unbiased' which can be a limitation for replicating or generalising our study and our findings in a larger population. Lerum, (2001), suggests that objectivity and emotion are not necessarily at odds. Social identity, too, needs not to be perceived as a threat to objectivity. Goffman (1989), for instance, argues that the researcher's identity is as much part of fieldwork as the worlds that one studies. Attempting to remove it from a given context could hurt the quality of the study. Most face-to-face qualitative research is reflexive - that is, it demands the researcher to explore oneself and scrutinise one's own experiences. This is what makes qualitative research unique. In other words, the person cannot be divorced entirely from research interpretations. This means that to be objective in qualitative research can be equated with understanding oneself and being honest with your audience about the effects your own social identity might have had on your interpretations. As such, disclosing, examining and controlling one's social associations and their possible effects on interpretations is perhaps the closest one could come to claiming objectivity in qualitative research. In design work (participatory design activities), the researcher moderates and takes part in the design of the artefact. As a result, the fixation to specific ideas is a limitation the set of methods that we applied that can occur. By being aware of this limitation, we tried to avoid it. In the first iteration, we did not lead design by presenting only the tools and methods and created two prototype systems for them to compare and critique later.

7.5.4. REFLEXIVITY INSTEAD OF GENERALISABILITY LIMITATION

Our study does not generalise the results reported to a larger group and is limited to the understanding of the specific participants. A generalisation to a larger population can be difficult for several reasons. The first is due to the nature of our studies. Understanding of a particular group of people and designing for them or with them does not necessarily mean that the designs can be applied with the same success to a larger population. Secondly, as explained before it is particularly challenging to find adequate participants when designing and evaluating artefacts.

Consequently, a much-debated question among ethnographers, participatory designers and other sociology and anthropology scientists are concerned with the generalisability of the result. The question is whether the result of these studies needs to be generalisable or if it even can be generalisable by definition. There are theories and design principles in individual design domains such as architecture, engineering design, and software engineering. However, according to NFS, a science of design will not emerge from core domains. It has to come from an overarching disciplinary scientific field. The science of design and its theories should be generalisable and applicable across a wide variety of domains and specialities (A. Hevner and Chatterjee, 2010).

In contrast, A. Hevner and Chatterjee, (2010) in their book, highlight Hooker's argument that Design theory should provide knowledge of how to design. Much of this exists within the creative mind, is highly problem and scenario dependent, and is extremely dynamic to be generalisable. Hooker points out that there can be a supporting theory that is uniquely associated with a practice, even though it does not entirely explain the practice itself. In the same line of thought Alfred Schultz (sociologist from the mid-20th century), argues that unlike the objects of study in the natural sciences, those studied in social research are active, sense-making human beings, who are engaged in interpreting and ascribing meaning to their world in interaction with each other, the same way as we provide a pragmatic interpretation of our findings. This also applies to the social scientist, who is a further active interpreter of the same social world inhabited by those she would observe and understand. A consequence for social science is that researchers need to acknowledge their interpretative work as they analyse the social worlds they are researching, and recognise that in making sense of an actor's sense-making, they impose a second level of interpretation, that is itself subject to what Weber called verstehen (understanding). This is a critical issue for social researchers, especially those using qualitative interpretivist approaches, as they must recognise that their human, rationalising, constructive activity is behind their analyses of actors' life-worlds. This analysis has many consequences.

First, it acknowledges that people are engaged in an on-going project of producing the social world, and therefore that their sense-making must itself become part of the subject-matter of social science, ruling out a simplistic limitation of study to 'social facts', and accepting the context-specificity of knowledge.

Second, it recognises that the tools of study in social science are human beings' capacities as interpreters of the world. As such, these instruments work employing precisely the same processes of intersubjective meaning-attribution that the social scientist seeks to study. While there may be an aspiration to objectivity by the social scientist, this inheres only in their detachment from the practical commitments and interests of their subjects, not from some essential difference in their ability to interpret free from values, norms and so forth.

Participatory prototyping lies in the intersection of design sciences and social sciences since it both involves people and at the same time, it aims to a design result, co-designed by people, which is ultimately contributing to knowledge. This leads to the third feature, the need for social scientists to be reflexive about their interpretative work, both to aspire to detachment but at the same time to accept its ultimate impossibility.

The question of reflexivity in ethnography (and similarly in many other social sciences), is concerned with how the researcher is never independent of the object/subject their research. Incorporating reflexivity into ethnographic research (Jordan, 1996), the primary attitude is that of a novice who tries to become a part of the life of the community; at the same time, she needs to maintain enough distance to record her observations and reflect on her evolving understanding of the situations she encounters. In the Participatory Design world, Schön's notion of 'reflective practitioner' (Schon and DeSanctis, 1986)has been consistently used to gain an understanding of what designers artfully do and how different domains of knowledge figure in the design process.

7.6. DIRECTIONS FOR FUTURE WORK AND PUBLICATION IDEAS

7.6.1. EXPLORATORY STUDIES IN AUTONOMOUS VEHICLES

The majority of our participants agreed that there are not many car companies who got the resources to proceed in exploratory studies with no set research or design brief. In the typical cases in automotive research and design, practitioners know which features they are developing, the purpose of use of the vehicle, or which is the target group of users. Future work can close this gap in the lack of exploratory studies in the automotive HCI domain. Even though so far the designers and researchers also lacked the tools and methods to explore in-vehicle interactions as described in our study, the system we designed can support in this direction and shed light to the area of in-vehicle HCI and HMI of autonomous cars.

Future researchers are encouraged to test our system and the applied framework of UX goals in research in real-time interaction and communication. For this type of studies, vehicles need to be used in real driving scenarios. Deploying the vehicles and running the system can feedback to the enhancement of the system. Long term exploratory studies using both our system and vehicles can inform the body of participatory design research in the wild and contribute further to an open innovation initiative in the automotive domain. Furthermore, exploring the possibilities of intelligent agents as proposed in our system which can learn from the in-vehicle interactions in context and get trained to be able to complete naturalistic mediated communication. Supporting the identification of UX design patterns and potential problems of in-vehicle interactions by intelligent agents can considerably contribute to the automotive HCI and human factors community and the understanding of the social and physical context of the autonomous vehicle.

7.6.2. REMOTE DESIGN, TRUST AND ANONYMITY

Characteristics such as clarity, naturalness, and communication etiquette to build trust and rapport in remote communication were previously investigated in telepresence systems' applications in organisations. Previous studies have also reported that a decrease in the degree of naturalness of a communication medium leads to increased cognitive effort; increased communication ambiguity; and decreased physiological arousal (Kock, 2005). However, to build trust and rapport, one should consider that different types of technology require different forms of etiquette as previous studies have identified (George, Carlson and Valacich, 2013), and there are different kinds of etiquette for different settings (Jenny Preece, 2004). Additionally, rules of etiquette depending on the social environment in which people use them. Similar to other norms, they are learned through experience in a community. Preece (2004) emphasised this social dimension with the example of children who observe how adults and other children behave, absorb these norms, and, as a result, learn their community etiquette at an early age.

Consequently, the cultural characteristics of a community influence the perceived politeness and naturalness of the remote interaction. In essence, politeness means "*phrasing things in such a way to take into consideration the feelings of the others*" (Morand, Ocker and Simmons, 2003 p. 2). Future work can investigate future remote communication technologies and tools and identify how they affect the way people feel and behave while interacting with them.

However, anonymity is at the centre of attention due to the general concern about privacy while using technology. It is more relevant in the absence of nonverbal cues which may lead to changes in the quality of the interaction including increased self-disclosure and intimacy in the same way that it provides more control over self-presentation (Shalom *et al.*, 2015). Although the perceived social context of the in-vehicle situations may be the cause of the

increased privacy concern, this was not thoroughly investigated as part of our research, and we would recommend further exploration in this direction.

Furthermore, we propose further research by combining our findings and the findings of Wärnestål & Kronlid (2014), to develop a remote UX design Chabot to be used as a tool of our proposed system. Wärnestål & Kronlid (2014) have previously proposed a User Experience Design Framework for Adaptive Spoken Dialogue in Automotive Contexts. They describe a set of design principles for designing efficient, effective, coherent, and desirable adaptive spoken interaction. Anonymity, trust and privacy can also be explored in the context of the in-vehicle interaction chatbots. Chatbots can support the UX designers in co-designing with the drivers and at the same time, provide an anonymous way of interaction for them. As a future direction for democratising the in-vehicle UX design, the developers would need to train a chatbot to map from one user turn to the other user's response based on conversations about the in-vehicle interactions and the lived experience. These databases though are currently hard to find since the researchers who are interviewing drivers have to deal with sensitive data and cannot circulate their databases of transcripts. A collective research effort among UX researchers and designers is required to train a chatbot that could work with any vehicle and can support open innovation in the automotive domain.

7.6.3. PARTICIPATORY DESIGN AND CO-DESIGN ACTIVITIES

There is space for future work in UX research and design methods. We identify a general lack of studies that address both the design and the evaluation of UX informing the HCI research community about how to start and finish such ill-defined problems. There is a focus on evaluating pre-existing prototypes early on but not on how to co-design these prototypes. Despite the word 'design' in 'user-centred design' the HCI community focused overwhelmingly on use rather than design issues and did not contribute significantly on the 'design' front. However, over the years, a certain commingling of work in HCI and Participatory Design had occurred, both conceptually and empirically (Simonsen & Robertson 2013). However, looking to future research and having demonstrated the feasibility of this research approach in HCI we would recommend it to other researchers who are both interested in pragmatic results through artefacts or interpretative results to inform or revise previous theory on methods and tools. Also applying these methods and tools to other domains, including healthcare and education, can be very valuable for the body of scientific knowledge. Previous work (Onyeachu, 2016) reports that to date, research in Telehealth often ignores the patient perspective only focusing on issues regarding the usability of a technology proposed. As a result, there is a lack of research on the voices, beliefs, opinions and challenges of patients especially in Health informatics and that could be mitigated by the use of the methods and tools we design and apply in our study.

7.6.4. SOFTWARE DEVELOPMENT IN AGILE PROJECTS

Finally, we propose further work in developing interactive systems for agile projects by applying our methodological approach. Larusdottir et al. (Lárusdóttir, Cajander and Gulliksen, 2012) report that the biggest challenge in Scrum projects concerns losing the big picture of UX design. Law et al. (Law and Lárusdóttir, 2015) also investigate strengths and weaknesses of Kanban and Scrum concerning UX work and conclude that practitioners find it very challenging to integrate UX work with Kanban fully, and Scrum approaches to agile software development. The researchers relate this to the fundamental differences between the philosophies, methodologies, and practices of these two approaches compared to UX work and that Kanban and Scrum are developers- and customer-oriented, not user-oriented. Some organisations resist in introducing new models, tools, methods, or techniques. This means that

in these organisations, practitioners can only rely on the traditional interview and observation techniques when performing UX practices. As a result, we recommend further work on applying the methodological approach of our study in organisations to support agile development and further explore the advantages and disadvantages to agile projects in comparison to previous work.

REFERENCES

Abowd, G. D. *et al.* (1999a) 'Towards a Better Understanding of Context and Context-Awareness', in. Springer, Berlin, Heidelberg, pp. 304–307. doi: 10.1007/3-540-48157-5_29.

Abowd, G. D. *et al.* (1999b) 'Towards a Better Understanding of Context and Context-Awareness', in. Springer, Berlin, Heidelberg, pp. 304–307. doi: 10.1007/3-540-48157-5_29.

Alvarez, I. *et al.* (2010) 'Voice interfaced vehicle user help', in *Proceedings of the 2nd International Conference on Automotive User Interfaces and Interactive Vehicular Applications - AutomotiveUI '10*. New York, New York, USA: ACM Press, p. 42. doi: 10.1145/1969773.1969782.

Alvarez, I., Rumbel, L. and Adams, R. (2015) 'Skyline', in *Proceedings of the 7th International Conference on Automotive User Interfaces and Interactive Vehicular Applications - AutomotiveUI '15*. New York, New York, USA: ACM Press, pp. 101–108. doi: 10.1145/2799250.2799290.

B-N Sanders, E. and Dandavate, U. (1999) 'Design for Experiencing: New Tools'.

B-N Sanders SonicRim, E. (2002) 'From User-Centered to Participatory Design Approaches', *In Design and the Social Sciences. J.Frascara*. Available at: http://u.osu.edu/sanders.82/files/2015/02/FromUsercenteredtoParticipatory_Sanders_-02-15wjbq1.pdf (Accessed: 16 September 2017).

Balaam, M. *et al.* (2011) 'Motivating mobility', in *Proceedings of the 2011 annual conference on Human factors in computing systems - CHI '11*. New York, New York, USA: ACM Press, p. 3073. doi: 10.1145/1978942.1979397.

Bargas-Avila, J. A. and Hornbæk, K. (2011) 'Old wine in new bottles or novel challenges', in *Proceedings of the 2011 annual conference on Human factors in computing systems - CHI '11*. New York, New York, USA: ACM Press, pp. 2689–2698. doi: 10.1145/1978942.1979336.

Bartl, M., Jawecki, G. and Wiegandt, P. (2010) 'Co-Creation in New Product Development : Conceptual Framework and Application in the Automotive Industry', 9.

Baskerville, R., Pries-Heje, J. and Venable, J. (2009) 'Soft design science methodology', in *Proceedings of the 4th International Conference on Design Science Research in Information Systems and Technology - DESRIST '09*. New York, New York, USA: ACM Press, p. 1. doi: 10.1145/1555619.1555631.

Bauer, C. and Dey, A. K. (2016) 'Considering context in the design of intelligent systems: Current practices and suggestions for improvement', *Journal of Systems and Software*, 112(112), pp. 26–47. doi: 10.1016/j.jss.2015.10.041.

Bevan, N. (2008) 'Classifying and selecting UX and usability measures'. Available at: www.nigelbevan.com (Accessed: 3 July 2016).

Bevan, N. (2009) 'What is the difference between the purpose of usability and user experience evaluation methods.', *In Proceedings of the Workshop UXEM*, Vol. 9(UXME), pp. 1–4. Available at: https://www.semanticscholar.org/paper/What-Is-the-Difference-between-the-Purpose-of-Bevan/cba7403699582 1ca560d31bf397c695a460a63a5/pdf.

Beyer, H. and Holtzblatt, K. (1999) 'Contextual design', *interactions*. ACM, 6(1), pp. 32–42. doi: 10.1145/291224.291229.

Bickmore, T. W. (2004) 'Unspoken rules of spoken interaction', *Communications of the ACM*. ACM, 47(4), p. 38. doi: 10.1145/975817.975842.

Biehl, J. T., Avrahami, D. and Dunnigan, A. (2015) 'Not Really There', in *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing - CSCW '15*. New York, New York, USA: ACM Press, pp. 1567–1575. doi: 10.1145/2675133.2675220.

Van Der Bijl Brouwer, M. and Dorst, K. (2014) 'How deep is deep? A four-layer model of insights into human

needs for design innovation'. Ediciones Uniandes.

Bjerknes, G. *et al.* (1987) *Computers and democracy : a Scandinavian challenge*. Avebury.

Bødker, S. and Zander, P.-O. (2015) 'Participation in design between public sector and local communities', in *Proceedings of the 7th International Conference on Communities and Technologies - C&T '15*. New York, New York, USA: ACM Press, pp. 49–58. doi: 10.1145/2768545.2768546.

Boland, R. and Collopy, F. (2004) *Managing as designing*. Stanford Business Books. Available at: https://dl.acm.org/citation.cfm?id=1096152 (Accessed: 20 January 2019).

Brandt, E. *et al.* (2011) *XLAB*. Danish Design School Press. Available at: https://adk.elsevierpure.com/en/publications/xlab (Accessed: 10 January 2019).

Bratteteig, T. and Wagner, I. (2016) 'What is a participatory design result?', in *Proceedings of the 14th Participatory Design Conference on Full papers - PDC '16*. New York, New York, USA: ACM Press, pp. 141–150. doi: 10.1145/2940299.2940316.

Braun, V. and Clarke, V. (2006) 'Braun, V ., Clarke, V .Using thematic analysis in psychology., 3:2 (2006), 77-101.', *Qualitative Research in Psychology*. doi: 10.1191/1478088706qp0630a.

Breen, R. L. (2006) 'A Practical Guide to Focus-Group Research', *Journal of Geography in Higher Education*, 30(3), pp. 463–475. doi: 10.1080/03098260600927575.

Brodie, J. *et al.* (2003) 'Supporting human interaction through digital technology: theory and practice'. Trinity College Dublin, pp. 403–408. Available at: http://dl.acm.org/citation.cfm?id=963600.963680 (Accessed: 15 March 2016).

Brown, P. J., Bovey, J. D. and Xian Chen (1997) 'Context-aware applications: from the laboratory to the marketplace', *IEEE Personal Communications*, 4(5), pp. 58–64. doi: 10.1109/98.626984.

Buur, J. and Bødker, S. (2000) 'From usability lab to "design collaboratorium"', in *Proceedings of the conference on Designing interactive systems processes, practices, methods, and techniques - DIS '00*. New York, New York, USA: ACM Press, pp. 297–307. doi: 10.1145/347642.347768.

Cahir, J. and Lloyd, J. (2015) '"People just don't care": practices of text messaging in the presence of others', *Media, Culture & Society*.

Carlson, J. R. and Zmud, R. W. (1999) 'CHANNEL EXPANSION THEORY AND THE EXPERIENTIAL NATURE OF MEDIA RICHNESS PERCEPTIONS.', *Academy of Management Journal*, 42(2), pp. 153–170. doi: 10.2307/257090.

Carter, S., Mankoff, J. and Heer, J. (2007a) 'Momento: support for situated ubicomp experimentation', in *CHI '07*. doi: 10.1145/1240624.1240644.

Carter, S., Mankoff, J. and Heer, J. (2007b) 'Momento', in *Proceedings of the SIGCHI conference on Human factors in computing systems - CHI '07*. New York, New York, USA: ACM Press, p. 125. doi: 10.1145/1240624.1240644.

Checkland, P. (1981) 'Systems Thinking, Systems Practice', *John Wiley & Sons, Chichester*. Available at: http://papers.cumincad.org/cgi-bin/works/Show?91c4 (Accessed: 6 February 2019).

Christopher A. Miller, H. B. F. (2001a) 'Associates with Etiquette: Meta-Communication to Make Human-Automation Interaction more Natural, Productive and Polite'. Available at: http://citeseerx.ist.psu.edu/viewdoc/summary;jsessionid=5058DEC707900BC7D3854EA8793CDBBB?doi=10.1.1.16.3455 (Accessed: 5 November 2015).

Christopher A. Miller, H. B. F. (2001b) 'Associates with Etiquette: Meta-Communication to Make Human-Automation Interaction more Natural, Productive and Polite'. Available at: http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.16.3455 (Accessed: 14 May 2015).

Cooper, A. (1999) *The inmates are running the asylum*. Sams. Available at:

https://books.google.co.uk/books/about/The_Inmates_are_Running_the_Asylum.html?id=udsfAQAAIAAJ&redir_esc=y (Accessed: 18 January 2019).

Cooper, A. *et al.* (2007) *About face 3 : the essentials of interaction design*. Wiley Pub. Available at: https://dl.acm.org/citation.cfm?id=1406522 (Accessed: 18 January 2019).

Corbin, J. M. and Strauss, A. (1990) 'Grounded theory research: Procedures, canons, and evaluative criteria', *Qualitative Sociology*. Kluwer Academic Publishers-Human Sciences Press, 13(1), pp. 3–21. doi: 10.1007/BF00988593.

Csikszentmihalyi, M. (1990) *Flow : the psychology of optimal experience*. Harper & Row.

Csikszentmihalyi, M. (2014) *Flow and the Foundations of Positive Psychology*. Dordrecht: Springer Netherlands. doi: 10.1007/978-94-017-9088-8.

Cycil, C. *et al.* (2013) '"Eyes free" in-car assistance', in *Proceedings of the 15th international conference on Human-computer interaction with mobile devices and services - MobileHCI '13*. New York, New York, USA, New York, USA: ACM Press, p. 332.

Daft, R. L. and Lengel, R. H. (1983) 'Information Richness. A New Approach to Managerial Behavior and Organization Design'.

Dai, H. *et al.* (2015) 'Explaining consumer satisfaction of services: The role of innovativeness and emotion in an electronic mediated environment', *Decision Support Systems*, 70, pp. 97–106.

Dalsgaard, P. (2014) 'Pragmatism and Design Thinking.', *International Journal of design*, 8(1), pp. 143–155. Available at: http://eds.b.ebscohost.com/abstract?site=eds&scope=site&jrnl=19913761&AN=96053226&h=TcrywSmE4cKewjAFCxgrzjciO1RIfp3FHZgB1svGT%2BwqXA00F2nplu9tCD12tAelsPKtgfns3OM%2BV77fmOmuzQ%3D%3D&crl=c&resultLocal=ErrCrlNoResults&resultNs=Ehost&crlhashurl=login.aspx%3Fd (Accessed: 15 March 2018).

Le Dantec, C. and Christopher (2012) 'Participation and publics', in *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems - CHI '12*. New York, New York, USA: ACM Press, p. 1351. doi: 10.1145/2207676.2208593.

Dennis, A. R., Fuller, R. M. and Valacich, J. S. (2008) 'Media, tasks, and communication processes: a theory of media synchronicity', *MIS Quarterly*. Society for Information Management and The Management Information Systems Research Center, 32(3), pp. 575–600. Available at: http://dl.acm.org/citation.cfm?id=2017388.2017395 (Accessed: 16 May 2015).

Dennis, A. R. and Valacich, J. S. (1999) 'Rethinking media richness: towards a theory of media synchronicity', in *Proceedings of the 32nd Annual Hawaii International Conference on Systems Sciences. 1999. HICSS-32. Abstracts and CD-ROM of Full Papers*. IEEE Comput. Soc, p. 10. doi: 10.1109/HICSS.1999.772701.

Derks, D., Bos, A. E. R. and Grumbkow, J. von (2007) 'Emoticons and social interaction on the Internet: the importance of social context', *Computers in Human Behavior*, 23(1), pp. 842–849. doi: 10.1016/j.chb.2004.11.013.

Derks, D., Fischer, A. H. and Bos, A. E. R. (2008) 'The role of emotion in computer-mediated communication: A review', *Computers in Human Behavior*, 24(3), pp. 766–785.

DeRosa, D. M. *et al.* (2004) 'Trust and leadership in virtual teamwork: A media naturalness perspective', *Human Resource Management*, 43(2–3), pp. 219–232. doi: 10.1002/hrm.20016.

Desmet, P. and Hekkert, P. (2007) 'Framework of Product Experience Human-Product Interaction', *58 International Journal of Design*, 1(1), pp. 57–66.

Dewey, J. (2005) *Art as experience*. Berkley Pub. Group.

Dobbins, C. and Fairclough, S. (2017) 'A mobile lifelogging platform to measure anxiety and anger during real-life driving', in *2017 IEEE International Conference on Pervasive Computing and Communications*

Workshops (PerCom Workshops). IEEE, pp. 327–332. doi: 10.1109/PERCOMW.2017.7917583.

Dorneich, M. C. *et al.* (2012) 'Considering Etiquette in the Design of an Adaptive System', *Journal of Cognitive Engineering and Decision Making*, 6(2), pp. 243–265. doi: 10.1177/1555343412441001.

Dourish, P. (2001) *Where the action is : the foundations of embodied interaction*. MIT Press.

Eckoldt, K. *et al.* (2013) 'Alternatives : Exploring the car's design space from an experience-oriented perspective.', in *Proceedings of the 6th International Conference on Designing Pleasurable Products and Interfaces - DPPI '13*. New York, New York, USA: ACM Press, p. 156. doi: 10.1145/2513506.2513523.

Efeoglu, A. *et al.* (2013) 'Aalborg Universitet Design Thinking DESIGN THINKING: CHARACTERISTICS AND PROMISES', pp. 241–256.

Ehn, P. (1989) *Work-oriented design of computer artifacts*. Arbetslivscentrum.

Endsley, M. R. (1988) 'Design and Evaluation for Situation Awareness Enhancement', *Proceedings of the Human Factors Society Annual Meeting*. SAGE PublicationsSage CA: Los Angeles, CA, 32(2), pp. 97–101. doi: 10.1177/154193128803200221.

Ergonomics of human-system interaction — Part 11: Usability: Definitions and concepts (2018) *ISO/DIS 9241-11.2(en)*. Available at: https://www.iso.org/obp/ui/#iso:std:iso:9241:-11:dis:ed-2:v2:en (Accessed: 18 January 2019).

