

THESIS FOR THE DEGREE OF LICENTIATE OF ENGINEERING

THE TEMPORALITY OF IN-VEHICLE USER EXPERIENCE

Exploring user experiences from past to future

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Abstract

Cars are nowadays equipped with numerous interactive systems, aiding the driver by providing safety warnings, driving information, support, connectivity and entertainment. Traditionally in the field of in-vehicle system design, the focus of the automotive industry been on safety, i.e. on distraction measures and usability. To ensure competitiveness, however, attention is now being further directed towards *experiential* values of the systems, collected under the umbrella term of 'user experience' (UX). Whereas previous research of in-vehicle technology focused predominantly on numeric, momentary studies of experiences, user experience appears to be a much more complex topic than what can be understood from evaluative numbers from a short period of use.

The aim of this thesis is to contribute to knowledge of *the temporality of user experience*, using in-vehicle systems as an object of study. Following an analysis of existing theoretical frameworks, three empirical studies are conducted. The studies address users' past, present and (expectations on) future experiences. As an aid to stimulate in-depth, rich reflection on experiences, all three studies contained creative elements. In order to include research on expectations, a methodology for prospective UX research was developed, called '*setting the stage for future automotive experiences*'.

The thesis presents a model including the sequences of *aquaintancing*, *using* and *transforming*. The three sequences identified in the model are connected to different experience aspects (such as aesthetics, social relatedness, ease-of-use, stimulation, trust and attachment). By breaking down the temporality of user experience into sequences, it is suggested that designers and researchers can be helped in understanding and approaching experiences at different stages. The inclusion of the transformative aspects of using artefacts over time expands the taxonomy on user experience from the direct experiences to also include the experiences that have effect daily life over longer periods of time. A more complex relation was found than typically present in UX theory and empirical research, indicating a need to expand research tools and frameworks to further include temporal and ecological factors.

Keywords

User Experience, Design, Automotive, In-Vehicle Systems, Human Machine Interaction, Methodology, Over Time, Temporality, Future

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List of appended papers

Paper 1:

Dimitrios Gkouskos, Ingrid Pettersson, MariAnne Karlsson and Fang Chen

Exploring User Experience in the Wild: Facets of the Modern Car, HCII 2015 LA, USA

Paper 2:

Ingrid Pettersson, Dimitrios Gkouskos and MariAnne Karlsson

Exploring User Experiences Over Time: A Retrospective Study of In-vehicle Technologies, submitted to Behaviour and Information Technology Journal, 2016

Paper 3:

Ingrid Pettersson and MariAnne Karlsson, *Setting the stage for self-driving cars: Exploration of future autonomous driving experiences*, IET Intelligent Transport Systems Journal, September 2015, Volume 9, Issue 7

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Pettersson, I. and Osvalder, A. (2005) *Ergonomic evaluation of child car seats – comfort and usability*, Proceedings of the Nordic Ergonomics Society (NES) Conference, Oslo, Norway, 9-11 October 2005.

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I INTRODUCTION

Car commuting can make up a substantial part of many people's lives. For example, in Western Europe the average daily commute lasts 38 minutes, and for Americans the figure is 25 minutes (Rodrigue 2016). Cars are nowadays equipped with numerous interactive systems, able to aid the driver by providing safety warnings, driving information and support, navigation, connectivity and entertainment. The development rate of new systems is steadily increasing, offering new possibilities for safety, comfort, and stimulation.

Traditionally in the field of in-vehicle system design, the focus has been on safety, i.e. distraction measures and usability. To ensure competitiveness, however, efforts are now being further directed towards *experiential* values of the systems. This follows the development trend of other interactive consumer products, where the users' emotions, context, needs and judgements are given increasing attention. Research and industry efforts to understand experiences of and with products have been collected under the umbrella term of 'user experience' (UX).

Examples of the growing range of in-vehicle UX research include the experience of specific in-car systems such as infotainment touch interfaces (Pitts et al. 2014), haptic interfaces (Väänänen-Vainio-Mattila et al. 2014) and head-up displays (Soro et al. 2014). These studies mainly address momentary experiences of the systems, that is to say the studies capture users' immediate responses to the systems during usage.