Floyd, I. R., Jones, M. C. and Twidale, M. B. (2008) 'Resolving Incommensurable Debates: A Preliminary Identification of Persona Kinds, Attributes, and Characteristics'. Taylor & Francis. Available at: https://www.ideals.illinois.edu/handle/2142/9807 (Accessed: 18 January 2019).

Fong, K. and Mar, R. A. (2015) 'What does my avatar say about me? Inferring personality from avatars.', *Personality & social psychology bulletin*, 41(2), pp. 237–49. doi: 10.1177/0146167214562761.

Frauenberger, C. *et al.* (2012) 'Interpreting input from children', in *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems - CHI '12*. New York, New York, USA: ACM Press, p. 2377. doi: 10.1145/2207676.2208399.

Fridman, L. (2018) 'Human-Centered Autonomous Vehicle Systems: Principles of Effective Shared Autonomy'. Available at: http://arxiv.org/abs/1810.01835 (Accessed: 4 February 2019).

Frog Desgin (2014) *CREATE ACTIVITIES INTERFACE TOOLKIT.Bringing Users into Your Process Through Participatory Design*. Available at: https://www.slideshare.net/frogdesign/bringing-users-into-your-process-through-participatory-design/43-CREATE_ACTIVITIESINTERFACE_TOOLKITWHAT_IT_ISBased (Accessed: 28 February 2019).

Fulk, J. *et al.* (1987) 'A Social Information Processing Model of Media Use in Organizations', *Communication Research*, 14(5), pp. 529–552. doi: 10.1177/009365087014005005.

Gaver, B., Dunne, T. and Pacenti, E. (1999) 'Design: Cultural probes', *interactions*. ACM, 6(1), pp. 21–29. doi: 10.1145/291224.291235.

Gaver, W. and William (2012) 'What should we expect from research through design?', in *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems - CHI '12*. New York, New York, USA: ACM Press, p. 937. doi: 10.1145/2207676.2208538.

Gellatly, A. W. *et al.* (2010) 'Journey: General Motors' Move to Incorporate Contextual Design Into Its Next Generation of Automotive HMI Designs', in *Proceedings of the 2nd International Conference on Automotive User Interfaces and Interactive Vehicular Applications - AutomotiveUI '10*. New York, New York, USA: ACM Press, p. 156.

Gentile, C., Spiller, N. and Noci, G. (2007) 'How to Sustain the Customer Experience':, *European Management Journal*, 25(5), pp. 395–410. doi: 10.1016/j.emj.2007.08.005.

George, J. F., Carlson, J. R. and Valacich, J. S. (2013) 'Media selection as a strategic component of communication', *MIS Quarterly*. Society for Information Management and The Management Information Systems Research Center, 37(4), pp. 1233–1252. Available at: http://dl.acm.org/citation.cfm?id=2600480.2600492 (Accessed: 6 July 2015).

Giaccardi, E. and Cila, N. (2016) *Things As Co-ethnographers: Implications of a Thing Perspective for Design and Anthropology Multi-Situated Materials View project Resourceful Ageing View project*. Available at: https://www.researchgate.net/publication/303939085 (Accessed: 10 January 2019).

Goffman, E. (1989) 'On fieldwork', *Journal of Contemporary Ethnography*. doi: 10.1177/089124189018002001.

Goodwin, K. (2009) *Designing for the digital age : how to create human-centered products and services*. Wiley Pub. Available at: https://www.wiley.com/en-us/Designing+for+the+Digital+Age%3A+How+to+Create+Human+Centered+Products+and+Services-p-9780470229101 (Accessed: 15 January 2020).

Graham, S. L. (2007) 'Disagreeing to agree: Conflict, (im)politeness and identity in a computer-mediated community', *Journal of Pragmatics*, 39(4), pp. 742–759. doi: 10.1016/j.pragma.2006.11.017.

Grill, T. *et al.* (2010) 'The Christian Doppler Laboratory on Contextual Interfaces', in. Springer, Berlin, Heidelberg, pp. 325–332. doi: 10.1007/978-3-642-16917-5_40.

Halskov, K. and Dalsgård, P. (2006) 'Inspiration card workshops', in *Proceedings of the 6th ACM conference on Designing Interactive systems - DIS '06*. New York, New York, USA: ACM Press, p. 2. doi: 10.1145/1142405.1142409.

Harboe, G. *et al.* (2012) 'Computer support for collaborative data analysis', in *Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work - CSCW '12*. New York, New York, USA: ACM Press, p. 1179. doi: 10.1145/2145204.2145379.

Harboe, G. and Huang, E. M. (2015) 'Real-World Affinity Diagramming Practices: Bridging the Paper-Digital Gap', *Proceedings of the ACM CHI'15 Conference on Human Factors in Computing Systems*. doi: 10.1145/2702123.2702561.

Hassenzahl, M. (2005) 'The thing and I: understanding the relationship between user and product'. Kluwer Academic Publishers, pp. 31–42. Available at: http://dl.acm.org/citation.cfm?id=1139008.1139015 (Accessed: 20 May 2013).

Hassenzahl, M. (2010) 'Experience Design: Technology for All the Right Reasons', *Synthesis Lectures on Human-Centered Informatics*. Morgan & Claypool Publishers, 3(1), pp. 1–95.

Hassenzahl, M. *et al.* (2015) 'Experience-Oriented and Product-Oriented Evaluation: Psychological Need Fulfillment, Positive Affect, and Product Perception', *International Journal of Human-Computer Interaction*. Taylor & Francis, 31(8), pp. 530–544. doi: 10.1080/10447318.2015.1064664.

Hassenzahl, M. and Tractinsky, N. (2006) 'User experience - a research agenda', *Behaviour & Information Technology*. Taylor & Francis Group, 25(2), pp. 91–97.

Hazas, M., Scott, J. and Krumm, J. (2004) 'Location-aware computing comes of age', *Computer*, 37(2), pp. 95–97. doi: 10.1109/MC.2004.1266301.

Hekkert, P. and Dijk, M. van. (2011) *Vision in design : a guidebook for innovators*. BIS Publishers. Available at: https://www.bispublishers.com/vision-in-product-design.html (Accessed: 26 January 2019).

Hekkert, P., Mostert, M. and Stompff, G. (2003) 'Dancing with a machine', in *Proceedings of the 2003 international conference on Designing pleasurable products and interfaces - DPPI '03*. New York, New York, USA: ACM Press, p. 114. doi: 10.1145/782896.782925.

Hevner, A. and Chatterjee, S. (2010) *Design Research in Information Systems*. Boston, MA: Springer US (Integrated Series in Information Systems). doi: 10.1007/978-1-4419-5653-8.

Hevner, A. R. and Chatterjee, S. (2010) *Design research in information systems : theory and practice*. Springer.

Holtzblatt, K., Wendell, J. B. and Wood, S. (2005) *Rapid contextual design : a how-to guide to key techniques for user-centered design*. Elsevier/Morgan Kaufmann. Available at: https://books.google.co.uk/books?hl=en&lr=&id=yzOrcSl6zvMC&oi=fnd&pg=PP1&ots=aDKfUtz9DV&sig=SJhmz-Z29W6RP4QnddbGB-GAhZc&redir_esc=y#v=onepage&q&f=false (Accessed: 18 January 2019).

Hook, J. *et al.* (2011) 'A VJ centered exploration of expressive interaction', in *Proceedings of the 2011 annual conference on Human factors in computing systems - CHI '11*. New York, New York, USA: ACM Press, p. 1265. doi: 10.1145/1978942.1979130.

Hyde, J. *et al.* (2015) 'Using an Interactive Avatar's Facial Expressiveness to Increase Persuasiveness and Socialness', in *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems - CHI '15*. New York, New York, USA: ACM Press, pp. 1719–1728. doi: 10.1145/2702123.2702465.

Ili, S., Albers, A. and Miller, S. (2010) 'Open innovation in the automotive industry', *R&D Management*, 40(3), pp. 246–255. doi: 10.1111/j.1467-9310.2010.00595.x.

InteractionDesignFoundation (2019) *The Encyclopedia of Human-Computer Interaction, 2nd Ed. | Interaction Design Foundation*. Available at: https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed (Accessed: 18 January 2019).

'ISO 9241-210:2010 - Ergonomics of human-system interaction -- Part 210: Human-centred design for interactive systems' (2010). Available at: https://www.iso.org/standard/52075.html (Accessed: 21 January 2019).

Iversen, O. S., Halskov, K. and Leong, T. W. (2010) 'Rekindling values in participatory design', in *Proceedings of the 11th Biennial Participatory Design Conference on - PDC '10*. New York, New York, USA: ACM Press, p. 91. doi: 10.1145/1900441.1900455.

J McCarthy, P. W. (2004a) *Technology as Experience | The MIT Press*, *The MIT Press*. Available at: https://mitpress.mit.edu/books/technology-experience (Accessed: 9 March 2016).

J McCarthy, P. W. (2004b) *Technology as Experience | The MIT Press*, *The MIT Press*.

Jakus, G., Dicke, C. and Sodnik, J. (2015) 'A user study of auditory, head-up and multi-modal displays in vehicles.', *Applied ergonomics*, 46 Pt A, pp. 184–92. doi: 10.1016/j.apergo.2014.08.008.

Jenny Preece, Yvonne Rogers, H. S. (2002) *Interaction Design: Beyond Human-Computer Interaction*, *Wiley*. Available at: http://www.id-book.com/firstedition/ (Accessed: 9 March 2016).

Jiang, L. C., Bazarova, N. N. and Hancock, J. T. (2011) 'From Perception to Behavior: Disclosure Reciprocity and the Intensification of Intimacy in Computer-Mediated Communication', *Communication Research*, 40(1), pp. 125–143. doi: 10.1177/0093650211405313.

Jim Ross (2018) *The Role of Observation in User Research :: UXmatters*. Available at: https://www.uxmatters.com/mt/archives/2018/09/the-role-of-observation-in-user-research.php (Accessed: 21 September 2018).

Jordan, B., Wasson, C. and Roth-Lobo, H. S. (2015) *Ethnographic Study Lifts the Hood on what REALLY Goes On inside that Car*, *Ethnographic Study Lifts the Hood on what REALLY Goes On inside that Car. EPIC/Advancing the value of ethnography in Industry.* Available at: https://www.epicpeople.org/ethnographic-study-lifts-the-hood/# (Accessed: 14 March 2016).

Jordan, B. (1996) 'Ethnographic Workplace Studies and CSCW', in *The Design of Computer Supported Cooperatie Work and Groupware Systems, Vol. 12*.

Jumisko-Pyykkö, S. and Vainio, T. (2010) 'Framing the Context of Use for Mobile HCI', *International Journal of Mobile Human Computer Interaction*. doi: 10.4018/jmhci.2010100101.

Kaasinen, E. *et al.* (2015) 'Defining user experience goals to guide the design of industrial systKaasinen, E.,

Roto, V., Hakulinen, J., Heimonen, T., Jokinen, J. P. P., Karvonen, H., … Turunen, M. (2015). Defining user experience goals to guide the design of industrial systems.ems'. Taylor & Francis.

Kaikkonen, A. (2009) *TKK Dissertations 200 INTERNET ON MOBILES: EVOLUTION OF USABILITY AND USER EXPERIENCE Doctoral Dissertation*. Available at: http://lib.tkk.fi/Diss/2009/isbn9789522481900/ (Accessed: 21 January 2019).

Karapanos, E. *et al.* (2009) 'User experience over time', in *Proceedings of the 27th international conference on Human factors in computing systems - CHI 09*. New York, New York, USA: ACM Press, p. 729.

Karapanos, E., Jain, J. and Hassenzahl, M. (2012) 'Theories, methods and case studies of longitudinal HCI research', in *Proceedings of the 2012 ACM annual conference extended abstracts on Human Factors in Computing Systems Extended Abstracts - CHI EA '12*. New York, New York, USA: ACM Press, p. 2727. doi: 10.1145/2212776.2212706.

Karlsson, I. C. M. and Pettersson, I. (2015) 'Setting the stage for autonomous cars: a pilot study of future autonomous driving experiences', *IET Intelligent Transport Systems*, 9(7), pp. 694–701. doi: 10.1049/iet-its.2014.0168.

Katz, A. and Te'eni, D. (2007) 'The Contingent Impact of Contextualization on Computer-Mediated Collaboration', *Organization Science*. INFORMS, 18(2), pp. 261–279. doi: 10.1287/orsc.1060.0237.

Kenny, J. (2018) *Ideo Design Thinking Toolkit For Educators - Somurich.com*. Available at: http://somurich.com/design/ideo-design-thinking-toolkit-for-educators.php (Accessed: 26 September 2018).

Kensing, F. and Blomberg, J. (1998a) 'Participatory Design: Issues and Concerns', *Computer Supported Cooperative Work (CSCW)*. Kluwer Academic Publishers, 7(3–4), pp. 167–185. doi: 10.1023/A:1008689307411.

Kensing, F. and Blomberg, J. (1998b) *Participatory Design: Issues and Concerns*, *Computer Supported Cooperative Work*.

Van Kleef, E., Van Trijp, H. C. M. and Luning, P. (2005) 'Consumer research in the early stages of new product development: a critical review of methods and techniques', *Food Quality and Preference*, 16(3), pp. 181–201. doi: 10.1016/j.foodqual.2004.05.012.

Klemmer, S. R. *et al.* (2001) 'The designers' outpost', in *Proceedings of the 14th annual ACM symposium on User interface software and technology - UIST '01*. New York, New York, USA: ACM Press, p. 1. doi: 10.1145/502348.502350.

Kock, N. (2002) 'Evolution and Media Naturalness: A Look at E-Communication Through a Darwinian Theoretical Lens', *ICIS 2002 Proceedings*. Available at: http://aisel.aisnet.org/icis2002/34 (Accessed: 9 June 2015).

Kock, N. (2005) 'Media Richness or Media Naturalness? The Evolution of Our Biological Communication Apparatus and Its Influence on Our Behavior Toward E-Communication Tools', *IEEE Transactions on Professional Communication*, 48(2), pp. 117–130.

Körber, M. and Bengler, K. (2013) 'Measurement of momentary user experience in an automotive context', in *Proceedings of the 5th International Conference on Automotive User Interfaces and Interactive Vehicular Applications - AutomotiveUI '13*. New York, New York, USA: ACM Press, pp. 194–201. doi: 10.1145/2516540.2516555.

Kort, J., Vermeeren, A. and Fokker, J. (2007) 'Conceptualizing and Measuring User eXperience', *Proc. Towards a UX Manifesto, COST294 …*. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.177.7089&rep=rep1&type=pdf#page=63 (Accessed: 2 November 2013).

Koskinen, I. K. *et al.* (2012) 'Copyright', in Pieter Jan Stappers (ed.) *Design Research Through Practice*. Elsevier, pp. 81–91. doi: 10.1016/B978-0-12-385502-2.00015-8.

Kroeze, J. H. (2011) 'Interpretivism in Information Systems: A Postmodern Epistemology?', *All Sprouts*

Content. Available at: https://aisel.aisnet.org/sprouts_all/485 (Accessed: 27 February 2020).

Kujala, S. *et al.* (2011) 'UX Curve: A method for evaluating long-term user experience', *Interacting with Computers*, 23(5), pp. 473–483. doi: 10.1016/j.intcom.2011.06.005.

Kuutti, K. (2010) 'Where are the Ionians of user experience research?', in *Proceedings of the 6th Nordic Conference on Human-Computer Interaction Extending Boundaries - NordiCHI '10*. New York, New York, USA: ACM Press, p. 715. doi: 10.1145/1868914.1869012.

Kvale, S. (1996) *Interviews : an introduction to qualitative research interviewing*. Sage Publications.

Lafond, D. *et al.* (2014) *HCI Dilemmas for Context-Aware Support in Intelligence Analysis*. Available at: https://www.researchgate.net/publication/268521385 (Accessed: 27 January 2019).

Lallemand, C., Gronier, G. and Koenig, V. (2015) 'User experience: A concept without consensus? Exploring practitioners' perspectives through an international survey', *Computers in Human Behavior*, 43, pp. 35–48. doi: 10.1016/j.chb.2014.10.048.

Lárusdóttir, M. K., Cajander, Å. and Gulliksen, J. (2012) 'The big picture of UX is missing in scrum projects', in *CEUR Workshop Proceedings*.

Laurier, E. *et al.* (2008) 'Driving and "Passengering": Notes on the Ordinary Organization of Car Travel', *Mobilities*. Taylor & Francis, 3(1), pp. 1–23. doi: 10.1080/17450100701797273.

Law, E. *et al.* (2007) 'Towards a UX Manifesto'. Available at: http://www.cost.esf.org (Accessed: 8 June 2016).

Law, E. L.-C. *et al.* (2009) 'Understanding, scoping and defining user experience', in *Proceedings of the 27th international conference on Human factors in computing systems - CHI 09*. New York, New York, USA, New York, USA: ACM Press, p. 719. doi: 10.1145/1518701.1518813.

Law, E. L.-C. *et al.* (2014) 'Tracing links between UX frameworks and design practices: dual carriageway'. Hanbit Media, Inc., pp. 188–195. Available at: http://dl.acm.org/citation.cfm?id=2729485.2729513 (Accessed: 15 March 2016).

Law, E. L.-C. and Lai-Chong, E. (2011) 'The measurability and predictability of user experience', in *Proceedings of the 3rd ACM SIGCHI symposium on Engineering interactive computing systems - EICS '11*. New York, New York, USA: ACM Press, p. 1. doi: 10.1145/1996461.1996485.

Law, E. L.-C. and Lárusdóttir, M. K. (2015) 'Whose Experience Do We Care About? Analysis of the Fitness of Scrum and Kanban to User Experience', *International Journal of Human-Computer Interaction*. Taylor & Francis, 31(9), pp. 584–602. doi: 10.1080/10447318.2015.1065693.

Law, E. L.-C., van Schaik, P. and Roto, V. (2014) 'Attitudes towards user experience (UX) measurement', *International Journal of Human-Computer Studies*. Academic Press, 72(6), pp. 526–541. doi: 10.1016/J.IJHCS.2013.09.006.

Lee, C. *et al.* (2015) 'User Perceptions Toward In-Vehicle Technologies: Relationships to Age, Health, Preconceptions, and Hands-On Experience', *International Journal of Human-Computer Interaction*. Taylor & Francis, 31(10), pp. 667–681. doi: 10.1080/10447318.2015.1070545.

Lee, M. K., Fruchter, N. and Dabbish, L. (2015) 'Making Decisions From a Distance', in *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing - CSCW '15*. New York, New York, USA: ACM Press, pp. 1576–1589. doi: 10.1145/2675133.2675288.

Leonard-Barton, D. (1998) 'Wellsprings of knowledge: Building and sustaining the sources of innovation'. Available at: https://scholar.google.co.uk/scholar?q=building+and+sustaining+the+sourses+of+innovation&btnG=&hl=en&as_sdt=0%2C5#0 (Accessed: 7 October 2015).

Leonard, D. and Rayport, J. F. (1997) 'SPARK INNOVATION THROUGH EMPATHIC DESIGN', *Harvard business*

review. Harvard Business School Publishing, 75(6), pp. 102–114.

Lerum, K. (2001) 'Subjects of Desire: Academic Armor, Intimate Ethnography, and the Production of Critical Knowledge', *Qualitative Inquiry*. doi: 10.1177/107780040100700405.

Lindsay, S. *et al.* (2012) 'Empathy, participatory design and people with dementia', in *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems - CHI '12*. New York, New York, USA: ACM Press, p. 521. doi: 10.1145/2207676.2207749.

Liu, Y.-C. and Wen, M.-H. (2004) 'Comparison of head-up display (HUD) vs. head-down display (HDD): driving performance of commercial vehicle operators in Taiwan', *International Journal of Human-Computer Studies*, 61(5), pp. 679–697. doi: 10.1016/j.ijhcs.2004.06.002.

Lu, Y. and Roto, V. (2014) 'Towards meaning change', in *Proceedings of the 8th Nordic Conference on Human-Computer Interaction Fun, Fast, Foundational - NordiCHI '14*. New York, New York, USA: ACM Press, pp. 717–726. doi: 10.1145/2639189.2639241.

Lucero, A. (2015) 'Using Affinity Diagrams to Evaluate Interactive Prototypes', in. Springer, Cham, pp. 231–248. doi: 10.1007/978-3-319-22668-2_19.

Luff, P. *et al.* (2004) 'Only touching the surface', in *Proceedings of the 2004 ACM conference on Computer supported cooperative work - CSCW '04*. New York, New York, USA: ACM Press, p. 523. doi: 10.1145/1031607.1031695.

Maceli, M. and Monica (2016) 'Co-design in the wild', in *Proceedings of the 14th Participatory Design Conference on Full papers - PDC '16*. New York, New York, USA: ACM Press, pp. 161–170. doi: 10.1145/2940299.2940300.

MacIntyre, B. *et al.* (2004) 'DART', in *Proceedings of the 17th annual ACM symposium on User interface software and technology - UIST '04*. New York, New York, USA: ACM Press, p. 197. doi: 10.1145/1029632.1029669.

Mahlke, S. (2005) 'Understanding users' experience of interaction'. University of Athens, pp. 251–254. Available at: http://dl.acm.org/citation.cfm?id=1124666.1124702 (Accessed: 16 February 2016).

Mandryk, R. L., Inkpen, K. M. and Calvert, T. W. (2006) 'Using psychophysiological techniques to measure user experience with entertainment technologies', *Behaviour & Information Technology*. Taylor & Francis Group, 25(2), pp. 141–158.

March, S. T. and Smith, G. F. (1995) 'Design and natural science research on information technology', *Decision Support Systems*. North-Holland, 15(4), pp. 251–266. doi: 10.1016/0167-9236(94)00041-2.

Markus, M. L. (1987) 'Toward a "Critical Mass" Theory of Interactive Media: Universal Access, Interdependence and Diffusion', *Communication Research*, 14(5), pp. 491–511. doi: 10.1177/009365087014005003.

Markus, M. L., Majchrzak, A. and Gasser, L. (2002) *A Design Theory for Systems That Support Emergent Knowledge Processes*, *Source: MIS Quarterly*. Available at: https://www.jstor.org/stable/pdf/4132330.pdf?refreqid=excelsior%3A124de3b1b7bbf486afdaa348d4947406 (Accessed: 20 January 2019).

Martelaro, N. and Ju, W. (2017a) 'WoZ Way: Enabling Real-Time Remote Interaction Prototyping & Observation in On-Road Vehicles', in *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing - CSCW '17*. doi: 10.1145/2998181.2998293.

Martelaro, N. and Ju, W. (2017b) 'WoZ Way', in *Companion of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing - CSCW '17 Companion*. New York, New York, USA: ACM Press, pp. 21–24. doi: 10.1145/3022198.3023271.

Martin, B. and Hanington, B. M. (2012) *Universal methods of design : 100 ways to research complex problems, develop innovative ideas, and design effective solutions*. Rockport Publishers. Available at:

https://books.google.co.uk/books?hl=en&lr=&id=pCVATIpzYfUC&oi=fnd&pg=PA1&ots=_D5qqJwNCf&sig=3dsMz4hqaHbYrOnU5G-O1NZ-RoM&redir_esc=y#v=onepage&q&f=false (Accessed: 18 January 2019).

Mattelmäki, T. (2005) 'Applying probes–from inspirational notes to collaborative insights', *CoDesign*. Taylor & Francis Ltd , 1(2), pp. 83–102. doi: 10.1080/15719880500135821.

Mekler, E. D. and Hornbæk, K. (2016) 'Momentary Pleasure or Lasting Meaning?', in *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems - CHI '16*. New York, New York, USA: ACM Press, pp. 4509–4520.

Meschtscherjakov, A. *et al.* (2011) 'Capture the car!', in *Proceedings of the 3rd International Conference on Automotive User Interfaces and Interactive Vehicular Applications - AutomotiveUI '11*. New York, New York, USA: ACM Press, p. 105.

Meschtscherjakov, A. *et al.* (2012) 'Trip experience sampling', in *Proceedings of the 4th International Conference on Automotive User Interfaces and Interactive Vehicular Applications - AutomotiveUI '12*. New York, New York, USA, New York, USA: ACM Press, p. 225.

Meschtscherjakov, A. *et al.* (2016) *HCI and Autonomous Vehicles: Contextual Experience Informs Design*, *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems - CHI EA '16*. New York, New York, USA: ACM Press. doi: 10.1145/2851581.2856489.

Meschtscherjakov, A. *et al.* (2018) 'Interacting with Autonomous Vehicles', in *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems - CHI '18*. New York, New York, USA: ACM Press, pp. 1–8. doi: 10.1145/3170427.3170614.

Michel, R. and Board of Research in Design. (2007) *Design research now : essays and selected projects*. Birkhäuser.

Middleton, D. and Brown, S. D. (2005) *The Social Psychology of Experience: Studies in Remembering and Forgetting*. 1 Oliver's Yard, 55 City Road, London EC1Y 1SP United Kingdom: SAGE Publications Ltd. doi: 10.4135/9781446221808.

Mikal, J. P. *et al.* (2013) 'Transition, stress and computer-mediated social support', *Computers in Human Behavior*, 29(5), pp. A40–A53. doi: 10.1016/j.chb.2012.12.012.

Miller, C. A. (2004) '"Human-Computer Etiquette: Managing Expectations with Intentional Agents."', *Communications of the ACM*. ACM, 47(4), p. 30.

Montoya, M. M. *et al.* (2009) 'Can You Hear Me Now? Communication in Virtual Product Development Teams', *Journal of Product Innovation Management*, 26(2), pp. 139–155. doi: 10.1111/j.1540-5885.2009.00342.x.

Morand, D. A. and Ocker, R. J. (2003) 'Politeness theory and computer-mediated communication: a sociolinguistic approach to analyzing relational messages', in *36th Annual Hawaii International Conference on System Sciences, 2003. Proceedings of the*. IEEE, p. 10 pp. doi: 10.1109/HICSS.2003.1173660.

Morand, D. A., Ocker, R. J. and Simmons, T. L. (2003) 'Politeness theory and computer-mediated communication: a sociolinguistic approach to analyzing relational messages', in *36th Annual Hawaii International Conference on System Sciences, 2003. Proceedings of the*. IEEE, p. 10 pp.

Mull, I. *et al.* (2015) 'An exploratory study of using 3D avatars as online salespeople', *Journal of Fashion Marketing and Management: An International Journal*. Emerald Group Publishing Limited, 19(2), pp. 154–168. doi: 10.1108/JFMM-05-2014-0033.

Muller, M. J. (2002) 'Participatory design: the third space in HCI'. L. Erlbaum Associates Inc., pp. 1051–1068.

Muller, M. J. and Kuhn, S. (1993) 'Participatory design', *Communications of the ACM*. ACM, 36(6), pp. 24–28. doi: 10.1145/153571.255960.

Naujoks, F. *et al.* (2018) 'A review of non-driving-related tasks used in studies on automated driving', in *Advances in Intelligent Systems and Computing*. doi: 10.1007/978-3-319-60441-1_52.

NHTSA (2013) *Preliminary Statement of Policy Concerning Automated Vehicles*, *National Highway Traffic Safety Administration*.

Nielsen Norman Group: UX Training, Consulting, & Research. Available at: https://www.nngroup.com/ (Accessed: 17 March 2020).

Niforatos, E. and Karapanos, E. (2015) 'EmoSnaps: a mobile application for emotion recall from facial expressions', *Personal and Ubiquitous Computing*. Springer-Verlag, 19(2), pp. 425–444. doi: 10.1007/s00779-014-0777-0.

Norman, D. A. (2013) *The Design of Everyday Things: Revised and Expanded Edition*. Basic Books. Available at: https://books.google.com/books?hl=en&lr=&id=nVQPAAAAQBAJ&pgis=1 (Accessed: 23 March 2016).

Norman, D., Miller, J. and Henderson, A. (1995) 'What you see, some of what's in the future, and how we go about doing it', in *Conference companion on Human factors in computing systems - CHI '95*. New York, New York, USA: ACM Press, p. 155. doi: 10.1145/223355.223477.

Olsen, K. A. (2011) 'Programmed Politeness', *Computer*, 44(7), pp. 108–107. doi: 10.1109/MC.2011.217.

Onyeachu, P. (2016) 'The role of age and illness in the adoption of tele-health'. Brunel University London. Available at: https://bura.brunel.ac.uk/handle/2438/14666 (Accessed: 25 March 2019).

Parasuraman, R. and Miller, C. A. (2004) 'Trust and etiquette in high-criticality automated systems', *Communications of the ACM*. ACM, 47(4), p. 51. doi: 10.1145/975817.975844.

Park, E. K. and Sundar, S. S. (2015) 'Can synchronicity and visual modality enhance social presence in mobile messaging?', *Computers in Human Behavior*, 45, pp. 121–128. doi: 10.1016/j.chb.2014.12.001.

Park, N. *et al.* (2014) 'Understanding the acceptance of teleconferencing systems among employees: An extension of the technology acceptance model', *Computers in Human Behavior*. Emerald Group Publishing Limited, 39(3), pp. 118–127.

Partala, T. and Kallinen, A. (2012) 'Understanding the most satisfying and unsatisfying user experiences: Emotions, psychological needs, and context', *Interacting with Computers*. No longer published by Elsevier, 24(1), pp. 25–34. doi: 10.1016/J.INTCOM.2011.10.001.

Pettersson, I. and Ju, W. (2017) 'Design Techniques for Exploring Automotive Interaction in the Drive towards Automation', *Proceedings of the 2017 Conference on Designing Interactive Systems*. ACM, pp. 147–160. doi: 10.1145/3064663.3064666.

Pfleging, B., Rang, M. and Broy, N. (2016) 'Investigating user needs for non-driving-related activities during automated driving', in *Proceedings of the 15th International Conference on Mobile and Ubiquitous Multimedia - MUM '16*. New York, New York, USA: ACM Press, pp. 91–99. doi: 10.1145/3012709.3012735.

Pine, B. J. and Gilmore, J. H. (2011) *The Experience Economy*. Harvard Business Review Press. Available at: https://books.google.com/books?hl=en&lr=&id=edtOyzyKgXUC&pgis=1 (Accessed: 7 October 2015).

Prahalad, C. K. C. and Ramaswamy, V. (2004) 'Co-creation experiences: The next practice in value creation', *Journal of interactive marketing*, 18(3), pp. 5–14.

Preece, Jennifer (2004) 'Etiquette, empathy and trust in communities of practice: Stepping-stones to social capital', *Journal Of Universal Computer Science*, 10, pp. 294–302. doi: http://dx.doi.org/10.3217/jucs-010-03-0294.

Preece, Jenny (2004) 'Etiquette online', *Communications of the ACM*. ACM, 47(4), p. 56. doi: 10.1145/975817.975845.

Prendinger, H. and Ishizuka, M. (eds) (2004) *Life-Like Characters*. Berlin, Heidelberg: Springer Berlin Heidelberg (Cognitive Technologies). doi: 10.1007/978-3-662-08373-4.

Rachel Charlotte Smith, Kasper Tang Vangkilde, Mette Gislev Kjaersgaard, Ton Otto, Joachim Halse, T. B.

(2016) *Design Anthropological Futures*. Bloomsbury Academic. doi: 10.5040/9781474280617.

Rae, I. *et al.* (2015) 'A Framework for Understanding and Designing Telepresence', in *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing - CSCW '15*. New York, New York, USA: ACM Press, pp. 1552–1566. doi: 10.1145/2675133.2675141.

Ramaswamy, V. and Gouillart, F. J. (2010) *The power of co- creation : build it with them to boost growth, productivity, and profits*. Free Press.

Rebelo, F. *et al.* (2012) 'Using Virtual Reality to Assess User Experience', *Human Factors: The Journal of the Human Factors and Ergonomics Society*. SAGE PublicationsSage CA: Los Angeles, CA, 54(6), pp. 964–982. doi: 10.1177/0018720812465006.

Rhoads, M. (2010) 'Face-to-Face and Computer-Mediated Communication: What Does Theory Tell Us and What Have We Learned so Far?', *Journal of Planning Literature*, 25(2), pp. 111–122.

Rico, R. *et al.* (2009) 'The joint relationships of communication behaviors and task interdependence on trust building and change in virtual project teams', *Social Science Information*, 48(2), pp. 229–255.

Riedl, R. *et al.* (2014) 'Trusting Humans and Avatars: A Brain Imaging Study Based on Evolution Theory', *Journal of Management Information Systems*. Routledge. Available at: http://www.tandfonline.com/doi/abs/10.2753/MIS0742-1222300404 (Accessed: 22 June 2015).

Rittel, H. W. J. and Webber, M. M. (1973) 'Dilemmas in a general theory of planning', *Policy Sciences*. Kluwer Academic Publishers, 4(2), pp. 155–169. doi: 10.1007/BF01405730.

Rizzo, F. (2011) '12. Co-design versus User Centred Design: Framing the differences', *Notes on Doctoral Research in Design. Contributions from the Politecnico di Milano: Contributions from the Politecnico di Milano*. FrancoAngeli, p. 125.

Robert, L. and Dennis, A. R. (2005) 'Paradox of Richness: A Cognitive Model of Media Choice', *IEEE Transactions on Professional Communication*, 48(1), pp. 10–21. doi: 10.1109/TPC.2004.843292.

Rödel, C. *et al.* (2014) 'Towards Autonomous Cars', in *Proceedings of the 6th International Conference on Automotive User Interfaces and Interactive Vehicular Applications - AutomotiveUI '14*. New York, New York, USA: ACM Press, pp. 1–8. doi: 10.1145/2667317.2667330.

Rokeach, M. (1973) *The nature of human values*. Available at: https://www.uzh.ch/cmsssl/suz/albert/lehre/wertewandel2011/B01_Rokeach1973.pdf (Accessed: 7 October 2015).

Roto, V. (2006) 'User experience building blocks', *proceedings of 2nd COST294-MAUSE Workshop– …*. doi: 10.1.1.146.5442.

Roto, V. (2007) 'User Experience from Product Creation Perspective', *Towards a UX Manifesto*, p. 37.

Roto, V. *et al.* (2011a) 'Best practices for capturing context in user experience studies in the wild', in *Proceedings of the 15th International Academic MindTrek Conference on Envisioning Future Media Environments - MindTrek '11*. New York, New York, USA: ACM Press, p. 91. doi: 10.1145/2181037.2181054.

Roto, V. *et al.* (2011b) 'Best practices for capturing context in user experience studies in the wild', in *Proceedings of the 15th International Academic MindTrek Conference on Envisioning Future Media Environments - MindTrek '11*. New York, New York, USA: ACM Press, p. 91.

Sadeghian Borojeni, S. *et al.* (2019) 'Looking into the Future', in *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems - CHI EA '19*. New York, New York, USA: ACM Press, pp. 1–8. doi: 10.1145/3290607.3299031.

Sanders, E. B.-N. (1999) 'Postdesign and participatory culture', *Useful & Critical: The Position of Research in Design. 9-11 September 1999; Tuusula, Finland.*

Sanders, E. B.-N. (2000) 'Generative Tools for Co-designing'. Springer, London, pp. 3–12. doi: 10.1007/978-1-4471-0779-8_1.

Sanders, E. B.-N., Brandt, E. and Binder, T. (2010) 'A framework for organizing the tools and techniques of participatory design', in *Proceedings of the 11th Biennial Participatory Design Conference on - PDC '10*. New York, New York, USA: ACM Press, p. 195. doi: 10.1145/1900441.1900476.

Sanders, E. B.-N. and Stappers, P. J. (2008) 'Co-creation and the new landscapes of design', *CoDesign*. Taylor & Francis , 4(1), pp. 5–18. doi: 10.1080/15710880701875068.

Sanders, E. B.-N. and Stappers, P. J. (2012) *Convivial design toolbox : generative research for the front end of design*. BIS.

Sanders, E. B.-N. and Stappers, P. J. (2014) 'Probes, toolkits and prototypes: three approaches to making in codesigning'. Taylor & Francis.

Schieben, A. *et al.* (2009) 'The theater-system technique', in *Proceedings of the 1st International Conference on Automotive User Interfaces and Interactive Vehicular Applications - AutomotiveUI '09*. New York, New York, USA: ACM Press, p. 43. doi: 10.1145/1620509.1620517.

Schilit, B., Adams, N. and Want, R. (1994) 'Context-aware computing applications', in *Workshop on Mobile Computing Systems and Applications*. IEEE Comput. Soc. Press, pp. 85–90. doi: 10.1109/MCSA.1994.512740.

Schmidt, A. (2000) 'Implicit human computer interaction through context', *Personal Technologies*. Springer-Verlag, 4(2–3), pp. 191–199. doi: 10.1007/BF01324126.

Schmidt, A., Aidoo, K. and Takaluoma, A. (1999) 'Advanced interaction in context', *Handheld and …* . Available at: http://link.springer.com/chapter/10.1007/3-540-48157-5_10 (Accessed: 7 October 2015).

Schon, D. A. and DeSanctis, V. (1986) 'The Reflective Practitioner: How Professionals Think in Action', *The Journal of Continuing Higher Education*. Taylor & Francis Group , 34(3), pp. 29–30. doi: 10.1080/07377366.1986.10401080.

SCUPIN, R. (1997) 'The KJ Method: A Technique for Analyzing Data Derived from Japanese Ethnology', *Human Organization*. Society for Applied Anthropology, pp. 233–237. doi: 10.2307/44126786.

Seidel, V. P. and Langner, B. (2015) 'Using an online community for vehicle design: project variety and motivations to participate', *Industrial and Corporate Change*, 24(3), pp. 635–653. doi: 10.1093/icc/dtv016.

Shalom, J. G. *et al.* (2015) 'Social anxiety and physiological arousal during computer mediated vs. face to face communication', *Computers in Human Behavior*, 44, pp. 202–208. doi: 10.1016/j.chb.2014.11.056.

Simmons, T. L. (1994) 'Politeness Theory in Computer Mediated Communication: Face Threatening Acts in a "Faceless" Medium.' Available at: http://eric.ed.gov/?id=ED381005 (Accessed: 28 April 2015).

Simon, H. A. (1996) *The Sciences of the Artificial*. MIT Press. Available at: https://books.google.com/books?hl=en&lr=&id=k5SronFw7psC&pgis=1 (Accessed: 14 April 2016).

Simonds, C. J. (1997a) 'Classroom understanding: An expanded notion of teacher clarity', *Communication Research Reports*. Taylor & Francis Group, 14(3), pp. 279–290. doi: 10.1080/08824099709388671.

Simonds, C. J. (1997b) 'Classroom understanding: An expanded notion of teacher clarity', *Communication Research Reports*. Taylor & Francis Group, 14(3), pp. 279–290. doi: 10.1080/08824099709388671.

Simonsen, J. and Robertson, T. (2012) *Routledge International Handbook of Participatory Design*. Routledge. Available at: https://books.google.com/books?hl=en&lr=&id=SnO5JDzp3t4C&pgis=1 (Accessed: 13 October 2016).

Simonsen, J. and Robertson, T. (2013a) *Routledge international handbook of participatory design*. Routledge. Available at: https://books.google.co.uk/books?hl=en&lr=&id=SnO5JDzp3t4C&oi=fnd&pg=PA117&dq=organising+principl

es+and+general+guidelines+for+participatory+design+projects&ots=9EduKRrsvB&sig=JOSztwJIsExOGO1_HwUuwQbRdXA#v=onepage&q=organising principles and general guide (Accessed: 23 January 2019).

Simonsen, J. and Robertson, T. (2013b) *Routledge international handbook of participatory design*. Routledge. Available at: https://www.routledge.com/Routledge-International-Handbook-of-Participatory-Design-1st-Edition/Simonsen-Robertson/p/book/9780415694407 (Accessed: 24 July 2019).

Six, J. M. (2017) *Tools for Remote, Collaborative UX Design :: UXmatters*. Available at: https://www.uxmatters.com/mt/archives/2017/11/tools-for-remote-collaborative-ux-design.php (Accessed: 18 September 2018).

Sleeswijk Visser, F., van der Lugt, R. and Stappers, P. J. (2007) 'Sharing User Experiences in the Product Innovation Process: Participatory Design Needs Participatory Communication', *Creativity and Innovation Management*. Blackwell Publishing Ltd, 16(1), pp. 35–45. doi: 10.1111/j.1467-8691.2007.00414.x.

Sodnik, J. *et al.* (2008) 'A user study of auditory versus visual interfaces for use while driving', *International Journal of Human-Computer Studies*, 66(5), pp. 318–332. doi: 10.1016/j.ijhcs.2007.11.001.

Standaert, W., Muylle, S. and Basu, A. (2015) 'An empirical study of the effectiveness of telepresence as a business meeting mode', *Information Technology and Management*.

Stappers, P. J., Sleeswijk Visser, F. and Keller, I. (2003) 'Mapping the Experiential Context of Product Use: Generative techniques beyond questions and observations', in *In Asian Design International Conference, Tsukuba, Asian Society for the Science of Design.* Available at: https://pdfs.semanticscholar.org/0f35/d591f8423354a403beaeeb0a631c4fa8bba2.pdf (Accessed: 8 February 2019).

Suchman, L. A. (2007) *Human-machine reconfigurations : plans and situated actions*. Cambridge University Press. Available at: https://dl.acm.org/citation.cfm?id=1212951 (Accessed: 21 January 2019).

Sutcliffe, A. (2009) 'Designing for User Engagement: Aesthetic and Attractive User Interfaces', *Synthesis Lectures on Human-Centered Informatics*. Morgan & Claypool Publishers , 2(1), pp. 1–55. doi: 10.2200/S00210ED1V01Y200910HCI005.

Takayama, L. and Nass, C. (2008) 'Driver safety and information from afar: An experimental driving simulator study of wireless vs. in-car information services', *International Journal of Human-Computer Studies*, 66(3), pp. 173–184. doi: 10.1016/j.ijhcs.2006.06.005.

Tasoudis, S. and Perry, M. (2016) 'Mediated participatory design , for contextually aware in - vehicle experiences', in *AutomotiveUI'16 Adjunct Proceedings*. MI, US.

Tasoudis, S. and Perry, M. (2018a) 'Participatory Prototyping to Inform the Development of a Remote UX Design System in the Automotive Domain', *Multimodal Technologies and Interaction*. Multidisciplinary Digital Publishing Institute, 2(4), p. 74. doi: 10.3390/mti2040074.

Tasoudis, S. and Perry, M. (2018b) 'RAUX', in *Proceedings of the 10th International Conference on Automotive User Interfaces and Interactive Vehicular Applications - AutomotiveUI '18*. New York, New York, USA: ACM Press, pp. 225–229. doi: 10.1145/3239092.3268264.

Te'eni, D. (2001) 'Review: A Cognitive-Affective Model of Organizational Communication for Designing IT', *MIS Quarterly*. Society for Information Management and The Management Information Systems Research Center, 25(2), p. 251. doi: 10.2307/3250931.

Thew, S. *et al.* (2008) 'Experience in e-Science Requirements Engineering', in *2008 16th IEEE International Requirements Engineering Conference*. IEEE, pp. 277–282. doi: 10.1109/RE.2008.34.

Thomas, J. and McDonagh, D. (2013) 'Empathic design: Research strategies.', *The Australasian medical journal*, 6(1), pp. 1–6. doi: 10.4066/AMJ.2013.1575.

Tonetto, L. M. and Desmet, P. M. A. (2016) 'Why we love or hate our cars: A qualitative approach to the development of a quantitative user experience survey', *Applied Ergonomics*, 56, pp. 68–74.

Torrance, E. (1974) 'The Torrance test of Creative Thinking: Norms and technical manual. Bensenville, Illinois: Scholastic Testing Service'. Available at: https://scholar.google.co.uk/scholar?q=the+torrance+tests+of+creative+thinking+Norms+1974&btnG=&hl=en&as_sdt=0%2C5#0 (Accessed: 7 October 2015).

User Experience Network. Available at: http://www.uxnet.org/ (Accessed: 17 March 2020).

Uzor, S., Baillie, L. and Skelton, D. (2012) 'Senior designers', in *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems - CHI '12*. New York, New York, USA: ACM Press, p. 1179. doi: 10.1145/2207676.2208568.

Väätäjä, H. *et al.* (2012) 'UX Goals 2012 workshop–how to utilize user experience goals in design?' Available at: https://tutcris.tut.fi/portal/files/1625399/ux_goals_2012_workshop.pdf (Accessed: 29 July 2018).

Vermeeren, A. P. O. S. *et al.* (2010a) 'User experience evaluation methods', in *Proceedings of the 6th Nordic Conference on Human-Computer Interaction Extending Boundaries - NordiCHI '10*. New York, New York, USA: ACM Press, p. 521. doi: 10.1145/1868914.1868973.

Vermeeren, A. P. O. S. *et al.* (2010b) 'User experience evaluation methods', in *Proceedings of the 6th Nordic Conference on Human-Computer Interaction Extending Boundaries - NordiCHI '10*. New York, New York, USA: ACM Press, p. 521. doi: 10.1145/1868914.1868973.

Vines, J., Blythe, M., Dunphy, P., *et al.* (2012) 'Cheque mates', in *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems - CHI '12*. New York, New York, USA: ACM Press, p. 1189. doi: 10.1145/2207676.2208569.

Vines, J., Blythe, M., Lindsay, S., *et al.* (2012) 'Questionable concepts', in *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems - CHI '12*. New York, New York, USA: ACM Press, p. 1169. doi: 10.1145/2207676.2208567.

Vines, J. *et al.* (2013) 'Configuring participation', in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '13*. New York, USA: ACM Press, p. 429.

Visser, F. S. *et al.* (2005) 'Contextmapping: experiences from practice', *CoDesign*. Taylor & Francis Ltd, 1(2), pp. 119–149.

Walther, J. B. (1992) 'Interpersonal Effects in Computer-Mediated Interaction: A Relational Perspective', *Communication Research*, 19(1), pp. 52–90. doi: 10.1177/009365092019001003.

Walther, J. B. (2005) 'Let Me Count the Ways: The Interchange of Verbal and Nonverbal Cues in Computer-Mediated and Face-to-Face Affinity', *Journal of Language and Social Psychology*, 24(1), pp. 36–65. doi: 10.1177/0261927X04273036.

Wärnestål, P. and Kronlid, F. (2014) 'Towards a user experience design framework for adaptive spoken dialogue in automotive contexts', in *Proceedings of the 19th international conference on Intelligent User Interfaces - IUI '14*. New York, New York, USA: ACM Press, pp. 305–310. doi: 10.1145/2557500.2557506.

Weinberg, G., Harsham, B. and Medenica, Z. (2011) 'Evaluating the usability of a head-up display for selection from choice lists in cars', *Proceedings of the 3rd …*. Available at: http://dl.acm.org/citation.cfm?id=2381423 (Accessed: 7 October 2015).

Weng, F. *et al.* (2016) 'Conversational In-Vehicle Dialog Systems: The past, present, and future', *IEEE Signal Processing Magazine*, 33(6), pp. 49–60. doi: 10.1109/MSP.2016.2599201.

Whiteside, J. and Wixon, D. (1987) 'Improving human-computer interaction—a quest for cognitive science'. MIT Press, pp. 353–365. Available at: http://dl.acm.org/citation.cfm?id=28446.28460 (Accessed: 4 May 2016).

Wilfinger, D. *et al.* (2013) 'The car data toolkit', in *Proceedings of the 5th International Conference on Automotive User Interfaces and Interactive Vehicular Applications - AutomotiveUI '13*. New York, New York, USA: ACM Press, pp. 168–175. doi: 10.1145/2516540.2516550.

Woolrych, A. *et al.* (2011) 'Ingredients and meals rather than recipes: A proposal for research that does not treat usability evaluation methods as indivisible wholes', *International Journal of Human-Computer Interaction*. doi: 10.1080/10447318.2011.555314.

Wright, P. and McCarthy, J. (2008) 'Empathy and experience in HCI', in *Proceeding of the twenty-sixth annual CHI conference on Human factors in computing systems - CHI '08*. New York, New York, USA: ACM Press, p. 637. doi: 10.1145/1357054.1357156.

Wright, P. and McCarthy, J. (2010) 'Experience-Centered Design: Designers, Users, and Communities in Dialogue', *Synthesis Lectures on Human-Centered Informatics*. Morgan & Claypool Publishers , 3(1), pp. 1–123. doi: 10.2200/S00229ED1V01Y201003HCI009.

Wu, P. and Miller, C. (2010a) 'Can polite computers produce better human performance', in *Proceedings of the 3rd international workshop on Affective interaction in natural environments - AFFINE '10*. New York, New York, USA: ACM Press, p. 87. doi: 10.1145/1877826.1877848.