However, there is growing research evidence that experiences are not stable over prolonged use (e.g. Karapanos et al. 2009; Kujala et al. 2011; Karapanos et al. 2012). The need to establish knowledge of the temporality of experiences has thus been identified in academia (see for instance Hassenzahl, 2010; Huang, 2015; Kujala et al. 2011) as well as by industry UX specialists (Varsaluoma and Sahar 2014). In addition, user experiences are by nature subjective, rich and individual, and need to be understood as such (Wright et al. 2008; Forlizzi and Battarbee 2004). As stated, previous research of in-vehicle technology has focused predominantly on numeric, momentary studies of experiences (see for example Körber and Bengler 2013; Korber and Eichinger 2013), whereas user experience appears to be a much more complex topic than what can be understood from evaluative numbers from a short period of use.

The aim of this thesis is therefore to contribute to knowledge of *the temporality of user experience*, using in-vehicle systems as an object of study. Following an analysis of existing theoretical frameworks, three empirical studies are undertaken, addressing temporality and user experiences of in-vehicle systems.

1.1 FRAME OF REFERENCE – MODELS AND METHODS WITHIN UX RESEARCH

Over the past few decades, much research effort has been invested in describing the UX phenomenon. Several definitions exist. One is proposed by ISO, The International Organization for Standardization, which defined user experience as "A person's perceptions and responses that result from the use or anticipated use of a product, system or service" (ISO 9241-210).

Another definition is "All the aspects of how people use an interactive product: the way it feels in their hands, how well they understand how it works, how they feel about it while they're using it, how well it serves their purposes, and how well it fits into the entire context in which they are using it." (Alben 1996).

These definitions are quite broad, and as there is a need to address UX in greater detail, a number of the related research frameworks are analysed in terms of their underlying theory, describing their framework contribution to the user experience field, followed by a description of the methodologies typically used in empirical studies. From the frame of reference, research questions and approach are identified for the thesis.

In the following text, the term 'user experience' is used as the authors themselves have employed it in their writings.

1.1.1 THEORETICAL FRAMEWORKS

JORDAN'S FOUR PRODUCT PLEASURES

Patrick Jordan was a pioneer in the exploration of the concept of interactive products' qualities beyond usability and functionality, by deploying knowledge about what creates pleasurable experiences. Thus, Jordan (2000) constructed the 'Four Pleasures' framework based on the research of anthropologist Tiger (1992) who claimed that there are four types of pleasures that can be universally found in cultures. Relating to pleasures derived from products, Jordan translated the theory into a product's:

- *Physio-pleasure*: the ability to evoke physical pleasure, derived from the five senses.
- *Psycho-pleasure*: the ability to provide a psychologically rewarding experience, such as experiencing flow and fulfilment.
- *Socio-pleasure*: the ability to evoke pleasure from supporting social relatedness.
- *Ideo-pleasure*: the ability to connect to the user's values, beliefs and ideals.

A range of methodologies, from methods such as psychometric scales to ethnographic methods, are mentioned in Jordan’s work, advised as applicable at different stages of product development. However, the framework does not offer any specifically developed methodologies for researching product pleasure.

DESMET’S PRODUCT EMOTIONS

Emotions are an inseparable part of the responses to products, and one direction of research within the field of experience focuses on the emotional reactions originating from product use. Based on appraisal theory (see for example Ortony et al. 1988) a basic model of product emotions has been proposed by Desmet (2002) describing how products elicit emotions (Fig. 1). According to the model an emotion is the result of an appraisal process, where the characteristics of the product are appraised against the concerns (e.g. goals, standards, attitudes) of the individual. When the characteristics of a product match the concerns of a user, positive emotions are elicited. When there is a mismatch, negative emotions are elicited. This work proposes a number of emotions as relevant to products, such as disappointment, boredom, fascination and pleasant surprise.

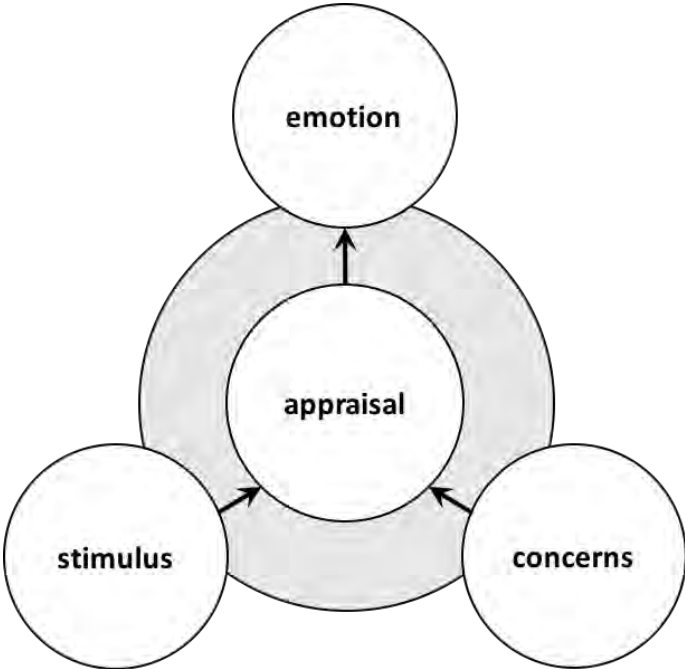


Figure 1. The basic model of product emotion, adapted from Desmet (2002)