Wu, P. and Miller, C. (2010b) 'Interactive Phrasebook - Embedding Human Social Dynamics in Language Training', in *2010 IEEE Second International Conference on Social Computing*. IEEE, pp. 636–640. doi: 10.1109/SocialCom.2010.182.

Zhang, C., Lakens, D. and IJsselsteijn, W. A. (2015) 'The illusion of nonmediation in telecommunication: Voice intensity biases distance judgments to a communication partner.', *Acta psychologica*, 157C, pp. 101–105. doi: 10.1016/j.actpsy.2015.02.011.

APPENDIX A: CONSENT FORM, SEMI-STRUCTURED QUESTIONS, AND STIMULI MATERIAL

MODEL CONSENT FORM

Consent Form for Research Participants

Please complete this form after you have read the Information Sheet.

A study to inform the design of a system which supports remote participatory UX design in Automotive.

This study has been approved by the Brunel University Research Ethics Committee.
Thank you for your interest in taking part in this research. Before you agree to take part, the person organizing the research must explain the project to you. If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you to decide whether to join in.

Participant's Statement

Please tick the appropriate box

- Have you read the Research Participant Information Sheet? YES ☐ NO ☐
- Do you understand that you will not be referred to by name in Any report concerning the study? YES ☐ NO ☐
- Do you understand that you are free to withdraw from the study before the results are published without having to give a reason for withdrawing? YES ☐ NO ☐
- I agree to the participatory workshop being recorded and I consent to the use of this material by the research team, as part of the study. YES ☐ NO ☐
- I agree to the use of non- attributable direct quotes when the study is written up or published. YES ☐ NO ☐
- I agree that the research project named above has been explained to my satisfaction and I agree to take part in this study. YES ☐ NO ☐
- I understand that the information I have submitted will be Published as a report and that I can contact the researchers to get a copy. YES ☐ NO ☐

Signed: ……

Participant Name: …… **Date:**……

Information Sheet for Research Participants

You will be given a copy of this information sheet.

A study to inform the design of a system which supports remote participatory UX design in Automotive.

We would like to invite you to participate in this research project. It involves a driving simulation study in which you can help us design a system to support the needs of automotive UX designers for remote UX design.

What is the study about?

A. You will be asked to interact with a driver remotely in order to understand his behaviour, gather insights and report the findings to other stakeholders. A number of contextual, communication and presentation components will be presented to you in order to use them to synthesize the architecture of the proposed system. You will be asked to choose the components that you find most relevant and compose the 3 basic screens of the proposed supportive system (Context, Communication, and Presentation). For this purpose a remote real time communication interaction with the driver is simulated. The environment consisted of a room where the participants remotely communicate with the drivers and a car simulation room where drivers drive while this communication is taking place.

B. A participatory design workshop will take place after the individual participants create the artefact of their interaction. In the participatory design workshop both the participants and the drivers will take part in order to get insights of the acceptance of the drivers both to the design process and to the data/components used. The participants will be asked to present their creation to the rest and then co-create the final artefact with the other participants. A facilitator will make sure that all parties have equal opportunity to design the final artefact.

What do the researchers want to find out?

All the teams concluded in the creation of artefacts. The artefact by itself will inform the design of the supportive system.

The think aloud process and the semi-structured interviewing while the real time interaction is taking place will give us insight on the goals of the automotive designers when they design for UX remotely. The sessions will be video recorded and the transcripts will be analyzed later by the researcher. The original goals based on the literature review will be revised and informed.

The videos and transcripts of the interactions capturing behavior and conversation will help us define the why and how the designers want to design. A thematic analysis of the transcripts will help us

define instrumental and non-instrumental needs and inform UX design theories and communication theories.

Special interest groups will be defined by this study and will be included in the participatory design workshops of the future.

Do I have to take part? No. It is completely up to you whether you take part or not.

What happens to my information? All information, including what is being discussed during the conversation, the qualitative interview and video recordings, is kept confidential (private) within the research team. No one outside the research team will have access to information which could be used to identify you. The researchers will remove any information, which could identify you (like your name) so that the data we keep is anonymous. Once this has been done, it will not be possible to withdraw your data. When we write our study report, we will not mention any names or other identifying information.

Can I find out the results of the study?

Yes. If you would like to be sent a copy of the study report, please contact the researcher using the email or phone number above.
Stavros.Tasoudis@brunel.ac.uk

Can I keep this information sheet?

Yes, this information sheet is for you to keep.

All data will be collected and stored in accordance with the Data Protection Act 1998.

Simulator Sickness Questionnaire

Instructions: Circle how much each symptom below is affecting you right now.

1. General discomfort	None	Slight	Moderate	Severe
2. Fatigue	None	Slight	Moderate	Severe
3. Headache	None	Slight	Moderate	Severe
4. Eye strain	None	Slight	Moderate	Severe
5. Difficulty focusing	None	Slight	Moderate	Severe
6. Salivation increasing	None	Slight	Moderate	Severe
7. Sweating	None	Slight	Moderate	Severe
8. Nausea	None	Slight	Moderate	Severe
9. Difficulty concentrating	None	Slight	Moderate	Severe
10. « Fullness of the Head »	None	Slight	Moderate	Severe
11. Blurred vision	None	Slight	Moderate	Severe
12. Dizziness with eyes open	None	Slight	Moderate	Severe
13. Dizziness with eyes closed	None	Slight	Moderate	Severe
14. *Vertigo	None	Slight	Moderate	Severe
15. **Stomach awareness	None	Slight	Moderate	Severe
16. Burping	None	Slight	Moderate	Severe

* Vertigo is experienced as loss of orientation with respect to vertical upright.
** Stomach awareness is usually used to indicate a feeling of discomfort which is just short of nausea.

MODEL CONSENT FORM

Consent Form for Research Participants

Please complete this form after you have read the Information Sheet.

A study to inform the design of a system which supports remote participatory UX design in Automotive.

This study has been approved by the Brunel University Research Ethics Committee.
Thank you for your interest in taking part in this research. Before you agree to take part, the person organizing the research must explain the project to you. If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you to decide whether to join in.

Participant's Statement

Please tick the appropriate box

- Have you read the Research Participant Information Sheet? YES ☐ NO ☐
- Do you understand that you will not be referred to by name in Any report concerning the study? YES ☐ NO ☐
- Do you understand that you are free to withdraw from the study before the results are published without having to give a reason for withdrawing? YES ☐ NO ☐
- I agree to the participatory workshop being recorded and I consent to the use of this material by the research team, as part of the study. YES ☐ NO ☐
- I agree to the use of non- attributable direct quotes when the study is written up or published. YES ☐ NO ☐
- I agree that the research project named above has been explained to my satisfaction and I agree to take part in this study. YES ☐ NO ☐
- I understand that the information I have submitted will be Published as a report and that I can contact the researchers to get a copy. YES ☐ NO ☐

Signed: .....

Participant Name: ..... **Date:** .....

Information Sheet for Research Participants

You will be given a copy of this information sheet.

A study to inform the design of a system which supports remote participatory UX design in Automotive.

Designing for user experiences is a field that emerged quite quickly in Economic and Psychology studies and is recently one of the main concerns in Human Computer Interaction. Even though there were attempts in the past for in-depth context aware situational research in the automotive domain, which can lead to the real life understanding and designing for experiences in the automotive domain, there is still a general lack of supportive tools for achieving it. Following the design science research paradigm in this study, we design and evaluate a system that supports participatory UX design in the automotive. We would like to invite you to participate in this research project. This system and our study will help us explore the limitations and the possibilities of remote in-vehicle design for experiences.

What is the purpose of the study?

The purpose of the project is to identify the user 'goals' of the proposed remote participatory design system, for the early stages of designing for in-vehicle experiences. To implement the goals prototype and evaluate the System and its front end interactions in the early stages of the design process. Finally, to propose a Framework that supports developing remote UX design systems.

Why have been invited to participate?

We feel that you might provide valuable input into the process of design and evaluation of the proposed remote communication system, and that your views are valuable. You have been invited because either you are an automotive designer, user researcher or both.

Do I have to take part?

No. It is completely up to you whether you take part or not. Also you have the option to withdraw from the study at any point.

What will happen to me if I take part?

In this workshop we will ask you to interact with the prototype systems developed to support the remote UX design process in automotive. You will be asked to read and use the goal-driven personas and scenarios we will provide you with. The workshop will take approximately 2 hours of your time and a £20 amazon voucher is provided to you as a good practice to balance your effort and time.

While interacting with the system you will be asked to:

1. Evaluate the UX design goals synthesized during the previous iterations.
2. Validate the affordances of the 2 online proposed prototypes.
3. Critique the scenarios and the interactivity of the interaction.
4. Re-design the remote UX design system.

Workshop process and timeframe	
5 min	Introduction
5 min	Free form interface exploration
25 min 35 min	Reading and applying the Personas and Scenarios of use
25 min	Qualitative Semi-structure interviewing
5 min	BREAK
20 min	Critique and co-design

What do I have to do?

Based on the proposed scenarios of use and personas that we will provide you with, you will be asked the following questions after interacting with the online system. The qualitative interviewing protocol is based on semi-structured interviewing. As a result, the questions may change according to the conversation flow and the insights elicited.

What are the possible disadvantages and risks of taking part?

There are no disadvantages or risks in taking part other than a small amount of your time and effort.

What if something goes wrong?

The ethical guidelines and procedures put in place will ensure that there is very little that can go wrong and if it did would have minimal impact on any participant.

What do the researchers want to find out?

All the participants will conclude in the creation or revising of artefacts. The artefact by itself will inform the design of the supportive system.

The interviewing while the interaction with the prototypes is taking place will give us insight on the goals of the automotive designers when they design for UX remotely. The sessions will be video recorded and the transcripts will be analyzed later by the researcher. The original goals will be revised and informed. The videos and transcripts of the interactions capturing behavior and conversation will help us define the why and how the designers want to design. A thematic analysis of the transcripts will help us define instrumental and non-instrumental needs and inform the UX design goals and the affordances of the system. Special interest groups will be defined by this study and will be included in the participatory design workshops of the future.

Will my taking part on this study be kept confidential?

The data will be anonymized – so that no individual is attributed to any particular view. The data will be aggregated and so it will be impossible to distinguish between participants.

What will happen to the results of the research study?

These will be anonymized and published more widely as part of Conference and Journal papers. All information, including what is being discussed during the conversation, the qualitative interview and video recordings, is kept confidential (private) within the research team. No one outside the research team will have access to information which could be used to identify you. The researchers will remove any information, which could identify you (like your name) so that the data we keep is anonymous. Once this has been done, it will not be possible to withdraw your data. When we write our study report, we will not mention any names or other identifying

information.

Who is organizing and funding the research?

Brunel University is Funding the research and Stavros Tasoudis is organizing it.

Can I find out the results of the study?

Yes. If you would like to be sent a copy of the study report, please contact the researcher using the email or phone number above.
Stavros.Tasoudis@brunel.ac.uk

Can I keep this information sheet?

Yes, this information sheet is for you to keep.

All data will be collected and stored in accordance with the Data Protection Act 1998.

A study to inform the design of a system which supports remote participatory UX design in Automotive.
Semi-structured interview questions based on the system development:

Questions for Scenario 1:

A. A designer previously said 'I am not sure what one sees in your face is what you feel, I think there is a discrepancy there.' 'My facial expression can be affected by so many factors.' UX designers need to empathize with the user in his every-day life environment. Do you believe the technologies used here can adequately support you in this direction?

B. Are there any other contextual data that you think are missing from the system and you think would support you getting valuable insights?

C. Experience designers identify patterns of behavior through time. If the system informed you when a possible pattern occurred, would it be helpful for you? (Triggering a communication between you and the user to decide whether there is a pattern.)

Questions for Scenario 2:

A. Observing face to face or video recording is a common method for designers and researchers to bring valuable insights to their designs. Do you think observation using technologies such as real-time 360-degree video would have a negative effect on the driving experience of your cars?

B. Do you think privacy is a concern for using tracking technologies such as eye/ face/ audio, video or avatars? Does this have a negative effect on your understanding of the user's behavior?

Questions for Scenario 3:

A. Most of the UX designers believe that experience is a phenomenon that happens during time. Therefore, they chose a tool to illustrate the whole episode of the experience and not only the moment that occurred. Do you think an interactive customer journey would help you communicate a problem/phenomenon to your colleagues?

Questions for Scenario 4:

A. When there is no set brief the user experience designers want to explore the problem space and gather insights. This is a difficult process because it helps to either know your users or what you are looking for. Do you think the system adequately supports the exploration of 'wicked' problems?

Questions for Scenario 5:

A. What do you think of the interactivity of the system? Do you think there is any redundant information that could have been excluded?

B. Some UX designers expressed their anxiety about their self-presentation during any communication with a user. Do you feel that your personal image or your presentation is going to affect the communication through the system?

C. An automatic transcript function was added to our system among other automated tasks. Do you feel that the interaction is adequately intelligent or more automation could be used?

Questions for Scenario 6:

A. Do you feel that the system will support you in having a fluent and empathetic communication with the user? Are the tools provided adequate? What would you change?

Questions for Scenario 7:

A. UX Designers tend to explore a small group of people to get deeper insights. Communicating and arguing with them to other stakeholders sometimes requires that they generalize their findings or prove the transferal of the situation. Do you think the system supports this goal adequately? Do you think this is a necessary tool for our system or it could have been excluded?

1

AFFORDANCE: The metaphor of you being in the real vehicle with real passengers

2

AFFORDANCE: The metaphor of you being in a game-vehicle with avatars of the passengers

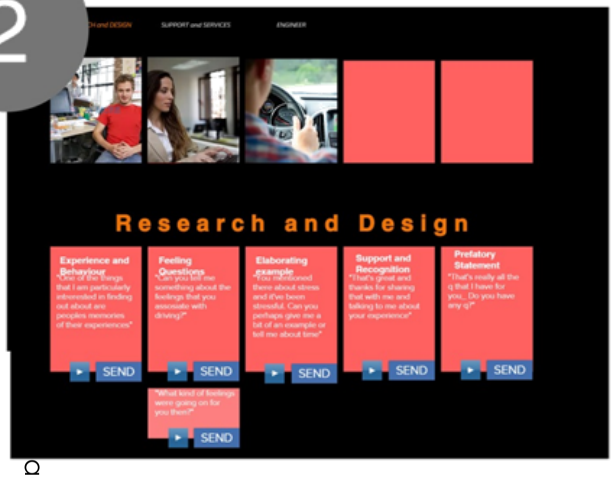
OTHER INSIGHTS

PLEASE COMPARE AND CRITIQUE THE CONCEPTS USED

1

AFFORDANCE: The conceptual model of gamebooks - Suggested Guidelines to your actions

2

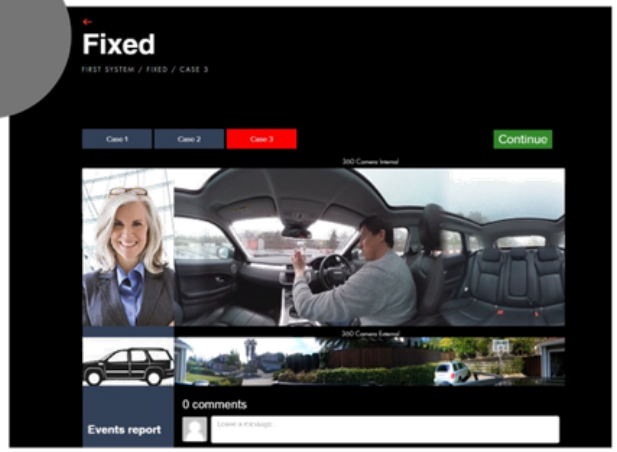


AFFORDANCE: The conceptual model of archetypes - Pre-defined Characters and communication styles

OTHER INSIGHTS

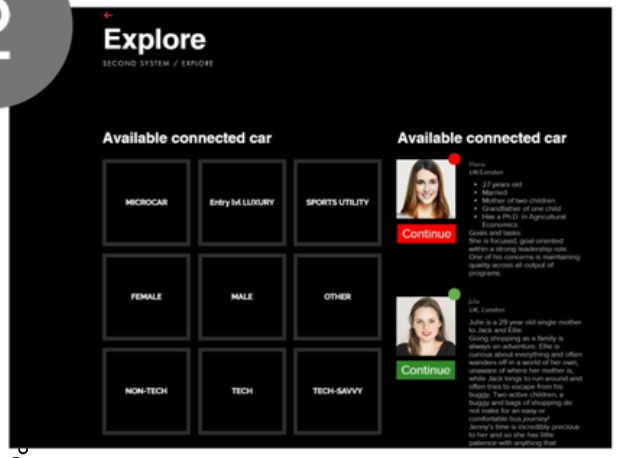
PLEASE COMPARE AND CRITIQUE THE CONCEPTS USED

1



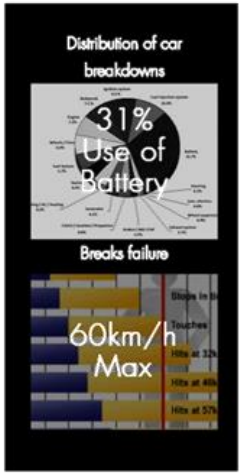
AFFORDANCE: The conceptual model of a pre-defined target group pf users and use cases (Brand Driven innovation)

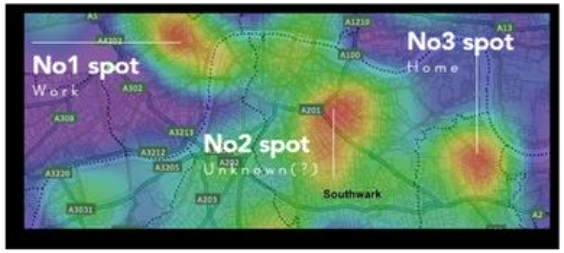
2



AFFORDANCE: The conceptual model of narrowing down by adding limitations (User driven innovation)

OTHER INSIGHTS





DRIVING EXPERIENCE CONTEXT OF USE:

o Demographics,

o Internal and External environment,

o Flagged events,

o In-vehicle Information Systems and Use,

o Heat maps of most visited locations,

o A-B Maps and stops of the vehicle

OTHER:

OTHER INSIGHTS

PLEASE CRITIQUE THE CONCEPTS USED

AUTOMATED TASKS

o Search scenario,

o Trigger communication of available user scenario,

o Auto-transcribe conversation

OTHER:

OTHER INSIGHTS

INTERACTIVE CUSTOMER JOURNEY MAP:

AFFORDANCE: The conceptual model of a chronological review of a complete episode of use

EXTRA COMPONENTS:

OTHER INSIGHTS

APPENDIX B: PUBLICATIONS

Multimodal Technologies and Interaction

MDPI

Article

Participatory Prototyping to Inform the Development of a Remote UX Design System in the Automotive Domain

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Abstract: This study reports on the empirical findings of participatory design workshops for the development of a supportive automotive user experience design system. Identifying and addressing this area with traditional research methods is problematic due to the different user experience (UX) design perspectives that might conflict and the related limitations of the automotive domain. To help resolve this problem, we conducted research with 12 user experience (UX) designers through individual participatory prototyping activities to gain insights into their explicit, observable, tacit and latent needs. These activities allowed us to explore their motivation to use different technologies; the system's architecture; detailed features of interactivity; and to describe user needs including efficiency, effectiveness, engagement, naturalness, ease of use, information retrieval, self-image awareness, politeness, and flexibility. Our analysis led us to design implications that translate participants' needs into UX design goals, informing practitioners on how to develop relevant systems further.

Keywords: user experience; remote UX; participatory design; co-creation; prototyping; automotive user interfaces; autonomous vehicles; automotive

1. Introduction

Autonomous driving is transforming the driving experience in the 21st-century vehicle. Artificial intelligence is core to this automation in enhancing safety and reducing accidents, although it may bring with it a loss of the traditional driving experience and the sense of being in control. This new paradigm results in a radical shift of the traditional driving experience. While part of the driving experience may be taken away by automation, travellers also have the convenience of using their free commuting time to explore different driving experiences and in-vehicle interactions in the car context. Given the possibilities of web 2.0 and the Internet of things (IoT), what were previously considered as secondary driving tasks or activities, such as interacting with in-vehicle information systems, infotainment, in-car productivity or social interactions and real-life experiences with other passengers in the car, are slowly emerging as primary activities. Previous research has investigated the non-driving-related activities that drivers want to perform while driving partly or entirely automated, and has identified the potential for mobile and ubiquitous multimedia applications in the car [1]. As a result, the recent focus of attention in automotive UX research includes design techniques for exploring automotive interaction in the drive towards automation [2]. Furthermore, understanding what it means to drive in an autonomous vehicle shows the potential of a shift from a "joy of driving" to a "joy of being driven" through the exploration of new forms of connectivity, entertainment, productivity, gaming as well as transportation-related services [3]. This space hands designers new opportunities

for innovation, yet the deficiencies [4] entailed by the context of the car add layers of complexity to the research and design practitioners. Drawing from previous research, a critical disadvantage of the traditional context-aware methods (including Contextual inquiry, Ethnography and Cultural probes) is the effect of the physical presence of the researcher within the driving experience itself. Added to other secondary limitations, such as motion sickness of the researcher while taking notes inside the car, intrusiveness, loss of privacy, organizational challenges and effort [5], these approaches are not ideally suited to this context.

Previous attempts to mitigate some of the domain-specific deficiencies and support designers in the exploration of new user experiences have led to driving simulator platforms [6] that support the rapid iterative development of in-vehicle user experiences. Other research attempting to explore this design space "in-context" has led to new methods and tools, such as "trip experience sampling" (TES) [7], a context-aware low-tech method of remote user experience research in the car that addresses the immediateness and situatedness of automotive user experience research. Similar tools designed by Niforatos et al. [8] address in-situ measurement methods and avoid the disruption of users, a limitation for which TES has attracted criticism. Their work introduces EmoSnaps, a mobile application that captures pictures of facial expressions unobtrusively throughout the day and uses them for the later recall of momentary emotions. More recent research [9] has introduced systems that attempt to make sure that the in-vehicle automotive interactions can be designed, tested and understood before mass production, inspired by previous knowledge in ubiquitous computing and remote user experience research systems including "Momento" and "Dart" [10,11] to support the holistic understanding of a safe driving experience. We therefore see the emergence of a research agenda attempting to overcome the difficulties inherent in the setting and which can capture the situated context holistically, by developing supportive user experience design systems to meet the needs of the automotive UX designers.

The needs of UX designers in any domain have been the subject of debate within the research community. Much of the available literature on experience design is in line with the needs that TES is addressing, by supporting the capturing of an experience, momentarily, when it happens [12]. Other researchers [13], however, disagree that UX is a momentary emotion, and the designers need to capture it, evaluate it with psycho-physiological measurements, before later designing for it. Here, it is supporting the long-term user experience that matters, rather than the momentary emotion that could even be meaningless to the user. Other recent work explores eudemonic user experiences (contrasted with hedonic experiences), in accomplishing personal goals through technology use [14]. This orients to technology design in supporting people's values, such as keeping up with fitness through technology. For instance, eating healthy food is hard and sometimes unpleasant, but it can serve the personal values and eudemonic goals of being healthy in the long term.

The needs of the UX practitioners when they remotely design an autonomous car are ill-defined and, to design for such needs is, as Horst Rittel and Melvin Webber proposed, a "Wicked Problem". An ill-defined or wicked problem occurs because the conflicting perspectives of the stakeholders cannot be accurately modeled or addressed using the reductionist approaches of science and engineering [15]. In our study, both the automotive domain limitations and the conflicting perspectives on how to approach automotive UX design have led us to deploy a pragmatic epistemological paradigm and to apply participatory prototyping methods.

Our aim was to identify these under-constrained needs of UX designers so that we can inform the development of a new remote UX design system that democratizes automotive innovation. The new remote UX design system is an interactive system that consists of methods and tools similar to TES, Momento, Dart, Emosnaps and Woz Way with an aim to support remote UX research and design in the automotive context. With an aim to democratize automotive innovation, the system serves as a platform for non-trained UX designers and drivers/passengers to collectively come up with the most innovative automotive experiences. Our research focused on the UX professionals' side of the interactive system and their interactive experience with it. To achieve this, we applied a

participatory approach to design the supportive system by actively involving UX designers in the making process. We explored implications including the participants' motivation to use the supportive technologies, the detailed interactivity of the system, and the system's architecture, allowing us to translate participants' (UX designers) needs into UX design goals that serve as actionable insights for the development of a relevant system-solution. We conclude on a pragmatic interpretation of our findings to inform the design of such systems and offer directions for future work in automotive user experience design.

2. Background

Following a pragmatic epistemological standpoint, a critical review of previous work resulted in the collection of design guidelines and deficiencies. Following its multidisciplinary orientation, there are various domains that this primary knowledge is derived from and this also allows us to identify conflicting perspectives. As a result, there are no set requirements for the design of a compatible remote automotive UX system, but we can identify a set of guidelines. We highlight the most relevant guidelines from previous work in the three research areas identified: the UX design process, the design of remote communication systems, and design deficiencies identified in automotive systems. These guidelines were used as stimuli in our participatory design methods to initiate discussion and action around them. They were then also used to design the components of a toolkit used in the early stage of our participatory design. We present some of these guidelines in the following subsections.

2.1. UX Design Process Guidelines

User experience designers follow different methods and processes when designing for interactive experiences. Following on the most relevant manifestations of design methods and processes, we used Design Thinking approaches (IDEO) [16], at the early stages of the design cycle. As a result, the design of a supportive system regarding tasks and processes should be able to help the designer through the understanding of the challenge, the preparation of the research and the gathering of research inspiration supporting the "discovery" cycle. The approach also involves storytelling, the search for meaning and the framing of opportunities in the "interpretation" cycle.

Previous researchers have also mentioned the need for insights into the emotions of the users. The fact that consumers are "feelers" as well as "thinkers" [17] suggests a need for supporting the identification of emotions in user behavior. A system that supports the user experience design process according to Hassenzahl and Tractinsky [18] will need to support the designer to identify the user's internal state and the environment and the context when the interaction occurs.

Contextual understanding is undeniably a critical need for user experience designers. As previously mentioned [19], the social environment of the interaction, the physical environment (where the space of the interaction is dynamic or static), and the time-dependence of the interaction in a specific situation, should be observed by the designer to spark inspiration or to help them in gathering insights into and achieve a deep understanding of the user. Supporting the mapping of the context is both of great importance to a holistic understanding of the interactions taking place and necessary in designing for people and their experiences while involving them [19].

According to Whiteside and Wixon [20], productivity and learnability are not experienced as primary features of use, and thus the system should support the identification of the user's experience at the moment that they experience it. Other research highlights finding the right timing for communication or interruption [21] when exploring behavior in its context to favor intrusiveness avoidance at the expense of time-dependence. Nevertheless, there is controversy surrounding the time dependence of contextual understanding when designing for UX. Some researchers suggest supporting the previous process of understanding the user immediately after the interaction when the situation occurs [22], while others [13] suggest supporting the long-term understanding of context to help design for the overall UX.

2.2. Remote Communication Guidelines

When designing for remote systems, the social context of the communication and the medium of communication are considered of great importance. Context has been found to influence a communication medium's perception and effectiveness [23]. In a remote communication, this can be frustrating as social appraisals are more likely to play an important role when others are present than when absent [24]. For instance, a person may perceive a communication technology as inappropriate because his or her friends or family who are present were intimidated. As a result of these abstract social, moral codes, systems are recommended to support the avoidance of disruption in situations of co-presence [25].

As previously highlighted, choosing the medium for a remote system is controversial and dependent on the context. Different media are better equipped to disseminate information ("conveyance") while others are better at engendering mutual understanding ("convergence") [26]. Guidelines on previous research suggest that media used in remote systems should support the avoidance of Face-threatening acts (FTA), including acts of criticizing, disagreeing, interrupting, imposing, asking favors, making requests, and embarrassment [27]. In addition, systems should support etiquette in communication to make social interactions more pleasant and polite [28] by using the appropriate medium.

A system's effectiveness also depends on the medium used. To support UX designers in observation of a hidden or latent need, the communication medium used should support the identification of cues such as frustration, confusion, or unexpected usage. Other guidelines on the communication media and the effectiveness of a remote system include the importance of social "presence". These studies suggest that, to communicate effectively, one should match the social presence of the medium with the level of personal involvement and attention of the communication task [23]. For example, when the medium allows teleconferencing, employees are more aware of others' status and reactions, and they will be more cautious about their self-image and behaviors [29].

2.3. Automotive Domain Deficiencies

When designing for interactions, designers need to attend to the context, i.e., the social, physical and temporal environments of the interaction, in a given situation. Any of these aspects can have a direct effect on the interactive experience. Designers and researchers [5,19,30] generally agree that context is both of great importance to a holistic understanding of the interactions taking place and necessary in designing for people and their experiences. However, in automotive studies of Human-Computer Interaction (HCI), there are few studies (with some exceptions, e.g., [31–33]) that have previously investigated the influence of the automotive context in a systematic way using qualitative methods in real time driving situations, based on a holistic research approach. Ethnographic research in the automotive environment is unconventional; nonetheless, recent studies have used it to explore sociocultural issues in the driving experience in collaboration with Nissan [34]. Other Companies including BMW have even undertaken early remote open innovation and co-creation paradigms [35] involving people in the generation and the design phase. Meschtscherjakov et al. [5] highlighted important limitations for researchers and designers in the automotive domain. At a higher level, supporting the holistic understanding of the automotive context dictates that we mitigate these limitations. Previous research [4] has summarized the deficiencies which affect automotive design and communication. These include the distortion of the experience by the physical presence of the researcher in the car, intrusiveness, minimization of the effort of traditional contextual methods, the avoidance of cognitive effort, as well as concerns for the safety and privacy of the driver and/or passenger(s) while the interaction takes place.

Finally, we cannot neglect the fact that the communication involves two people, a researcher/designer, and a driver/passenger. Designing to support this communication also relies on the perceived trust, control, ease of use, enjoyment, attitude towards the methods and tools used to

interact and the intention to interact, of both the researcher/designer and the driver/passenger and we therefore add them to our set of limitations.

2.4. Remote UX Design Systems and Automotive

In user research, the two main activities are observing and interviewing participants as seen in (see Figure 1). User experience researchers are interested in accurate information about people, their tasks, and their needs, and, since interviews are not always accurate, observation has greater value. Observation of human behavior is an essential element of most user-research, including usability testing, contextual inquiry, naturalistic observation, shadowing, covert observation, and participant observation. The main differences between these methods are the location of the observation, the amount of interaction with participants, the proximity to the participant, and the participants' knowledge of being observed [36]. To achieve unobtrusive results, practitioners use a variety of tools [37] in UX Research and Design UX researchers need to share their inspiration material, data or insights using synchronous or asynchronous communication tools. Sketches and discussion of the ideas can be supported using a combination of tools such as Google Drive or InVision and Skype or Zoom. The simplest solution is to ask team members to sketch on their own, then take photos of their sketches and share them on Google Drive or InVision, so everyone can see them while discussing the problem via Skype or Zoom. To understand the problem of interviewing or communicating orally, a variety of Web conferencing tools, including WebEx, GoToMeeting, and Zoom, can support UX designers. Finally, screen sharing is more effective than any shared drawing tool. Just as UX designers come from a variety of backgrounds, they like a variety of different tools that they use when designing user experiences.

Figure 1. Remote automotive UX systems support in UX research and design by observing; interacting with synchronous or asynchronous data concerning the context of the car; and communicating in real-time with the passengers or the drivers.

Automotive researchers use remote observation techniques initially applied in the mobile phone domain since similar systems in the automotive domain are not fully developed to the extent that supports both UX research and design. Previous researchers [38] introduced toolkits that use Android smartphones to offer a low-cost, manufacturer-independent and scalable in-car agile prototyping and research environment. CarDaT (Car Data Toolkit) enables researchers to gather data on human

behavior and designers to create novel context-aware interface solutions remotely by combining available remote data, smartphone sensor data and other car generated data. Even though these toolkits are not part of a complete system proposition which also supports interviewing, as a fundamental part of user research, they can still support or even replace observation and the identification of behavioral patterns of drivers or passengers. Only a few attempts have been made to extend previous remote systems, foreshadowed by Carter et al. [11], by providing real-time video and automotive data with the ability of designers to directly interact with a driver through speech and in-car interfaces. WoZ Way [9], for example, allows designers to watch the real-time driving experience via high-fidelity video and audio, and also simultaneously receive meta-data about the drive. The designer can also ask questions by using a text-to-speech messaging system, or remotely triggering custom in-car screen and electromechanical interfaces.

3. Methods

Even though user-centered design (UCD) has influenced our methods, our study deploys participatory design and co-design techniques to actively involve non-expert users (automotive domain experts) to the generation and conceptualization of our prototype system. UCD is a design method whose application conducts designers to develop usable design solutions for end users. Co-design, on the other hand, is a set of creative techniques whose aim is to inspire design. Creative exercises are usually applied to enhance idea generation and concept design; they are characterized by the presence of non-designers (experts) as participants, and usually led by designers [39].

As participation in this study, we refer to the term that in HCI, as part of participatory design, means democratization and end-user involvement in the design process and it is used in the design innovative technological interventions. Previously, the use of the term within HCI research often described the involvement of people in a design process [40–43], or the gathering of insights and requirements to inform future design [44,45]. As Vines et al. described, the term participatory design generates reflection on participation in design in broader terms than if we were to reduce ourselves to tight definitions or specific traditions. They also explained how within HCI, many previous researchers describing participatory processes provide examples of working with groups who might be excluded [40,43,46,47], including people with special needs in terms of health and emotional wellbeing [41,48] or in contexts where the introduction of information and communication technologies might conflict with cultural traditions [49]. The automotive context—given the long tradition in different research methods and tools, which is mostly a result of the many limitations of the domain as explained in this study—does not follow the current trends in opening the design process to non-trained individuals and the gathering of insights and requirements to inform future design.

In the past, participatory design approaches including narratives, games, and artifact construction have been applied under different contexts [50]. In co-design, the participants are active design partners. The co-design process deploys tools and generative techniques [51] to access people's feelings, aspirations, and imaginations and delve deeper into the explicit, observable, tacit and latent needs of the participants. By co-designing an artifact in our study, the prototype of the system designers can gather data on what the participants say, do and make to get a deeper understanding of their needs: *"One should keep in mind that the relationship between designer and user (consumer, recipient) is bi-directional. It is not as if users have well-defined requirements, which only wait to be discovered. Indeed, requirements are co-constructed in the ongoing dialog between the user and designer."* [12]. In this study, our users are User Experience researchers and designers working in various non-automotive domains. They are familiar with the UX design process, but not professionally familiar with automotive contexts, as we explain below.

As we have shown, previous work developing remote automotive UX design systems does not provide us with well-defined requirements. Consequently, we followed a top-down approach which initially capitalizes on the available knowledge of the UX design processes, automotive limitations and remote communication guidelines from previous research. Driven by our pragmatic epistemological standpoint and the nature of the problem, we apply individual participatory design workshops that actively involve participants to prototype the proposed remote UX design system and triangulate our findings. The analysis of qualitative data is our primary source to inform theory and design. Tonetto et al. [52] highlighted the fact that quantitative data are more precise and are useful for attracting investments or convincing stakeholders about the effectiveness of design decisions. This could explain, to some extent, why quantitative data are widely used in automotive research and design. Some of our participants also preferred a combination of the two.

Our methodology included the following:

- a review of guidelines;
- a design tailored to the design problem toolkit;
- participatory prototyping sessions;
- analysis of the rich data on user needs; and
- the translation of user needs to UX goals.

The use of these methods allowed us to identify users' needs and provide actionable insights in the form of UX design goals to help practitioners in the development of relevant systems.

3.1. Toolkit

Participatory design tools and methods are widely used to share control, share expertise and get inspiration for change [49]. Participation through co-design has attracted the attention of researchers in HCI who need to gain rich insights into the explicit, observable, tacit and latent needs of the participants [30]. In line with this, McCarthy et al. [53] suggested identifying the uniqueness of the individual's experience by eliciting the salient situational circumstances.

Previous research [54] summarizes the terminology used to highlight techniques and toolkits when one uses a participatory design method. It describes a method as a collection of the material components (toolkits) and techniques that are used in combination with participatory design activities to serve a specific purpose. Previously, Sanders et al. and Sleeswijk et al. used participatory design toolkits [54,55] and Pettersson et al. [2] used participatory design techniques in co-design and co-creation activities, to achieve higher active involvement of the participants. In some cases, previous researchers even delve into the latent explicit and observable needs of the participants when using them. Sanders [56] explained that, to gain insights into experiences, thoughts, feelings, and dreams, we should provide the participants with tools which are focused primarily on what people make in addition to what they say and do. To serve this purpose, we designed and applied a participatory prototyping toolkit as part of our method.

We based our prototyping toolkit on the Design Thinking (DT) model for designing new artifacts. The toolkit consisted of low-fidelity representations of: (A) the processes, which involved three basic screen-wireframes representing the three steps of the process used to support the need for discovery and interpretation; and (B) the available components, including communication technologies and interactive elements. Two previous low-fidelity designs served as stimuli material for the co-design workshop.

The first part of the toolkit consists of cards of low-fidelity paper illustrations of components (see Figure 2) derived from the guidelines of previous work. These cards both serve as stimuli for discussion (i.e., what the users say and do) about the design and application of the system in context, the acceptance of the technologies used, the system's architecture and interactivity, and lay the foundations as a tool for prototyping (what the users make). Similar tools presented by Sanders' "make" tools [51] are commonly used by practitioners, including the "interface toolkit" by Frog design. Components include the following: car passengers (1 or many); behavioral tendencies; relation (friends, family, and intimate other); emotion, skills; physical and temporal context; where (map); when (time and date); weather (sunny, rainy, etc.);temperature; noise (very loud, not loud at all, etc.) system context; percentage of use of in-vehicle information systems (IVIS); video/audio/text/emoticons/gifs; charts/pies; snapshots infographic; storyboard; and customer journey.

Figure 2. The paper cards represent technologies or affordances previously used to help in identifying the context of the vehicle, supporting the remote communication, and presentation. We base the selection and design of our cards on previous work on remote communication, automotive domain deficiencies and UX Design process guidelines.

Based on the IDEO's design thinking methodology, the second part of the toolkit serves the early design stages of the new experiences process. Three sheets of A3-size paper served as the space for low-fidelity prototyping of the basic-screens and interactivity for the proposed system. We designed the basic-screens as an empty web page with only a title and information on the design thinking processes. The technique that we recommended for the prototyping was to fill the basic-screens with information, notes, and the cards that we provided (see Figure 3).

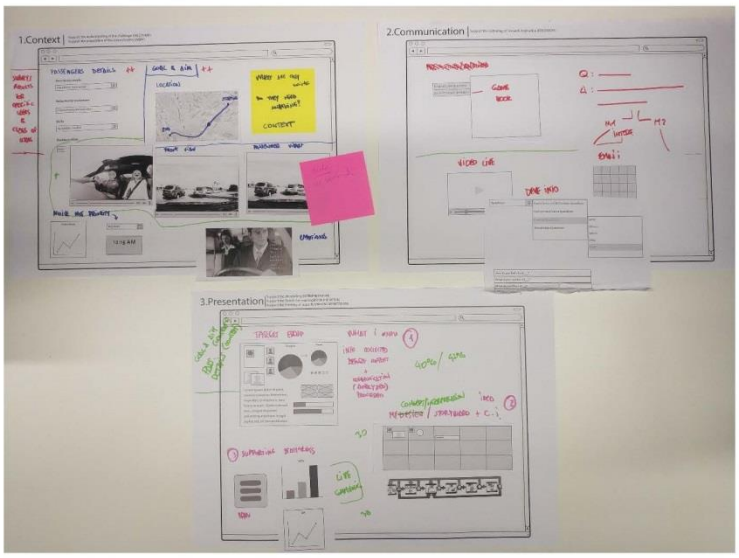

Figure 3. P6 participant's basic-screen paper prototypes of the interaction. The three basic screens represent the early stages of the design thinking process. UX researchers/designers individually co-designed their versions based on their needs.

3.2. Participants

Iversen et al. [57] argued for a value-led participatory design approach. They saw a co-design process, at its core, as a negotiation of values that all participants bring to the table or which emerge from a collaborative experience. It is not only which values are important, but also whose (participants) values drive the design process. To assess these values, we chose to involve UX designers who were not directly involved in the automotive domain. The democratization of UX design in automotive has two ends. The first one is to actively involve drivers and passengers in the design process. The second and most important, since it is the focus of this study, is to involve UX designers (not trained in the automotive context) in the automotive co-design process. It is in the interest of this study not to fixate on pre-conceived views of what are the right methods and tools based on Automotive UX designers since our end users are not necessarily UX designers with automotive design experience. Furthermore, our conversations with designers inside the automotive industry suggest that the industry is extremely traditional regarding the methods and tools used to design and evaluate interactions in comparison to other domains. To achieve a state-of-the-art result and an innovative outcome, we wanted to avoid traditional thinking, or recreate existing or obsolete solutions. Since the system itself aims to provide support not only to expert users such as automotive UX designers but also to general UX designers, this decision fits our purpose.

We recruited 12 UX professionals aged 18–34 years. These consisted of eight UX designers/researchers working in academia and four in industry, recruited from a "snowball" referral of seven initial participants. All participants had expertise in design and high familiarity with new technologies. The workshops were individually assessed. These were all holders of a driving license and were therefore non-professionally aware of the driving experience and driving context. The intention of this was to secure the holistic nature of our design, and to make sure that we did not exclude other stakeholders' values such as the drivers' values from the design result. Each study participant received a reward/token and a box of chocolates for their time and effort.

3.3. Participatory Prototyping Procedure

To identify the values of the designers that need to be fulfilled, we used prototyping workshops to collect rich data on what the participants say, do and make and to translate them into design goals. *"Prototyping is a venerable system development methodology that involves construction and test of prototypes of systems, often for purposes of clarifying vague requirements and often in collaboration with the prospective users."* [58]. Participatory design limitations including recruitment limitations, and time and location sensitivity dictated that we actively involved participants in individual sessions. Furthermore, individual sessions were useful because the system being designing was relatively new, and therefore under-constrained. Using group sessions would have undercut part of these insights. In contrast, in comparison to the group sessions, the results were more detailed and personalized due to the time spent with one individual at a time.

In each session, the participants co-designed a low-fidelity prototype of the front-end interactions of the system using the components that were previously provided to them. To conduct the paper prototyping along with the cards of the components, we provided sticky notes, a marker, pencils and glue for the participants to construct their three basic screen-wireframes. We encouraged them to use whatever means they felt were most natural to them and in many cases, we constructed meaning with them collaboratively.

The sessions were conducted similarly to a group session with one researcher as a moderator who is also involved in the discussion and the co-creation of meaning and content without leading or biasing participants. When the moderator is one of the artifact designers, they should be cautious not to introduce any personal bias into the presentation of the artifact. We tried to avoid bias on a prototype design since we provided the participants with the basic platform and raw materials that were then used to obtain their prototypes.

An introductory video of a physically present designer interviewing a driver while they are driving in a real-time driving situation was displayed before the workshop started. This was to inform UX designers of the current field methods used in Automotive Design and Research and to allow them to empathize with the automotive deficiencies mentioned above. Sessions lasted 50–60 min, with approximately 15 min for each of the three tasks to which the participants were assigned. We were mainly concerned with capturing "how" and "why" the participants would like to be supported in the discovery and interpretation phase in the early stages of the remote automotive UX design. Observation and semi-structured interviewing took place beside other complementary methods, such as co-designing the artifact. Observation, without following a specific observation scheme, was mainly a tool to capture the "do" and "make" data other than what they say. Notes of critical points were taken to support the findings and video/audio recordings of the sessions were taken for later analysis. At the end of the participants' tasks, we used a semi-structured interview to ask participants to identify the following:

- The contextual data that would support the UX designers in designing for people's "driving experience" in an autonomous vehicle. When we say "driving experience" in an autonomous vehicle, we mean understanding and designing mostly for secondary activities and interactive experiences in an autonomous vehicle including infotainment, productivity, and gaming or other digital services.
- The tools and techniques they would use for in-depth communication and information elicitation; what existing tools and techniques might support synchronous and asynchronous communication.
- The tools and techniques that would support them in communicating their results to other stakeholders; how to support them in presenting their rich findings.

Based on good interviewing practice, we used complementary "why" questions to shed light on short or unarticulated answers. We encouraged the participants to provide critical comments about their choices and designs. Furthermore, we prompted discussion by asking them to structure the information, the main groups of the content and add any other components that are not present in the stimuli material. As a result, we have captured rich data of what the participants say, do, and make, using a combination of observation, momentary qualitative interviewing and video records of the interaction. We also gathered the artifacts of each session and analyzed them to support the findings.

3.4. Analysis

After the participatory design sessions, we implemented an inductive approach to data coding and analysis. We transcribed and coded the audio-visual data. Thematic maps helped us to sort the transcripts into related groups from which we later drew our themes. However, it is impossible to be purely inductive and completely ignore the semantic content of the data when we code for a particular theoretical construct. What is essential in this first part is that we prioritized the participants' meanings. We concluded on the user experience designer's values that need to be fulfilled when we design such systems. These findings are presented as the needs of the UX designers in the automotive context and support the summative theoretical contribution which aims to evaluate such systems.

The prototypes created are the means that the participants use to express their multi-layered needs and the experiences they want to have when interacting with similar systems. Therefore, we can extract more in-depth information from the explanation of the created prototypes and even relate them to the previous data. Consequently, we go beyond the participants' meanings and the themes that are derived from our analysis and suggest a pragmatic interpretation of the UX Goals of the UX Designers based on context mapping techniques which include the illustrations of the artifacts. Affinity diagrams [59] and context mapping techniques [30] are both techniques that analyze rich qualitative data. They both use coding of participants' quotes or notes, and they both try to identify patterns or clusters of behavior or activity. They both use big spaces as tables or walls to map, structure, and cluster the previously collected data and extract meaning. We achieved a holistic understanding using these techniques (see Figure 4) to triangulate the video and audio transcripts (what participants say and do) with the paper prototypes (what participants make) in the second part of the analysis.

Approaches for visual element analysis in isolation, including Zmet and Kansei, were previously explored [30] without satisfactory results. More information is found in the stories of the participants and their relationship with the visual elements, in our case the prototypes. The participants' hidden or latent values that needed to be fulfilled based on our findings were later translated into seven UX goals. UX goals, as previous researchers explained [60], support designers in developing products or systems. In this study, these findings support the formative practical contribution to the design and development of remote UX design systems in the automotive domain. Nigel Bevan [61] also highlights how important it is to establish criteria for UX/usability goals at an early stage of design and to use summative measures to evaluate whether designers achieve them during development.

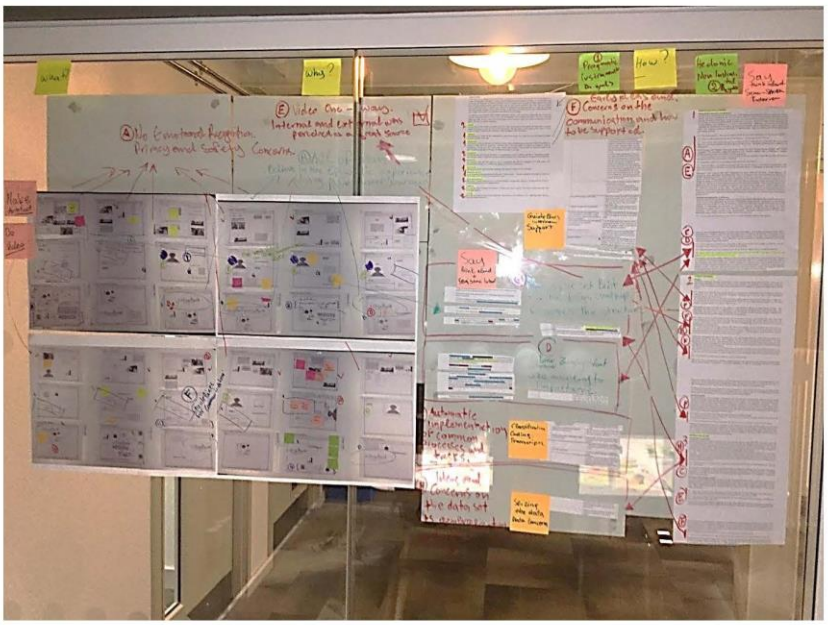

Figure 4. A glass wall was used to map all the information available, identify patterns, and cluster the critical issues concerning the prototypes. Ten needs and seven UX goals emerged from this analysis.