The framework focuses on instant responses from the immediate experience of a product. To measure these emotional responses, Desmet developed the Product Emotion measurement instrument, PrEmo. The tool makes use of expressive cartoons instead of relying on the use of words, as each of the fourteen measured emotions is portrayed by a cartoon character.

NORMAN'S EMOTIONAL DESIGN

Another framework that also originates from the importance of emotional reactions to products is presented by Don Norman in the book "Emotional Design: why we love (or hate) everyday things" (2004), where he expands on examples of emotional responses to products, based on their attributes. He divides emotional design into three aspects:

- *Visceral Design*: the product's appearance and appeal to the user's senses.
- *Behavioural Design*: the product's pleasure and effectiveness of use.
- *Reflective Design*: how the product appeals to the user's self-image, personal satisfaction, and meaning-making.

This work draws on theories from cognitive science, more specifically work on information processing described by Ortony and colleagues (Ortony et al. 2005) as three levels of information processing; *reactive* (i.e. fixed action responses), *routine* (i.e. well-learned behaviours and skills) and *reflective* (comprising consciousness and advanced cognitive skills).

The framework does not suggest specific methodologies for researching experiences.

PRODUCT EXPERIENCE

Relating to Desmet's framework for product emotion, Desmet and Hekkert (2007) bridges the concepts of emotion and experience, and claim that products can be experienced on three levels, adding meaning and aesthetics to emotions:

- *The aesthetic level*: a product's capacity to delight one or more of the sensory modalities.
- *The meaning level*: assigned personality or other expressive characteristics, resulting in personal or symbolic significance.
- *The emotional level*: emotions that are evoked by a product.

The framework does not advise any specific methodology for researching product experience, but suggests that experiences reach further than instant emotions into also remembering, anticipating and experiencing meaning retrieved from the product.

HASSENZAHL'S BE- AND DO-GOALS

One framework that further addresses the aspects of experience originating from experiencing interactive products, therefore positioned in research on human-machine interaction and cognitive science, is Hassenzahl (Hassenzahl 2010). He

distinguishes between the “*why, what and how*” of the interaction with a product. The *why* addresses people’s higher motives for using an artefact, such as establishing relatedness with another person through a telephone call, the *what* looks at what specifically can be achieved with the product (e.g. make a call), and the *how* addresses how the interaction is enabled by functionality and design. Hassenzahl (2008) defines UX as “... a momentary, primarily evaluative feeling (good-bad) while interacting with a product or service”, constituted along two product dimensions; pragmatic and hedonic qualities. Pragmatic qualities of a product concern the ‘do-goals’ of a product, that is to say practical goals of interaction such as making phone calls or uploading documents on a web site. The other category of goals, the ‘be-goals’ of a product, concerns the hedonic qualities, such as offering aesthetic and meaningful experiences.

In terms of methodology, Hassenzahl et al. (Hassenzahl et al. 2003) have constructed the AttrakDiff questionnaire, where both hedonic and pragmatic dimensions of UX are studied with semantic differentials. In addition, Hassenzahl et al (Hassenzahl et al. 2010) suggest methods such as questionnaires for ‘needs satisfaction’. Six needs are identified as especially important for satisfying experiences, namely *relatedness, meaning, stimulation, competence, security and popularity*. Affect is also measured, based on the Positive Affect Negative Affect Schedule (PANAS) (Watson et al. 1988), consisting of 20 verbal descriptors of affective experiences.

TECHNOLOGY AS EXPERIENCE

In a departure from previous frameworks, yet another direction of user experience research is based on pragmatist philosophy (e.g. Dewey 2005), acknowledging the emotional, subjective and transformational aspects of experiences. McCarthy and Wright (2004) define ‘four threads’ of experience in their work ‘Technology as experience’:

- *The Sensual Thread*: a user’s experience connected to sensory engagement.
- *The Emotional Thread*: value judgments of the experience; whether positive or negative emotions are connected to the experience.
- *The Compositional Thread*: relationships between the parts and the whole of an experience.
- *The Spatio-Temporal Thread*: how the experience relates to the user’s past, future and place where the experience takes place.

In addition to the four threads, the authors define six sense-making processes (Fig. 2) that can be used to discuss experiences through a temporal lens. The six steps of an experience are described as *anticipating* (e.g. expectations the user has from previous

experiences), *connecting* (immediate responses with little cognitive effort), *interpreting* (making sense of an experience in a more conscious way), *reflecting* (reflections on experiences by retrospect evaluation and examination), *appropriating* (relating the experience to past and future), and *recounting* (telling the experience to one self and others by storytelling). However, few empirical examples exist of how these processes are experienced by users.

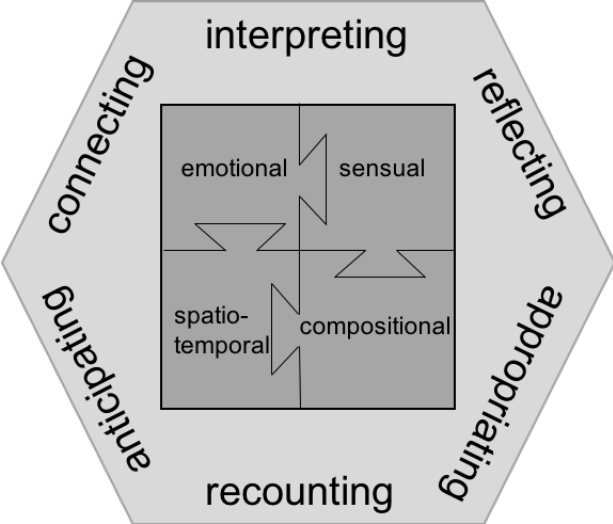


Figure 2. Technology as experience, adapted from McCarthy and Wright (2004)

Experience narratives are the main source of empirical knowledge for the work of McCarthy and Wright. The focus is on the individual, subjective and contextual experience.

THE BUILDING BLOCKS OF EXPERIENCE

Yet another direction of user experience research, referring to both pragmatism and human-machine interaction, further emphasises the *contextual* factors influencing experiences. The context of use and social and cultural factors as highlighted by Forlizzi and Ford (2000) have presented a model of how user experiences are shaped by the individual *user*, the *product*, the *context of use* and the *social and cultural factors* (Fig. 3).



Figure 3. Forlizzi's and Ford's (Forlizzi and Ford 2000) model of influences on experience

Methods and tools are to be used in close relation to the iterative development process, and Forlizzi and Battarbee state that "...the process needs to be visual, emphatic and emotionally driven to be ultimately successful in supporting inspiration and gaining insights into user experience". An example of such a tool is 'experience prototypes' (Buchenau and Suri 2000), where users are enabled first-hand experiences with products in the intended context of use.

USER EXPERIENCE AND TEMPORALITY

UX can be researched through different temporal lenses: *momentary* UX (responses to direct use), *episodic* UX (gathering data from a whole episode of use), *cumulative* UX (usage over several episodes over time), or even before use, that is to say *anticipated* UX (Roto et al. 2011).

The majority of existing UX research covers momentary and episodic UX (cf. Bargas-Avila and Hornbæk 2011). There are however examples of cumulative user experience research; for instance Karapanos et al. (2009), inspired by Silverstone and Haddon's (1996) theories of product adoption, presented a construct of temporal product adoption. The construct was derived from a five-week ethnographic study of novice Apple iPhone users. The research describes the users' process of adopting new technology as going through the stages of *orientation*, *incorporation* and *identification*. The orientation phase refers to users' initial experiences where the users are excited or frustrated when encountering new functionality. In the incorporation phase, the product becomes meaningful in the users' daily life, where usability and usefulness are important factors. Finally, in the identification phase, the product is connected to the users' self-identity. The researchers conclude that product qualities that make initial experiences valuable do not automatically motivate sustained use, and suggest a design focus for 'meaningful mediation' (supporting daily routines) and 'designing for the self' (supporting the users' desired self-identity).

Studying experiences as they develop over days, weeks and even months is time-consuming and involves high cost and considerable effort. One cost-effective alternative is to study experiences in retrospect, but the research then faces the challenge for the users to recollect their experiences. Mediating tools for studying UX in retrospect have therefore been developed to aid the user in effectively recalling experiences, for example by Huang (2015), Kujala et al. (2011) as well as Karapanos et al. (2012).