4. Results

The process of developing and validating these artifacts identified numerous areas where future research is required. Using the knowledge gained from this study will provide insight into what researchers might look for and what they might see when studying remote UX design systems in the automotive domain. We collected digital audio and video data of the workshop and analyzed the transcripts and the field notes using color coding and thematic maps. We mainly coded repetitiveness of a phenomenon or a participant's opinion, commonalities, and relationships with other participants' views and actions, and patterns of behavior. Grouping and naming the themes, we prioritized the participants' meanings and concluded on the participants' values that need to be fulfilled when we design such systems. Although most of the themes express non-instrumental hedonic or eudemonic values, some themes are purely instrumental and pragmatic including the "contextual components" and "preferred communication medium". As a result, the findings are structured and presented in themes. We examined the role of a set of values that we identified in this study and aimed to develop a remote participatory UX design system. The first theme examines the role of intrusiveness, emotions, and behavior, followed by usability and information architecture and their impact on the effectiveness of our system. The third theme of the findings presents the value of the quality of communication and the fourth designer's empathy about their end users. The last themes examine the role of context, and the preference of the participants with regard to the communication medium of our system. Below, we present a summary of the needs and how they relate to the UX goals that are derived from our analysis.

4.1. Intrusiveness, Emotion and Behavior

The first theme that emerged was Intrusiveness. Even though some participants were more enthusiastic about the various supportive technologies that we provided as stimuli, the majority

expressed a general mistrust of the effectiveness of using emotion recognition technologies to support design. The fact that emotions could not rely only on facial recognition and the fact that emotions can be affected by different factors when users are in social settings leads designers to a develop a mistrust of the technology. Additionally, even though the participants understand the possibilities of the technologies as mentioned above, ethical considerations such as privacy and safety were expressed as they see themselves as potential users. Thus, we mainly avoided face tracking and similar technologies.

P1: *"For safety purposes" "You can see children inside the car, and the passengers are not properly protected."*

P1: *"I am not really attracted by this kind of information. For the same concern. Privacy."*

P5: *"I am not sure what one sees in your face is what you feel, I think there is a discrepancy there. It is really difficult to understand emotions just from the facial expressions", "my facial expression can be affected by so many factors."* On the contrary, the behavior of the users in the vehicle was more important for the designers than emotion recognition. The participants suggested alternative, less intrusive methods such as observation, empathy building, and technologies such as video or audio monitoring.

P6: *"I would probably like to see him. If I was doing the interview remotely, I would like to see how he reacts to the questions that I ask and to different situations."*

P6: *"If you have a 360 view of everything around you can see the behavior."*

P7: *"You can design a car based on emotions, but you can also design a car based on demographics and behavioral (aspects). If someone is eco-friendly and likes nature, I could design for them but I cannot do the same with emotions."*

The participants provide evidence that other technologies are more useful in designing for experiences. More specifically, technologies such as video or 360-degree view of the environment are suggested. A possible explanation for these results is that the context of the person interacting in the car is more important than the individual and can generate insights or inspirations for the design of the new automotive experiences. Even though the designers avoid monitoring facial expressions through technology, paradoxically they would like to see the users interact with their environment and want to observe their reactions. That is possible because of the identification of cues such as frustration, confusion, or unexpected usage, which show a hidden or latent need as we mentioned previously in this paper. The fact that designers empathize at all times as drivers themselves can explain this reaction. Therefore, ethical considerations of private information lead them to decisions of mistrust of specific communication mediums in comparison to the rationale of the media richness hypothesis [62].

4.2. Usability and Information Architecture

Regarding the information architecture of the system, participants had various useful suggestions and ideas, and many usability qualities were highlighted as necessary by the participants. Although some of the participants wanted to include all the possible information they found on the system's toolkit, most highlighted the need for a minimalistic design approach. Thus, participants avoided redundant or complementary components regarding information content and architecture. Even though the hierarchy of information was generally not considered essential, participants used patterns of content-architecture to group content and brought essential components in the front of the interaction, avoiding an utterly loose interaction with no hierarchical structure. Even though sometimes the complementary information occupied most of the free space of the basic-screens, participants mainly followed the rule of bigger equals more critical, enlarging the more critical information.

P1: *"You want punctual information really direct, visual maybe audio I think is really effective."*

Moreover, they highlighted the need for a flexible design that adapts to their needs each time they interact with it. Immediateness is another quality that the participants stated as crucial for this type of interaction. The participants want the information to be immediately available to them. Finally, Information retrieval and ease of use were reportedly found to be crucial for our system, with the participants being concerned both by the "hustle" of the interaction and the possibility of forgetting information and missing essential findings throughout the process.

P6: *"I don't think there should be any hierarchy in the position of the visual systems. If I am blue sky and I don't know what I am doing I would choose this hierarchy though."*

P1: *"With emoticons, you have a question and a list of emoticons that the driver can reply immediately."*

P5: *"Maybe what is very useful you can star it and it can get down to the 20 per cent. If you think it is important and you like it and not want to forget about it, why not?"*

The designers preferred flexibility in the way they are going to use their tools as part of the system. The need for exploration and experimentation is fundamental in the early stages of the design process, and that could be one explanation about their preferences. Another explanation is that they do not have a predetermined set of scenarios, but they depend on the observation to identify the behavioral patterns of the users. It seems possible that the designers need some initial time to grasp the interaction scenario, identify the preferred contextual information and then decide on how they want the system to support them accordingly.

4.3. Quality

Participants expressed concerns about the quality of the communication being affected by trust. When the system supports them in communication with the driver/passenger, it is vital that the used technologies support a trustworthy communication interaction for both parties. They generally believe that when there is a lack of trust, the goal of the designer is undermined. Accordingly, they propose a more natural, transparent and socially present communication to mitigate the feelings of mistrust to them and the system by the passengers/drivers.

P7: *"If there is no point between you and the user, It is going to go downhill from there because you will never understand each other, that should be established. Building trust is the first thing. I want unstructured (interviewing) for the same reason."*

P8: *"Having an audio of me or of another person for self-presentation issues doesn't make much of a difference. If it wouldn't be my voice and it was somebody else's I don't want it to sound artificial. That is a very bad idea. I prefer a terrible natural voice than an artificial one."*

Participants are also concerned about the quality of communication affected by self-presentation issues. Their appearance can affect the level of engagement with a communication interaction that is going to take place. The same effect also works vice versa, i.e., when people are distracted by the image that the designer communicates towards them and change their responses and behavior accordingly.

P5: *"I don't want to be good looking in case they are looking at my face, and start thinking about other stuff rather than design. We don't need to have the same interaction every day. We can have different types. We can see each other today. If I am not presentable. If I have an initial video it can work and then you can have another type of communication."*

P12: *"They cannot see the designer. Because the answer can change. If I see your facial expression, then my next answer is going to be different. For example, you are asking me how is research going and I am responding I didn't do my literature review and you are laughing. Your next question if you ask me how often do you see your supervisor, I might say every week. (very often)."*

Finally, the participants feel that a structured way of communication feels like a duty and a preferred semi-structured manner will give them more feedback. On the bases of instantaneous communication and face-threatening acts, they are also concerned that they may lack the skills to provide high-quality communication and that they need to be supported by the system to achieve the levels of quality that are expected by this kind of qualitative conversations with people.

P9: *"People react in a way you react towards them. If you yell at someone they will probably yell back at you. The driver is going to see you sometimes. If he is going to make signs you can see him. Human beings respond to the way they are being treated. I would strongly lean on that the designer should be trained and experienced."*

P11: *"Unstructured (communication) needs an experienced researcher."*

The results here are in agreement with those obtained by previous studies about the self-image of people using remote communication technologies. A possible explanation is that the participants are trying to protect themselves from an unexpected situation and at the same time to protect the validly

of the insights gained by the interaction with the driver/passenger through the system. The fact that they do not want their presentation to affect the interaction shows again empathy for the people with whom they are going to be interacting.

Building trust and maintaining engagement is again expressed as a desire here by participants. The medium that can serve these needs of the designers is presumably the most useful as well. It is worth highlighting here that the effectiveness of the medium in use is not a primary concern of the designers.

4.4. Empathetic Design

On many occasions, the participants empathized with the user and explained their decisions based on the experience that they would like the driver/passenger to have in this two-way interaction. Their values and their company's values (when applied) lead them to a definition of the appropriate interaction. They are concerned with the perceived safety, comfort, naturalness, politeness and the feeling of being valued or any possible frustration that the drivers or passengers will experience during this interaction. The participants consider it essential that the driver finds himself in control and that the communication medium that they are going to use is appropriate for the situation.

P4: *"Create an environment where they feel safe because it is a radical change."*

P9: *"Structured feels like a duty. If someone is relaxed, he or she tells you more. A bridge between being polite and having all the information you need."*

P12: *"Unstructured questions allow a better user experience because people like their opinion to be heard."*

Participants highlighted the need for the naturalness of the communication, possibly prioritizing the sense of more informal and natural communication. Empathy is expressed here by many participants. One of the participant's claim provides a possible explanation: the insights are going to be more in-depth if the person feels more relaxed. Another explanation is that they are already "walking in the driver's shoes" and feel that they would not like a cold closed and structured interaction.

4.5. Contextual Components

Participants generally expressed the need for contextual data that they can relate to, at the time, when the driving experience takes place. The place and the environment also shape the experiences of people and are equally important. Participants find the social context of the drivers to be of great importance to a deeper understanding of the situation. Finally, long-term patterns of behavior are thought to be of help to designers in identifying opportunities before they delve into a more in-depth understanding of the situation.

P5: *"You need to know if its rush hour in the morning and you have to get your kids to school or if it is a bit later in the day."*

P8: *"It goes back to the personality depending on different things. With the personality, If you have your girlfriend in your car or someone you really care about, you might be driving a little bit more carefully, but then if you are with your first date you might want to impress her and drive more dangerously. And you might want to identify a pattern based on that."*

P6: *"Otherwise how can we improve the commodities of this family here maybe you need data that are collected over a few months."*

The majority of participants agreed on longitudinal behavioral data and supporting rich contextual information as a source of inspiration for the design of new automotive experiences in autonomous cars. A possible explanation is that they want to design for long-lasting, meaningful experiences in comparison to momentary hedonic experiences [14].

4.6. Preferred Communication Medium

The primary communication medium was also a concern for the participants. A video is generally considered a vital medium towards the understanding of emotions and behavior. In such a manner, the participants' video technologies are suggested to capture behavioral patterns and to achieve more

in-depth communication with the user. Video of the internal and external environment can give a deeper understanding of how people experience driving.

P7: *"That is why I want the video. The reaction of how he is sitting, the reactions. The pattern that leads to a personality, because if someone is constantly doing something, it leads to a personality."*

P11: *"The external is important because we can see how he is reacting based on the environment. Sometimes he is feeling bored and sees the other way."*

Furthermore, some of the participants suggested a two-way video interaction to communicate transparency and build trust among them. However, one participant expressed concerns about the importance of the video on the driver's side, basing his argument on the attention the video requires from the drivers. Many of the above qualities such as recognizing the feeling and the level of personal involvement in the communication are also expressed for only audio communication. Finally, they found text, gifs, and emoticons to be exciting means of communication but as an additional medium and not the primary medium due to the limitations in comparison to the video as mentioned above or only audio.

P2: *"I would use the voice because with the voice you can perceive the feelings as well." "So if you use emoticons or text other than your voice could be less personal, so harder to build trust."*

Building trust and maintaining engagement is again expressed as a desire here by participants. Additionally, participants added characteristics of utility to their decisions choosing the most appropriate medium for convergence (better at engendering mutual understanding) [26].

5. Discussion

Our participants' goals express their aim to fulfill specific needs. Our summative interpretation of these needs, based on empirical evidence drawn from our co-design workshops, informs relevant theory in automotive design for experiences. Furthermore, we suggest a formative interpretation of our findings in the form of UX Goals as actionable insights. Each of these UX goals relates to one or more user needs, as presented below.

5.1. UX Needs

Previous work by Eckoldt et al. [63] supports the notion that meaning and positivity are related to the fulfillment of universal psychological needs (an experience becomes positive and meaningful if it fulfills a psychological need) and explores the potential of an experience-oriented approach to design for interactivity in and through cars. Identifying these needs for design and evaluation purposes attracted the focus of automotive research measuring both momentary and long-term user experiences as explained by Körber and Bengler [64], and Kujala et al. [65], consecutively. In this study, the analysis of our rich data led us to identify the following needs of our participants.

Privacy: Privacy refers to the avoidance of intrusiveness. We can achieve levels of privacy when the participants are using secure technological interventions that can mediate communication, and that can inspire the sense of being in control. People trust the interaction with the system when they feel in control of their privacy but without compromising the quality of the interaction.

Efficiency: Immediateness is crucial for the communication result of the system. As a result, we want the system to interact with the user quickly, on the spot.

Effectiveness: The majority of the participants lean towards a deep understanding of long-term behavioral patterns in contrast to data about the momentary emotional state of the participant. To support the designer's goals in empathizing with the user and in achieving a deeper understanding of the situation, we want the system to be able to map the participant's feelings and behavioral patterns over time.

Engagement: A more personal and informal interaction. A communication which is going to provide us with more in-depth insights. We want the system to support the designer in achieving these levels of personal involvement when interacting.

Naturalness: An interaction that will feel natural to use. A technology that will be acceptable, thus enabling both parties to communicate instinctively. A naturalistic approach to the design of a system is one that supports a natural user experience.

Ease of Use: The most convenient and hassle-free interaction. We want the system to feel comfortable.

Information retrieval: To be assisted in avoiding information loss due to lack of memory as well as the system to store and retrieve data on the spot during the use of the system.

Self-Image awareness: The system supports different levels of self-presentation, supporting the designer in dealing with the situations of face-threatening acts in the communication.

Politeness: The system supports the designer to interact only when it matches the situation, "at the right time" and in the right manner.

Flexibility: The system dynamically adapts its needs based on the situation of use, supporting the user with the right tools and interactivity.

5.1.1. Emotion Recognition Technologies

Previous studies on real-life driving by Dobbins and Fairclough [66] have reported that the area of lifelogging has emerged as an application that is designed to continuously measure personal data with the purpose of supporting recall and self-reflection. Emotions can be captured continuously and in an unobtrusive manner. In our study, the participants do not trust the effectiveness of using face tracking, emotion recognition technologies, and in general psychophysiological techniques [67], due to technical and ethical considerations including false positives and effectiveness, privacy and safety. Even though the majority of our participants agree with the notion that it is the long-term user experience that matters [13], they are not primarily interested in momentary emotions especially coming from physiological measures. Thus, participants perceive mediums including video and audio for long-term behavioral observation, empathy building, and possible communication, as more effective and less intrusive forms of interaction.

5.1.2. Unobtrusive Long-Term Behavioral Research

As we previously mentioned, researchers in the automotive domain [66] have established the need for unobtrusive research. Furthermore, in-situ methods such as the Experience Sampling Method and the Day Reconstruction Method are increasingly applied in longitudinal settings, as Karapanos et al. [68] highlighted, while retrospective techniques offer a cost-effective alternative to longitudinal studies. Our results are in agreement with the theoretical framework of unobtrusive behavioral research in the automotive domain. The results indicate that the participants need to achieve a deeper understanding of the situation and map insights on feelings and long-term behavioral patterns, in other words, behavioral research which avoids intrusiveness by limiting their interaction with the driver/passenger.

The majority of our participants prefer a deeper understanding of the situation choosing holism versus reductionism and contextual data as previously defined by Roto et al. [69] to design for the new automotive experiences. Identifying the behavior of the users in the vehicle and their experience over time [70] was more critical to the designer's aims than identifying momentary emotions. An interesting finding is that UX designers are willing to design for experiences based on emotions as defined by [71] but not to draw inspiration by detected emotions since they perceive that they do not reflect on the overall experience.

5.1.3. Empathy and Trust

Our participants agree that trust in communication is essential and that it is achieved when the communication is natural, informal, transparent and high in social presence. They also expressed that the lack of a specific set of skills will result in impolite, unnatural and ineffective communication, hence a non-trustworthy interaction. As previous researchers highlight [60], trust as an experiential

issue has been included in earlier approaches, but rarely as the primary objective of the design process. Trust has been an essential factor in many e-commerce user studies. Another important finding was that self-presentation issues need to be addressed since our participants are concerned about their appearance and how that will affect a possible communication with the driver/passenger or distract from the design task itself. In previous research [29], employees when teleconferencing were more aware of others' status and reactions, thereby were more cautious of their self-image and behaviors. Our participants believe that their self-presentation can affect the communication behavior and thus the driving experience itself. Even though we are designing for them, the participants empathize with the driver/passenger, and they only support/propose interventions that apply to all stakeholders of the system. Hence, the most compelling finding is that the participants believe that it is also crucial for the driver/passenger to find himself in control, valued, and interacting through the appropriate communication medium.

5.2. UX Goals

A user experience goal (UX goal) is an actionable insight for the development of products, services or systems. It describes the intended momentary emotion or the emotional relationship/bond that a person has with the designed product/service/system, as Lu and Roto [72] described. The same research also highlights that, in a multidisciplinary product development and marketing process, these concrete UX goals can be quite valuable since various stakeholder groups need to agree on what to design. Väätäjä et al. [73] considered a UX goal to be good when it guides design towards a positive experience, helps in communicating objectives, and is measurable. As a result of our study, we came up with actionable insights to communicate how to achieve a positive experience when designing for remote UX design systems in the automotive domain. These are UX goals, as presented below, that can inform the design of goal-directed personas and scenarios and the development of high fidelity prototypes. Designers use scenarios and personas to realize their users and their users' goals and place them in context. "A scenario is a concise description of a user using a software-based product to achieve a goal" [74] where the goals stem from the persona description. The prototype system or systems are then built based on the user scenarios of use.

The UX goals by themselves are general so as not to direct pre-defined design solutions. They only become more specific when connected with the needs that they fulfil and the context in which they need to be fulfilled: in our case, the automotive domain. Thus, we include the needs that must be fulfilled for each UX Goal in brackets, and we explain them in context. A list of the recommended UX goals when designing for relevant remote UX design systems in the Automotive domain is presented below:

1. Support the contextual understanding (Empathy and Effectiveness).

   Supporting the contextual understanding in the car is a need that was also previously highlighted by Meschtscherjakov [5]. For example, given the mobility of the car, the context of it is dynamic and can only be compared with that of mobile devices. As a result, the affordances for understanding the context of a static home or office environment are not the same, and choosing the right ones will prove the effectiveness of the system. Since the form of transportation in this study is private, the car context is different concerning the social norms and relations among the passengers than when in a public environment. Building Empathy and Rapport as a need here differs from being able to afford it when in a public environment such as a train or even a library.
2. Reduce the intrusion of people's lives (Privacy).

   Reducing the intrusion of people's lives in the automotive domain is a UX goal that can be afforded with various interventions. However, given the fact that the car will need to be connected in order for the remote system to work synchronously, some of the interventions that were previously applied in asynchronous settings are not applicable here.
3. Support long-term understanding of behavioral patterns (Effectiveness).

In mobility and more specifically in transportation, where the metaphor of the customer journey comes from, users' behavior is identified by a sequence of events and not by an isolated moment as practitioners agreed. Support in identifying these patterns is a goal that will prove the system effective to practitioners when achieved.

4. Operate even when the problem is ill-defined (Flexibility and Effectiveness).

   In many cases, designers have no set brief for designing a new product/service or system. Setting the brief, in this case in the automotive domain, requires flexibility to avoid the limitations that come with remote work. By being able to explore a situation without frustration or annoyance, the UX designer can effectively propose a design result. To support the designers to achieve these levels of effectiveness and flexibility, the system requires relevant affordances. We have previously highlighted that when designing for remote systems, the social context of the communication and the communication medium are of great importance. What is most important though is that the context has been found to influence the medium's perception and effectiveness. For example, even though telepresence is one of the most effective means of remote communication within the work environment, it might be neither flexible nor effective in a constantly changing mobile and private environment.

5. Avoid redundant information at any interaction (Efficiency, Ease of Use, and Flexibility).

   The automotive context includes many spaces such as driver, front seat passenger, and rear seat passenger. As previously defined by Meschtscherjakov et al. [5] to capture the context holistically and gather insights, UX practitioners need to interact with a considerable amount of different data. The interplay between these data coming from these three different spaces should be usable and should fulfill the above-mentioned needs.

6. Avoid anxiety about uncertainty (Privacy, Engagement, Naturalness, and Self-image awareness).

   Given the aforementioned limitations, including the dynamic and private nature of the automotive context, a supportive system should avoid making the non-automotive expert practitioner anxious about the quality of his work when interacting with it. Fulfilling the above-mentioned needs is crucial for the practitioner to interact smoothly and gather fruitful insights.

7. Feeling of intelligent interactivity (Efficiency, Ease of Use, and Information retrieval).

   Intelligent interfaces are applied in many domains. Affordances for this UX goal should be common in relevant systems. However, the availability of these affordances does not mean that there is no need to fulfill these needs in the automotive context as well.

We learn that these UX Goals, excluding the increased privacy concern and the support of long-term behavioral patterns, are not exceptionally different from what we see in other domains where remote systems are applied. This welcomes opportunities to apply state-of-the-art practices and technologies from other domains for the implementation of the remote automotive UX system. We further recommend the design of compatible systems using the suggested UX Goals and their evaluation by automotive User experience researchers and designers which will shed light on automotive organization challenges for the adoption of such Research and Design Systems.

Remote Design Trust and Privacy Relevance in Other Domains

Characteristics such as clarity, naturalness, and communication etiquette to build trust and rapport in remote communication were previously investigated in telepresence systems' applications in organizations. Previous studies have also reported that a decrease in the degree of naturalness of a communication medium leads to increased cognitive effort; increased communication ambiguity; and decreased physiological arousal [62]. However, to build trust and rapport, one should consider that different types of technology require different forms of etiquette as previous studies have identified [75], and there are different kinds of etiquette for different settings [76]. Additionally, rules of etiquette depend on the social environment in which people use them. Similar to other norms, they are learned through experience in a community. Preece [76] emphasized this social dimension with the example of

children who observe how adults and other children behave, absorb these norms, and, as a result, learn their community etiquette at an early age. Consequently, the cultural characteristics of a community influence the perceived politeness and naturalness of the remote interaction. In essence, politeness means "phrasing things in such a way to take into consideration the feelings of the others" [27].

Previous work on trust in automated vehicles [77] has identified the need to calibrate and understand trust. Scholars have long debated trust issues in other domains, for example, Metsctecherjakov et al. [78]; the findings of their studies could apply in the automotive domain. Studies in remote systems in organizations [79] suggest that the stage of the communication defines how trust is perceived and communicated: from the project starting-point to one week before the project mid-point, we identify that communication behaviors associated with trust are characterized by a combination of socially and task-oriented communications and the conveyance of enthusiasm. From the project mid-point to the project end, a sense of predictability in the interaction is generated by communication behaviors associated with trust.

Other researchers could further investigate the increased concern about privacy and safety in the automotive domain compared to other domains. Social situations in a car, compared to a personal situation, are a contextual metric that can alter the driving experience. For example, when designers and a user need to collaborate on a daily basis, one of the two parties intrudes the personal space of the other by having face-to-face (FTF) communication or computer-mediated communication (CMC) while being physically present in the first case or present but not physically present in the second case. However, anonymity is at the center of attention due to the general concern about privacy while using technology. It is more relevant in the absence of nonverbal cues which may lead to changes in the quality of the interaction including increased self-disclosure and intimacy in the same way that it provides more control over self-presentation [80]. Although the perceived social context of the in-vehicle situations may be the cause of increased privacy concern, this was not thoroughly investigated as part of our research, and we would recommend further exploration in this direction.

6. Conclusions

In this study, we co-designed a remote participatory automotive UX system. We increased active participation as a means to match the UX designer's needs with the affordances of remote UX design systems. To achieve that, we conducted individual co-design workshops with UX designers. These workshops also allowed us to identify their explicit, observable, tacit and latent needs based on empirical qualitative data. Needs including privacy, efficiency, effectiveness, engagement, naturalness, ease of use, information, retrieval, self-image awareness, politeness, and flexibility were identified and explained concerning the prototype system. We triangulated our data with the artifacts provided by the participants to translate these needs into UX goals. UX Goals that reflect UX designers' needs included trust and empathy building, privacy and self-image awareness, and holistic and behavioral long-term understandings of the user. We offer suggestions on future work to explore goal-directed personas and scenarios of use to inform practitioners on how to develop relevant future automotive UX systems.

Author Contributions: S.T. designed the process of the workshop, recruited the participants, designed the prototypes and facilitated the participatory design workshops. S.T. conducted the literature review for this study and both the thematic analysis and the glass wall analysis. M.P. helped review and edit the paper to its current form (as the supervisor of S.T.).

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References

1. Pfleging, B.; Rang, M.; Broy, N. Investigating user needs for non-driving-related activities during automated driving. In Proceedings of the 15th International Conference on Mobile and Ubiquitous Multimedia, Rovaniemi, Finland, 12–15 December 2016; ACM Press: New York, NY, USA, 2016; pp. 91–99.
2. Pettersson, I.; Ju, W. Design Techniques for Exploring Automotive Interaction in the Drive towards Automation. In Proceedings of the 2017 Conference on Designing Interactive Systems, Edinburgh, UK, 10–14 June 2017; pp. 147–160.
3. Meschtscherjakov, A.; Ju, W.; Tscheligi, M.; Szostak, D.; Krome, S.; Pfleging, B.; Ratan, R.; Politis, I.; Baltodano, S.; Miller, D.; et al. HCI and Autonomous Vehicles: Contextual Experience Informs Design. In Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems, San Jose, CA, USA, 7–12 May 2016.
4. Tasoudis, S.; Perry, M. Mediated participatory design, for contextually aware in-vehicle experiences. In Proceedings of the 8th International Conference on Automotive User Interfaces and Interactive Vehicular Applications, Ann Arbor, MI, USA, 24–26 October 2016.
5. Meschtscherjakov, A.; Wilfinger, D.; Gridling, N.; Neureiter, K.; Tscheligi, M. Capture the car!: Qualitative in-situ methods to grasp the automotive context. In Proceedings of the 3rd International Conference on Automotive User Interfaces and Interactive Vehicular Applications, Salzburg, Austria, 30 November–2 December 2011; ACM Press: New York, NY, USA, 2011; p. 105.
6. Alvarez, I.; Rumbel, L.; Adams, R. Skyline: A rapid prototyping driving simulator for user experience. In Proceedings of the 7th International Conference on Automotive User Interfaces and Interactive Vehicular Applications, Nottingham, UK, 1–3 September 2015; ACM Press: New York, NY, USA, 2015; pp. 101–108.
7. Meschtscherjakov, A.; Wilfinger, D.; Osswald, S.; Perterer, N.; Tscheligi, M. Trip experience sampling: Assessing driver experience in the field. In Proceedings of the 4th International Conference on Automotive User Interfaces and Interactive Vehicular Applications, Portsmouth, NH, USA, 17–19 October 2012; ACM Press: New York, NY, USA, 2012; p. 225.
8. Niforatos, E.; Karapanos, E. EmoSnaps: A mobile application for emotion recall from facial expressions. *Pers. Ubiquitous Comput.* **2015**, *19*, 425–444. [CrossRef]
9. Martelaro, N.; Ju, W. WoZ Way: Enabling real-time remote interaction prototyping & observation in on-road vehicles. In Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing, Portland, OR, USA, 25 February–1 March 2017; ACM Press: New York, NY, USA, 2017; pp. 21–24.
10. MacIntyre, B.; Gandy, M.; Dow, S.; Bolter, J.D. DART: A toolkit for rapid design exploration of augmented reality experiences. In Proceedings of the 17th Annual ACM Symposium on User Interface Software and Technology, Santa Fe, NM, USA, 24–27 October 2004; ACM Press: New York, NY, USA, 2004; p. 197.
11. Carter, S.; Mankoff, J.; Heer, J. Momento: Support for situated ubicomp experimentation. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, San Jose, CA, USA, 30 April–3 May 2007; ACM Press: New York, NY, USA, 2007; p. 125.
12. Hassenzahl, M. Experience Design: Technology for All the Right Reasons. *Synth. Lect. Hum.-Cent. Inf.* **2010**, *3*, 1–95. [CrossRef]
13. Roto, V. User Experience from Product Creation Perspective. Towards a UX manifesto. In *Proceedings of the 21st British HCI Group Annual Conference on People and Computers: HCI... But not as We Know It-Volume 2*; Lancaster, UK, 2017; p. 37. Available online: https://pdfs.semanticscholar.org/3ae3/7d74a0aac4db3a5e232e7c83847f2e3a11ca.pdf (accessed on 31 July 2018).
14. Mekler, E.D.; Hornbæk, K. Momentary Pleasure or Lasting Meaning?: Distinguishing eudaimonic and hedonic user experiences. In Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems, San Jose, CA, USA, 7–12 May 2016; ACM Press: New York, NY, USA, 2016; pp. 4509–4520.
15. Rittel, H.W.J.; Webber, M.M. Dilemmas in a general theory of planning. *Policy Sci.* **1973**, *4*, 155–169. [CrossRef]
16. Kenny, J. IDEO Design Thinking Toolkit For Educators. Available online: https://designthinkingforeducators.com/design-thinking/ (accessed on 16 July 2017).
17. Addis, M.; Holbrook, M.B. On the conceptual link between mass customisation and experiential consumption: An explosion of subjectivity. *J. Consum. Behav.* **2001**, *1*, 50–66. [CrossRef]

18. Hassenzahl, M.; Tractinsky, N. User experience—A research agenda. *Behav. Inf. Technol.* **2006**, *25*, 91–97. [CrossRef]
19. Sanders, E.B.N.; Stappers, P.J. Co-creation and the new landscapes of design. *CoDesign* **2008**, *4*, 5–18. [CrossRef]
20. Whiteside, J.; Wixon, D. Improving human-computer interaction—A quest for cognitive science. In *Interfacing Thought: Cognitive Aspects of Human-Computer Interaction*; MIT Press: Cambridge, MA, USA, 1987; pp. 353–365.
21. Schmidt, A.; Aidoo, K.; Takaluoma, A. Advanced interaction in context. In *International Symposium on Handheld and Ubiquitous Computing*; Springer: Berlin/Heidelberg, Germany, 1999.
22. Csikszentmihalyi, M. *Flow and the Foundations of Positive Psychology*; Springer: Dordrecht, The Netherlands, 2014.
23. Standaert, W.; Muylle, S.; Basu, A. An empirical study of the effectiveness of telepresence as a business meeting mode. *Int. J. Inf. Technol. Manag.* **2015**, *17*, 323–339. [CrossRef]
24. Derks, D.; Fischer, A.H.; Bos, A.E. The role of emotion in computer-mediated communication: A review. *Comput. Hum. Behav.* **2008**, *24*, 766–785. [CrossRef]
25. Cahir, J.; Lloyd, J. 'People just don't care': Practices of text messaging in the presence of others. *Media Cult. Soc.* **2015**, *37*, 703–719. [CrossRef]
26. Rhoads, M. Face-to-Face and Computer-Mediated Communication: What Does Theory Tell Us and What Have We Learned so Far? *J. Plan. Lit.* **2010**, *25*, 111–122. [CrossRef]
27. Morand, D.; Ocker, R. Politeness theory and computer-mediated communication: A sociolinguistic approach to analyzing relational messages. In Proceedings of the 36th Annual Hawaii International Conference on System Sciences, Big Island, HI, USA, 6–9 January 2003; p. 10.
28. Miller, C.A. Human-Computer Etiquette: Managing Expectations with Intentional Agents. *Commun. ACM* **2004**, *47*, 30. [CrossRef]
29. Park, N.; Rhoads, M.; Hou, J.; Lee, K.M.; Lai, J.Y.; Ulhas, K.R. Understanding the acceptance of teleconferencing systems among employees: An extension of the technology acceptance model. *Comput. Hum. Behav.* **2014**, *39*, 118–127. [CrossRef]
30. Visser, F.S.; Stappers, P.J.; van der Lugt, R.; Sanders, E.B.N. Contextmapping: Experiences from practice. *CoDesign* **2005**, *1*, 119–149. [CrossRef]
31. Cycil, C.; Perry, M.; Laurier, E.; Taylor, A. "Eyes free" in-car assistance: Parent and child passenger collaboration during phone calls. In Proceedings of the 15th International Conference on Human-Computer Interaction with Mobile Devices and Services, Munich, Germany, 27–30 August 2013; ACM Press: New York, NY, USA, 2013; p. 332.
32. Jordan, B.; Wasson, C. Autonomous Vehicle Study Builds Bridges between Industry and Academia. *Ethnogr. Prax. Ind. Conf. Proc.* **2015**, *2015*, 24–35. [CrossRef]
33. Gellatly, A.W.; Hansen, C.; Highstrom, M.; Weiss, J.P. Journey: General Motors' Move to Incorporate Contextual Design Into Its Next Generation of Automotive HMI Designs. In Proceedings of the 2nd International Conference on Automotive User Interfaces and Interactive Vehicular Applications, Pittsburgh, PA, USA, 11–12 November 2010; ACM Press: New York, NY, USA, 2010; p. 156.
34. Jordan, B.; Wasson, C.; Roth-Lobo, H. Ethnographic Study Lifts the Hood on what REALLY Goes on Inside That Car, Ethnographic Study Lifts the Hood on What REALLY Goes on Inside That Car. EPIC/Advancing the Value of Ethnography in Industry. Available online: https://www.epicpeople.org/ethnographic-study-lifts-the-hood/# (accessed on 14 March 2016).
35. Bartl, M.; Jawecki, G.; Wiegandt, P. Co-Creation in New Product Development: Conceptual Framework and Application in the Automotive Industry. In Proceedings of the R&D Management Conference–Information, Imagination and Intelligence, Manchester, UK, 30 June–2 July 2010.
36. Ross, J. The Role of Observation in User Research: UXmatters. Available online: https://www.uxmatters.com/mt/archives/2018/09/the-role-of-observation-in-user-research.php (accessed on 20 October 2018).
37. Six, J.M. Tools for Remote, Collaborative UX Design: UXmatters. Available online: https://www.uxmatters.com/mt/archives/2017/11/tools-for-remote-collaborative-ux-design.php (accessed on 20 October 2018).
38. Wilfinger, D.; Murer, M.; Baumgartner, A.; Döttlinger, C.; Meschtscherjakov, A.; Tscheligi, M. The car data toolkit: Smartphone supported automotive HCI research. In Proceedings of the 5th International Conference on Automotive User Interfaces and Interactive Vehicular Applications, Eindhoven, The Netherlands, 28–30 October 2013; ACM Press: New York, NY, USA, 2013; pp. 168–175.

39. Rizzo, F. Co-design versus User Centred Design: Framing the differences. In *Notes on Doctoral Research in Design*; Franco Angeli: Milano, Italy, 2011; p. 125.
40. Frauenberger, C.; Good, J.; Keay-Bright, W.; Pain, H. Interpreting input from children: A designerly approach. In Proceedings of the 2012 ACM Annual Conference on Human Factors in Computing Systems, Austin, TX, USA, 5–10 May 2012; ACM Press: New York, NY, USA, 2012; p. 2377.
41. Lindsay, S.; Brittain, K.; Jackson, D.; Ladha, C.; Ladha, K.; Olivier, P. Empathy, participatory design and people with dementia. In Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems, Austin, TX, USA, 5–10 May 2012; ACM Press: New York, NY, USA, 2012; p. 521.
42. Halskov, K.; Dalsgård, P. Inspiration card workshops. In Proceedings of the 6th ACM Conference on Designing Interactive Systems, University Park, PA, USA, 26–28 June 2006; ACM Press: New York, NY, USA, 2006; p. 2.
43. Uzor, S.; Baillie, L.; Skelton, D. Senior designers: Empowering seniors to design enjoyable falls rehabilitation tools. In Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems, Austin, TX, USA, 5–10 May 2012; ACM Press: New York, NY, USA, 2012; p. 1179.
44. Vines, J.; Blythe, M.; Lindsay, S.; Dunphy, P.; Monk, A.; Olivier, P. Questionable concepts: Critique as resource for designing with eighty somethings. In Proceedings of the 2012 ACM Annual Conference on Human Factors in Computing Systems, Austin, TX, USA, 5–10 May 2012; ACM Press: New York, NY, USA, 2012; p. 1169.
45. Hook, J.; Green, D.; McCarthy, J.; Taylor, S.; Wright, P.; Olivier, P. A VJ centered exploration of expressive interaction. In Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems, Vancouver, BC, Canada, 7–12 May 2011; ACM Press: New York, NY, USA, 2011; p. 1265.
46. Le Dantec, C. Participation and publics: Supporting community engagement. In Proceedings of the 2012 ACM Annual Conference on Human Factors in Computing Systems, Austin, TX, USA, 5–10 May 2012; ACM Press: New York, NY, USA, 2012; p. 1351.
47. Vines, J.; Blythe, M.; Dunphy, P.; Vlachokyriakos, V.; Teece, I.; Monk, A.; Olivier, P. Cheque mates: Participatory design of digital payments with eighty somethings. In Proceedings of the 2012 ACM annual Conference on Human Factors in Computing Systems, Austin, TX, USA, 5–10 May 2012; ACM Press: New York, NY, USA, 2012; p. 1189.
48. Balaam, M.; Ricketts, I.; Mawson, S.; Burridge, J.; Rennick Egglestone, S.; Fitzpatrick, G.; Rodden, T.; Hughes, A.M.; Wilkinson, A.; Nind, T.; et al. Motivating mobility: Designing for lived motivation in stroke rehabilitation. In Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems, Vancouver, BC, Canada, 7–12 May 2011; ACM Press: New York, NY, USA, 2011; p. 3073.
49. Vines, J.; Clarke, R.; Wright, P.; McCarthy, J.; Olivier, P. Configuring participation: On how we involve people in design. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Paris, France, 27 April–2 May 2013; p. 429.
50. Muller, M.J. Participatory design: The third space in HCI. In *Human-Computer Interaction: Development Process*; Erlbaum Associates Inc.: Mahwah, NJ, USA, 2003; pp. 1051–1068.
51. Sanders, E.B.N.; Stappers, P.J. Probes, toolkits and prototypes: Three approaches to making in codesigning. *CoDesign* **2014**, *10*, 5–14. [CrossRef]
52. Tonetto, L.M.; Desmet, P.M. Why we love or hate our cars: A qualitative approach to the development of a quantitative user experience survey. *Appl. Ergon.* **2016**, *56*, 68–74. [CrossRef] [PubMed]
53. McCarthy, J.; Wright, P. Technology as experience. *Interactions* **2004**, *11*, 42. [CrossRef]
54. Sanders, E.B.N.; Brandt, E.; Binder, T. A framework for organizing the tools and techniques of participatory design. In Proceedings of the 11th Biennial Participatory Design Conference, Sydney, Australia, 29 November–3 December 2010; ACM Press: New York, NY, USA, 2010; p. 195.
55. Sleeswijk Visser, F.; van der Lugt, R.; Stappers, P.J. Sharing User Experiences in the Product Innovation Process: Participatory Design Needs Participatory Communication. *Creat. Innov. Manag.* **2007**, *16*, 35–45. [CrossRef]
56. Sanders, E.B.N. From User-Centered to Participatory Design Approaches. In *Design and the Social Sciences*; CRC Press: Boca Raton, FL, USA, 2003; pp. 18–25.
57. Iversen, O.S.; Halskov, K.; Leong, T.W. Rekindling values in participatory design. In Proceedings of the 11th Biennial Participatory Design Conference, Sydney, Australia, 29 November–3 December 2010; ACM Press: New York, NY, USA, 2010; p. 91.

58. Baskerville, R.; Pries-Heje, J.; Venable, J. Soft design science methodology. In Proceedings of the 4th International Conference on Design Science Research in Information Systems and Technology, Philadelphia, PA, USA, 7–8 May 2009; ACM Press: New York, NY, USA, 2009; p. 1.
59. Lucero, A. Using Affinity Diagrams to Evaluate Interactive Prototypes. In *Human-Computer Interaction*; Springer: Cham, Switzerland, 2015; pp. 231–248.
60. Kaasinen, E.; Roto, V.; Hakulinen, J.; Heimonen, T.; Jokinen, J.P.P.; Karvonen, H.; Keskinen, T.; Koskinen, H.; Lu, Y.; Saariluoma, P.; et al. Defining user experience goals to guide the design of industrial systems. *Behav. Inf. Technol.* **2015**, *34*, 976–991. [CrossRef]
61. Bevan, N. Classifying and selecting UX and usability measures. In Proceedings of the International Workshop on Meaningful Measures: Valid Useful User Experience Measurement, Reykjavik, Iceland, 18 June 2008; pp. 13–18.
62. Kock, N. Media Richness or Media Naturalness? The Evolution of Our Biological Communication Apparatus and Its Influence on Our Behavior toward E-Communication Tools. *IEEE Trans. Prof. Commun.* **2005**, *48*, 117–130. [CrossRef]
63. Eckoldt, K.; Hassenzahl, M.; Laschke, M.; Knobel, M. Alternatives: Exploring the car's design space from an experience-oriented perspective. In Proceedings of the 6th International Conference on Designing Pleasurable Products and Interfaces, Newcastle upon Tyne, UK, 3–5 September 2013; ACM Press: New York, NY, USA, 2013; p. 156.
64. Körber, M.; Bengler, K. Measurement of momentary user experience in an automotive context. In Proceedings of the 5th International Conference on Automotive User Interfaces and Interactive Vehicular Applications, Eindhoven, The Netherlands, 28–30 October 2013; ACM Press: New York, NY, USA, 2013; pp. 194–201.
65. Kujala, S.; Roto, V.; Väänänen-Vainio-Mattila, K.; Karapanos, E.; Sinnelä, A. UX Curve: A method for evaluating long-term user experience. *Interact. Comput.* **2011**, *23*, 473–483. [CrossRef]
66. Dobbins, C.; Fairclough, S. A mobile lifelogging platform to measure anxiety and anger during real-life driving. In Proceedings of the 2017 IEEE International Conference on Pervasive Computing and Communications Workshops (PerCom Workshops), Kona, HI, USA, 13–17 March 2017; pp. 327–332.
67. Mandryk, R.L.; Inkpen, K.M.; Calvert, T.W. Using psychophysiological techniques to measure user experience with entertainment technologies. *Behav. Inf. Technol.* **2006**, *25*, 141–158. [CrossRef]
68. Karapanos, E.; Jain, J.; Hassenzahl, M. Theories, methods and case studies of longitudinal HCI research. In Proceedings of the 2012 ACM Annual Conference Extended Abstracts on Human Factors in Computing Systems Extended Abstracts, Austin, TX, USA, 5–10 May 2012; ACM Press: New York, NY, USA, 2012; p. 2727.
69. Roto, V.; Väätäjä, H.; Jumisko-Pyykkö, S.; Väänänen-Vainio-Mattila, K. Best practices for capturing context in user experience studies in the wild. In Proceedings of the 15th International Academic MindTrek Conference on Envisioning Future Media Environments, Tampere, Finland, 28–30 September 2011; ACM Press: New York, NY, USA, 2011; p. 91.
70. Karapanos, E.; Zimmerman, J.; Forlizzi, J.; Martens, J.B. User experience over time. In Proceedings of the 27th International Conference on Human Factors in Computing Systems, Boston, MA, USA, 4–9 April 2009; ACM Press: New York, NY, USA, 2009; p. 729.
71. Desmet, P.; Hekkert, P. Framework of Product Experience Human-Product Interaction. *Int. J. Des. Nat.* **2007**, *30*, 57–66.
72. Lu, Y.; Roto, V. Towards meaning change: Experience Goals Driving Design Space Expansion. In Proceedings of the 8th Nordic Conference on Human-Computer Interaction Fun, Fast, Foundational, Helsinki, Finland, 26–30 October 2014; ACM Press: New York, NY, USA, 2014; pp. 717–726.
73. Väätäjä, H.; Olsson, T.; Savioja, P.; Roto, V. UX Goals 2012 workshop—How to utilize user experience goals in design? In Proceedings of the Workshop Held in Conjunction with NordiCHI 2012, Copenhagen, Denmark, 14 October 2012.
74. Hevner, A.R.; Chatterjee, S. *Design Research in Information Systems: Theory and Practice*; Springer Science and Business Media: New York, NY, USA, 2010; p. 127.
75. George, J.F.; Carlson, J.R.; Valacich, J.S. Media selection as a strategic component of communication. *MIS Q.* **2013**, *37*, 1233–1252. [CrossRef]
76. Preece, J. Etiquette online. *Commun. ACM* **2004**, *47*, 56. [CrossRef]

77. Mirnig, A.G.; Trösterer, S.; Meschtscherjakov, A.; Gärtner, M.; Tscheligi, M. Trust in Automated Vehicles. *i-com* **2018**, *17*, 79–90. [CrossRef]
78. Meschtscherjakov, A.; Tscheligi, M.; Pfleging, B.; Sadeghian Borojeni, S.; Ju, W.; Palanque, P.; Riener, A.; Mutlu, B.; Kun, A.L. Interacting with Autonomous Vehicles: Learning from other Domains. In Proceedings of the Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems, Montreal, QC, Canada, 21–26 April 2018; ACM Press: New York, NY, USA, 2018; pp. 1–8.
79. Rico, R.; Alcover, C.M.; Sanchez-Manzanares, M.; Gil, F. The joint relationships of communication behaviors and task interdependence on trust building and change in virtual project teams. *Soc. Sci. Inf.* **2009**, *48*, 229–255. [CrossRef]
80. Shalom, J.G.; Israeli, H.; Markovitzky, O.; Lipsitz, J.D. Social anxiety and physiological arousal during computer mediated vs. face to face communication. *Comput. Hum. Behav.* **2015**, *44*, 202–208. [CrossRef]

RAUX: A supportive system for remote automotive UX R&D

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Abstract
Natural science research methods are appropriate for the study of existing and emerging phenomena; However, they are insufficient for the study of "wicked problems". We use design science research methodology to answer research questions relevant to human problems via the creation of innovative artifacts (RAUX), thereby contributing new knowledge to the body of scientific evidence. RAUX demonstrates the front-end interaction of a supportive Remote UX design system in Automotive. It does not only mitigate the automotive domain deficiencies that previous research highlights but also supports in remote UX research and design activities. The users can navigate through and be supported in various activities including contextualization, communication, and presentation.

Author Keywords
User Experience; Remote UX; Co-creation; Interactive demo; Automotive user interfaces.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous; See http://acm.org/about/class/1998 for the full list of ACM classifiers. This section is required.

Basic screens of the RAUX interactivity

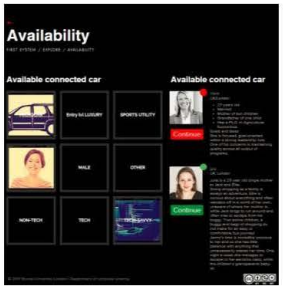

Figure 1: In this image, you can see the availability of the participants with the selected characteristics, given the driving conditions or their personal state.

Figure 1: In this image, you can see the 360-degree view of the vehicle and some of the communication options available.

Introduction

Automation in cars is shifting the driving experience paradigm. What was previously considered as a secondary task or activity such as interacting with in-vehicle information systems, infotainment, in-car productivity or social interactions and real-life experiences with other passengers in the car is now growing into a primary activity given the current developments in automation. Previous research investigated non-driving-related activities drivers want to perform while driving highly or fully automated and identified the potential for mobile and ubiquitous multimedia applications in the car[6]. As a result the focus of attention in automotive UX research includes, design techniques for exploring automotive interaction in the drive towards Automation[5]; understanding what it actually means to drive in an autonomous vehicle; potentials of a shift from a 'joy of driving' to a 'joy of being driven'; and the exploration of new forms of connectivity, entertainment, productivity, gaming as well as transportation-related services[7].

Previous attempts to support designers in the exploration of new user experiences led to driving simulator platforms [1] that support the rapid iterative development of in-vehicle user experiences. Other researchers attempted to explore this space in-context, which led to new methods and tools, such as 'trip experience sampling' (TES)[3]. Similar tools including EmoSnaps introduced by Niforatos et al. [4] to address in-situ measurement methods and avoiding the disruption of users. Most recent research [2] introduced systems that attempt to make sure that the in-vehicle automotive interactions can be designed, tested and understood before mass production.

We explore this space by developing RAUX. The main aim of RAUX is to support the activities of automotive UX designers and researchers. At the same time RAUX is overcoming the automotive domain limitations highlighted in previous work[8] including mitigating the distortion of the experience by the physical presence of the researcher; avoiding the motion sickness effect of the researcher while seeking for insights inside the car; Intrusiveness in terms of privacy; and minimizing the effort of traditional contextual methods.

System Description

RAUX is the front-end interaction of a Remote automotive UX system. It is designed to support the various tasks of the UX design process. The affordances introduced with this interactive demo demonstrate the mitigation of previously mentioned automotive domain deficiencies.

The front end of the system supports the automotive UX designers on:

- The understanding of the challenge.
- The preparation for research.
- The gathering of research inspiration.
- The search for meaning.
- The framing of opportunities and
- The storytelling

The tasks that can be completed by using the system are:

- Identifying the available drivers out of a given database of registered participants. (Figure 1)

- Observe the context of the interactions. (real-time 360-degree camera inside and outside of the vehicle.) (Figure 2)
- Get informed about car related information including heat maps, failures, and in-vehicle information systems' use.
- Synchronous and asynchronous communication with the driver/passenger. (Figure 3)
- Presenting Rich data experiences using interactive customer journeys. (Figure 4)
- Setting search agents to identify driving behavior over time.
- Tagging video events when they happen. (Figure 5)
- Leave comments for other team members to see. (Figure 6)
- Sending and receiving from the drivers/passengers' inspiration material including photo snaps, videos, audio, and illustrations. (Figure 3)

Demo Setup

A live demonstration of the interactivity of RAUX using goal-driven scenarios of use will take place. A simple setup of a table, a laptop and a monitor to host the interactive demo demonstration is necessary. Feedback from the participants will be collected and used for future iterations of the prototype system.

Figure 3: In this image, you can see the various ways of communication between the driver/passengers and the Automotive expert

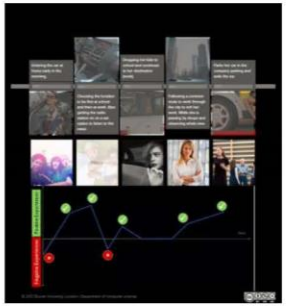

Figure 4: In this image, you can see the interactive customer journey presentation used in RAUX.

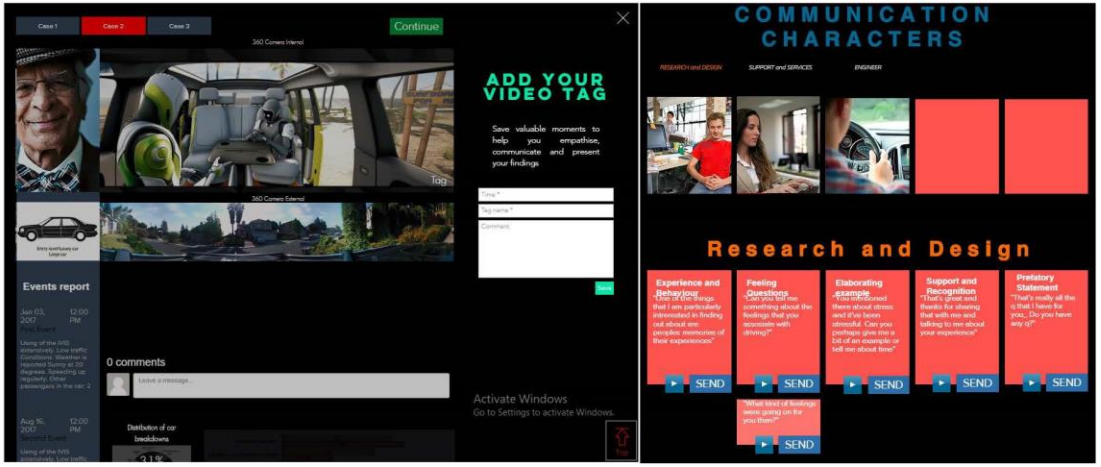

Figure 5 and 6: Some of the functionality of RAUX includes tagging video of the internal and external 360-degree view, where necessary to use when analyzing the data. RAUX communication affordances including the conceptual model of archetypes, pre-defined Characters and communication styles.

Contribution

Driven by a pragmatic epistemological standpoint we use artifacts as a mean to inform science. We use a Design science research methodology to answer research questions relevant to human problems via the creation of innovative artifacts (RAUX), thereby contributing new knowledge to the body of scientific evidence. We propose an interactive demo of a remote UX R&D system to support UX designers in automotive and especially in the research and design of the automated driving experiences.

References

1. Ignacio Alvarez, Laura Rumbel, and Robert Adams. 2015. Skyline. In *Proceedings of the 7th International Conference on Automotive User Interfaces and Interactive Vehicular Applications - AutomotiveUI '15*, 101–108. https://doi.org/10.1145/2799250.2799290

2. Nikolas Martelaro and Wendy Ju. 2017. WoZ Way. In *Companion of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing - CSCW '17 Companion*, 21–24. https://doi.org/10.1145/3022198.3023271
3. Alexander Meschtscherjakov, David Wilfinger, Sebastian Osswald, Nicole Perterer, and Manfred Tscheligi. 2012. Trip experience sampling. In *Proceedings of the 4th International Conference on Automotive User Interfaces and Interactive Vehicular Applications - AutomotiveUI '12*, 225.
4. Evangelos Niforatos and Evangelos Karapanos. 2015. EmoSnaps: a mobile application for emotion recall from facial expressions. *Personal and Ubiquitous Computing* 19, 2: 425–444. https://doi.org/10.1007/s00779-014-0777-0
5. Ingrid Pettersson and Wendy Ju. 2017. Design Techniques for Exploring Automotive Interaction in the Drive towards Automation. *Proceedings of the 2017 Conference on Designing Interactive Systems*: 147–160. https://doi.org/10.1145/3064663.3064666
6. Bastian Pfleging, Maurice Rang, and Nora Broy. 2016. Investigating user needs for non-driving-related activities during automated driving. In *Proceedings of the 15th International Conference on Mobile and Ubiquitous Multimedia - MUM '16*, 91–99. https://doi.org/10.1145/3012709.3012735
7. Dalila Szostak, Sven Krome, Rabindra Ratan, Bastian Pfleging, Sonia Baltodano, Dave Miller, Wendy Ju, Alexander Meschtscherjakov, and Manfred Tscheligi. HCI and Autonomous Vehicles: Contextual Experience Informs Design. https://doi.org/10.1145/2851581.2856489
8. Stavros Tasoudis and Mark Perry. 2016. Mediated participatory design , for contextually aware in - vehicle experiences. In *AutomotiveUI'16 Adjunct Proceedings*.

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Mediated participatory design, for contextually aware in-vehicle experiences

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ABSTRACT

Autonomous driving in the 21st century unleashes both concerns and possibilities. Secondary tasks or activities which now equally contribute to the driving experience may become a primary concern for researchers and designers, in the self-driving car era. Thus, a new set of experiences will gradually craft the future of automotive. Designing for user experiences is a field that emerged quite quickly in Economic and Psychology studies and is recently one of the main concerns in Human Computer Interaction. Even though there were attempts in the past for in-depth context aware situational research in the automotive domain, which can lead to the real life understanding and design for experiences in the automotive domain, there is still a general lack of tools and methods for achieving it. Following the design science research paradigm in this study, we design and evaluate a system for supportive participation in automotive design. This system and our study will help us explore the limitations and the possibilities of remote in-vehicle design for experiences.

Author Keywords

Experience Design; UX; Contextual design; Automotive; In-vehicle Interactions; Participatory Design; Co-creation; Telepresence; Remote Communication.

ACM Classification Keywords

Human-centered computing: **[Human computer interaction (HCI)]:** HCI design and evaluation methods, User studies; Human-centered computing: **[Human computer interaction (HCI)]:** HCI theory, concepts and models; Human-centered computing: **[Human computer interaction (HCI)]:** Empirical studies in HCI.

INTRODUCTION

Designing for user experiences is a field that emerged quite quickly in Economic studies (Experience economy), Marketing and Psychology studies (Customer Experience, CX) and (Technology as experience) and gradually became an important component of Design and Human-Computer Interaction, HCI (User Experience, UX) studies. Pine & Gilmore ,Gentile et al., McCarthy, Hassenzahl [1,2,3,4].

Many designers have previously defined design for experience in the context of HCI Kort et al. , Mahlke , Law et al. [5,6,7]. In this study, we use the definition given by Hassenzahl & Tractinsky [8]. Designing for experiences is dependent on the context of the interactions. Equally designing for in-vehicle interactions requires an understanding of the context of the car. The methods that are used by designers to design for experiences vary across disciplines and domains. Thus, specific limitations of some domains such as the automotive play a critical role in the adoption of some of these methods by designers. UX Designer goals and domain specific deficiencies need to be addressed in order to support the in-vehicle design for experiences. This research examines the emerging role of telepresence as a way to mediate the communication between the driver/passenger and the designer in the early stages of the design process. In this study we attempt to show how can a telepresence system overcome the main deficiencies for effective and efficient, long scale, context aware, situational design and support the experience design goals for participatory design in automotive. Following a Design science research paradigm we will design and evaluate a proposed system to support this remote communication. The rigorous methods used through the numerous iterations in both the construction and evaluation of the design artefact will inform research and design in the automotive ecosystem.

RELATED WORK

Scholars have long researched the automotive domain in order to inform design decisions and develop the new human computer and human-machine interactions in the vehicle. A considerable amount of literature has been published on simulation-based studies to capture driving performance, such as Liu & Wen [9] who conducted a simulator-based study comparing a visual display to an audio-only and a multi-modal display. Sodnik, on his study [10] compared three types of interfaces for in-vehicle information systems; a HDD was compared to two auditory interfaces, measuring cognitive/mental load or workload and system related factors such as task completion times. Similarly Weinberg et al. [11] compared the impact of interacting with combinations of an HDD and text-to-speech (TTS) system, an HUD and a TTS system, and an audio-only TTS representation of lists of

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choices. Destruction and safety of users is also in the focus of previous research examining which interface is less detrimental to driving performance, while interacting with an in-vehicle information system (IVIS) or another proposed technology. Therefore design frameworks and significant factors that can help design development are reported for secondary tasks while the primary task is still driving.

Despite their long empirical success, the studies previously mentioned have a number of problems according to other researchers. Meschtscherjakov et al. [12,13] argues that this occurs basically because there has not been a detailed investigation in the context of the automotive.

When designing for interactions, context refers to the social environment of the interaction; the physical environment either the space of the interaction is dynamic or static; and the time dependence of the interaction in a specific situation. Any of the above can have a direct effect on the interactive experience. It is generally agreed among designers and researchers, Meschtscherjakov et al. ,Visser et al. and Sanders & Stappers ,that context is both of great importance to a holistic understanding of the interactions taking place and necessary in designing for people and their experiences while involving them [12,14,15].

Even though the context is important a few studies have investigated the influence of automotive context in a systematic way using qualitative methods in real time driving situations. A study by Laurier et al. [16] gained a number of valuable insights drawing on analyses of video records of a series of quite ordinary episodes of car travel during driving journeys , such as the in-car hospitality and the slow conversations that were noticed when the car was going faster etc. The need to identify the most complex automotive tasks involving social interaction and the suggestion that methods and frameworks for fostering creativity and supporting the evaluation of early prototypes are to be considered a priority was previously a concern. To achieve that Cycil et al. [17] used a follow and film approach, which means that the researcher spends time with the participants inside the car and reflect on their experiences. Studies of ethnographic research are not common, nonetheless, we can identify some most recent studies using it for applying sociocultural understanding into the driving experience research in collaboration with Nissan [18].

Deficiencies

For some of these studies while their design is in line with the good practices of designing in context, the fact that the videos were pre-recorded means that there is not going to be an actual communication interaction between the designer and the driver to capture the situational in-vehicle interaction. Drawing from previous research the main disadvantage of the traditional context-aware methods (Contextual inquiry, Ethnographic study, Cultural probing) is 1) the effect of the physical presence of the researcher in the driving experience itself. Adding other secondary limitations such as 2) motion sickness of the researcher while taking notes inside the car, 3) intrusiveness, 4) privacy, 5) organizational challenges and 6) effort as previous researchers have mentioned [12].Previous attempts to mitigate these limitations lead to new methods and tools such as the 'trip experience sampling' (TES) Meschtscherjakov et al. [13].

Analyses of video recordings, video ethnography and or sensors to collect data are all interesting attempts to in-depth research of the in-vehicle interactions. Yet, Meschtescherjakov et al. [13] highlights that the main weakness of these methods is that participants should have the possibility 7) to express their feelings immediately after an event to mitigate retrospective bias. Immediateness and 8) situatedness [19] are limitations for capturing the experience when it happens. Besides, Hassenzahl also argues about the memorability of the experience and that people are not able to report what happened if the event is not memorable [4]. Auxiliary, early writings on usability already expressed the notion that manifestations of usability such as productivity or learnability are not primary. The primary is the person's experience at the moment experienced [20].

Even though there were attempts in the past for in-depth context aware situational design research, there is still a general lack of tools and methods for achieving it, effectively and efficiently based on the experience designer needs.

RESEARCH QUESTION

So far, very little attention has been paid to the role of telecommunications (VOIP) and telepresence as a way to mediate the communication in automotive during the design process. Telepresence refers to a set of technologies which allow a person to feel as if they were present, to give the appearance of being present, or to have an effect, via tele robotics, at a place other than their true location. Telepresence is previously used as a tool to mediate communication and collaboration between distant teams and to support participatory design. Despite the importance of telepresence technologies in various domains such as healthcare, organization, and aviation, no previous study has investigated how telepresence can contribute to support in-vehicle experience design.

This research examines the emerging role of telepresence as a way to mediate the communication between the driver/passenger and the designer in the early stages of the design process. This study attempts to show how can a telepresence system overcome the main obstacles for effective and efficient, long scale, context aware, in-situ design and support participatory design in automotive.

The research question of this study consists of two main sub-questions:

How can a telepresence system support experience designers in the early stages of the design process?

Sub question 1: How can designers design for automotive experiences remotely?

Sub question 2: How can a supportive system enhance their design results while being more effective and efficient?

Aim and Objectives

The main aim of this study is to investigate how telepresence can support in-vehicle context aware in-situ design research.

The objectives of this research are:

1. To propose a Communication Strategy (Communication Theory, Models, communication modes and communication technology) that supports design for in-vehicle experiences in the early stages.
2. To identify user needs and feelings, the 'goals' as defined by Kaasinen et al. [21], of the proposed remote participatory design system, for the early stages of designing for in-vehicle experiences.
3. To implement the Strategy and Prototype the remote participatory design System and its front end interactions.
4. To evaluate the remote participatory design System in the early stages of the design process in terms of the identified designer goals.
5. To determine whether the Prototype of the remote participatory design System is acceptable for the drivers/passengers.

SIGNIFICANCE AND CONTRIBUTION

This study provides an exciting opportunity to advance our knowledge of in-vehicle design for experiences. There are several important areas where this study makes an original contribution.

This study aims to contribute to automotive design for experiences by exploring the limitations of remote communication systems in the automotive domain, with the possibility of informing the existing communication theories. The growing area of distant collaboration and telepresence by exploring the relevance and the limitations of mediated participatory design in the context of automotive and the communication strategies that can support mediated interaction design.

In addition exploring the designers' goals, in the early stages of designing for situational context-aware experiences, will significantly contribute to the further understanding of the process of Automotive UX design and how to support it. Drawing on rich data, such as designer needs, wants, and feelings, informs the naturalistic understanding of the designer's goals in the early stages of the automotive UX design.

Finally, the state of research methods for the inspiration, design and evaluation of the proposed remote participation system as a User Experience, contribute to the currently growing UX research as a Strong Concept and to the Design Science Research community as an example of rigor and validity of the methodological paradigm.

PLANNED RESEARCH METHODOLOGY

Design science research is a research paradigm in which a designer answers questions relevant to human problems via the creation of innovative artefacts, thereby contributing new knowledge to the body of scientific evidence. The designed artefacts are both useful and fundamental in understanding that problem. Design Science as conceptualized by Simon [22], supports a pragmatic research paradigm that calls for the creation of innovative artefacts to solve real-world problems. 'Artefacts are not exempt from theories. They rely on kernel theories that are applied, tested, modified, and extended' [23].

Constructing a Communication Strategy that supports in-vehicle design for experiences is a need identified in the literature. The communication strategy has a goal to close this gap by mitigating the existing contextual limitations and enhancing the design process. The communication Strategy is going to be revised or extended based on the evaluation circles of its various components through this study. Valuable insights on the design process and the implementation of supportive communication system are going to be provided. The objective of design science research is to develop technology-based solutions to important and relevant business problems. As a result, we need to identify the designers 'do goals' in the early stages of designing for experiences. (Which are the activities they want to be able to achieve in the context of automotive?). Following the model of Hassenzahl [4], for 'be goals' and 'do goals', we also need to identify the designers 'be goals'. (How would the designers want to feel while interacting).

- Feelings they want to feel while interacting for achieving personal needs.
- And feelings and values they want to reflect while interacting and communicating, in respect to their Brand identity of their organization. Possible archetypes they want to communicate.

From Design Science research we acknowledge that the search for an effective artefact requires utilizing available means to reach desired ends while satisfying the laws in the problem environment. Thus following the identification of the goals, we propose the communication methods and models that are relevant to the designer needs that we have identified in the automotive context (laws and environment). Extension and/or revision of the artefact is expected through the evaluation processes. Effective design science research must provide clear and verifiable contributions in the areas of the design artefact, design foundations, and /or design methodologies.

Design research science relies upon the application of rigorous methods in both the construction and evaluation of the design artefact. To implement the strategy and prototype

the system. Low and high fidelity prototypes can serve in the early stages in order to iterate on the design. Evaluation of the prototype system will help us optimize the system and the strategy to fit the designer's goals and provide valuable scientific insights. In addition, in our holistic design approach, we need to determine whether the system is acceptable for the drivers/passengers. This is expected to feedback to our design process with new insights and will enhance the systems understanding and implementation. The utility, quality, and efficacy of the design artefact will be rigorously demonstrated via well-executed evaluation methods.

DISCUSSION

There are various methods to collect rich data that can reflect the interactive experience. Considerations of some of the most relevant qualitative methods, such as time-intensiveness, effort and participation are concerns in our study. A methodological mixed approach combining qualitative and quantitative data at different stages of our research was identified to be the best strategy. In contrast using less methods or even one method is yet an ease to the researchers and gives them the ability to get a higher level of depth in the analysis of the data. A concern that can lead to a fruitful discussion is whether triangulation and suggesting a methodological mix is more appropriate for this study.

QUESTIONS AND ISSUES

The issues we would like to rise to the doctoral colloquium could be summarized in the above three topics:

- Methodological strategy. Single in-depth method or mixed-methods approach for a holistic understanding and/or triangulation?
- Limitations of the study and possible considerations.
- Current User Experience processes in the domain.

CONCLUSION

As Pine and Gilmore [1] suggest: 'Goods and services are no longer enough to foster economic growth, create new jobs, and maintain economic prosperity. To realize revenue growth and increased employment, the staging of experiences must be pursued as a distinct form of economic output.' Design for experiences in the automotive domain is important for a wide range of scientific and industrial processes, due to the large scale of the market of transportation. Thus by achieving it, the impact in society is going to be instantly visible, and according to Pine and Gilmore, it will help maintain the economic prosperity.

To achieve designing for experiences in automotive we lack sophisticated methods to fit the automotive domain and the necessary tools to support designers using these methods. Designing for this goal though based on the designer needs and applying the most relevant technology is an ill-defined problem and research needs to be held in the fuzzy front end. Applying design science research and choosing the most relevant strategy of UX inspiration, design and evaluation methods for the automotive domain is what makes our approach significantly unique. It worth highlighting the fact that drawing from rich data from the designers remote communication experience we can optimally suggest capable methods and tools and inform the automotive UX design community.

REFERENCES

1. B. J. Pine and J. H. Gilmore, *The Experience Economy*. Harvard Business Review Press, 2011.
2. C. Gentile, N. Spiller, and G. Noci, "How to Sustain the Customer Experience:," *Eur. Manag. J.*, vol. 25, no. 5, pp. 395–410, Oct. 2007.
3. P. W. J McCarthy, "Technology as Experience | The MIT Press," *The MIT Press*, 2004. [Online]. Available: https://mitpress.mit.edu/books/technology-experience. [Accessed: 09-Mar-2016].
4. M. Hassenzahl, "Experience Design: Technology for All the Right Reasons," *Synth. Lect. Human-Centered Informatics*, vol. 3, no. 1, pp. 1–95, Jan. 2010.
5. J. Kort, A. Vermeeren, and J. Fokker, "Conceptualizing and Measuring User eXperience," *Proc. Towar. a UX Manifesto, COST294 …*, 2007.
6. S. Mahlke, "Understanding users' experience of interaction," pp. 251–254, Sep. 2005.
7. E. L.-C. Law, V. Roto, M. Hassenzahl, A. P. O. S. Vermeeren, and J. Kort, "Understanding, scoping and defining user experience," in *Proceedings of the 27th international conference on Human factors in computing systems - CHI 09*, 2009, p. 719.
8. M. Hassenzahl and N. Tractinsky, "User experience - a research agenda," *Behav. Inf. Technol.*, vol. 25, no. 2, pp. 91–97, Mar. 2006.
9. Y.-C. Liu and M.-H. Wen, "Comparison of head-up display (HUD) vs. head-down display (HDD): driving performance of commercial vehicle operators in Taiwan," *Int. J. Hum. Comput. Stud.*, vol. 61, no. 5, pp. 679–697, Nov. 2004.
10. J. Sodnik, C. Dicke, S. Tomažič, and M. Billinghurst, "A user study of auditory versus visual interfaces for use while driving," *Int. J. Hum. Comput. Stud.*, vol. 66, no. 5, pp. 318–332, May 2008.
11. G. Weinberg, B. Harsham, and Z. Medenica, "Evaluating the usability of a head-up display for selection from choice lists in cars," *Proc. 3rd …*, 2011.
12. A. Meschtscherjakov, D. Wilfinger, N. Gridling, K. Neureiter, and M. Tscheligi, "Capture the car!," in *Proceedings of the 3rd International Conference on Automotive User Interfaces and Interactive Vehicular Applications - AutomotiveUI '11*, 2011, p. 105.
13. A. Meschtscherjakov, D. Wilfinger, S. Osswald, N.

Perterer, and M. Tscheligi, "Trip experience sampling," in *Proceedings of the 4th International Conference on Automotive User Interfaces and Interactive Vehicular Applications - AutomotiveUI '12*, 2012, p. 225.

14. F. S. Visser, P. J. Stappers, R. van der Lugt, and E. B.-N. Sanders, "Contextmapping: experiences from practice," *CoDesign*, vol. 1, no. 2, pp. 119–149, Apr. 2005.
15. E. B.-N. Sanders and P. J. Stappers, "Co-creation and the new landscapes of design," *CoDesign*, vol. 4, no. 1, pp. 5–18, Mar. 2008.
16. E. Laurier, H. Lorimer, B. Brown, O. Jones, O. Juhlin, A. Noble, M. Perry, D. Pica, P. Sormani, I. Strebel, L. Swan, A. S. Taylor, L. Watts, and A. Weilenmann, "Driving and 'Passengering': Notes on the Ordinary Organization of Car Travel," *Mobilities*, vol. 3, no. 1, pp. 1–23, Mar. 2008.
17. C. Cycil, M. Perry, E. Laurier, and A. Taylor, "'Eyes free' in-car assistance," in *Proceedings of the 15th international conference on Human-computer interaction with mobile devices and services - MobileHCI '13*, 2013, p. 332.
18. Brigitte Jordan; Christina Wasson; Heather S. Roth-Lobo, "Ethnographic Study Lifts the Hood on what REALLY Goes On inside that Car," *EPIC/ Advancing the value of ethnography in Industry*, 2015. [Online]. Available: https://www.epicpeople.org/ethnographic-study-lifts-the-hood/. [Accessed: 14-Mar-2016].
19. M. Csikszentmihalyi, *Flow and the Foundations of Positive Psychology*. Dordrecht: Springer Netherlands, 2014.
20. J. Whiteside and D. Wixon, "Improving human-computer interaction—a quest for cognitive science," pp. 353–365, Jan. 1987.
21. E. Kaasinen, V. Roto, J. Hakulinen, T. Heimonen, J. P. P. Jokinen, H. Karvonen, T. Keskinen, H. Koskinen, Y. Lu, P. Saariluoma, H. Tokkonen, and M. Turunen, "Defining user experience goals to guide the design of industrial systems," *http://dx.doi.org/10.1080/0144929X.2015.1035335*, 2015.
22. H. A. Simon, *The Sciences of the Artificial*. MIT Press, 1996.
23. A. Hevner and S. Chatterjee, *Design Research in Information Systems*, vol. 22. Boston, MA: Springer US, 2010.