One research interest in retrospective studies has been to investigate how pragmatic and hedonic aspects of user experience interplay over time (see for example Kujala et

al. 2011; Hasan and Chandra Gope 2013), indicating that pragmatic factors (i.e. usability) are predominant for user experience judgments in initial stages over use, whereas over time hedonic values (for instance aesthetic, stimulation) became more dominant (Kujala et al. 2011) .

1.2 ANALYSIS

Before further analysis of the frameworks, a brief summary of my personal research context is presented so as to provide guidance to the existing applicability of UX frameworks in my context.

1.2.1 PERSONAL CONTEXT

My personal background and employment are within the automotive industry and the research originates within the design practice context. However, as academic research, it is also situated in design studies in order to understand more of the car users' perspective of their experiences.

Fallman (2008) identifies design research as constituted along three directions (Fig. 5):

- *design practice* - commercial development or case studies.
- *design studies* - looking at design practice and theory development from a distance.
- *design exploration* - introducing design as a tool to perform research into other topics.

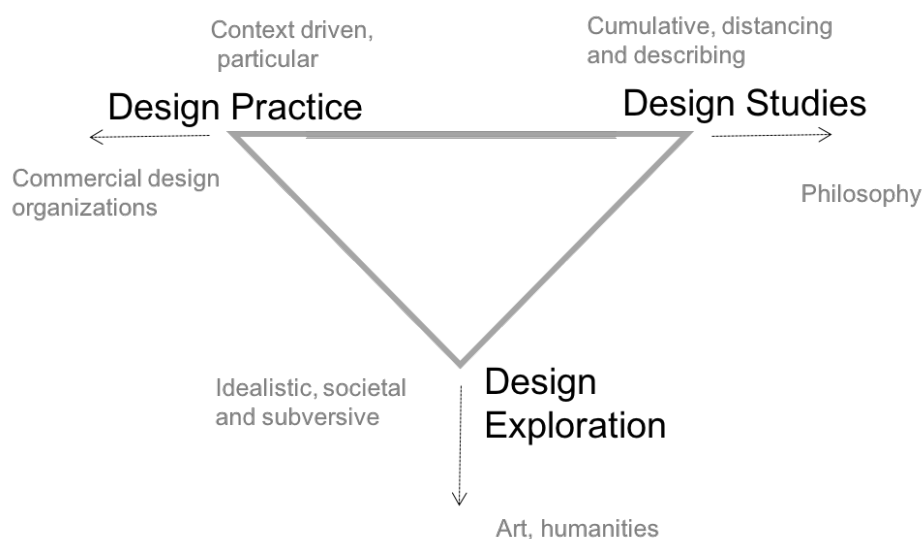


Figure 5. Fallman's (2008) triangle of types of design research.

Based on my background as an employee in the automotive industry, the temporality of UX is studied (i.e. design studies), but with a clear intent to contribute to *design practice*, i.e. product development. The automotive industry is characterised by long development times and a strong focus on validation and safety. User studies typically address momentary usability and distraction, often in a driving simulator setting.

The aim of my later research is to further investigate *user experience* evaluations, but before experience can be further addressed in evaluations, I believe I need to further understand the concept of experience. To properly understand user experiences of in-vehicle systems, the research must encounter the users' own rich, contextual and highly subjective experiences. In my research context, experience must then be explored in-depth to reach the level of detail needed to aid the development of a specific product. In a design process, designers typically do not have direct access to users, and therefore need information that is rich; multi-layered, subjective, and able to convey stories (Sleeswijk Visser 2009). In other words, it is typically not enough to rate the design on a scale from "attractive" to 'unattractive' – there must be some understanding of what makes the design attractive/unattractive and why, in order to inform the design process. This demands a high level of subjective richness with which to work, adding to the demands on methodologies applied for understanding user experience. In particular, studies of prospective user research in early phases of development are limited and would be beneficial in design activities, where suggestions for possible futures must be made. An automotive project's experience goals often need to be set very early on in the process, thus even further increasing the need to look ahead and to gain an early understanding of the user. However, the methodologies investigating experiences past, present and future, must be 'reasonable', i.e. able to inform design within a realistic time-frame and with reasonable effort.

1.2.2 FRAMEWORK ANALYSIS

The frameworks described earlier (see Table 1 for a summary) focus on different aspects, use different terminologies to define or describe experiences and seek different explanations for the elicitation of experiences.

Table 1. An overview of theoretical frameworks

| Authors | Focus | Theoretical basis | Basis of empirical knowledge | Addresses temporality |
|----------------------------|-----------------------|---|---|-----------------------------------|
| Norman (2004) | Product emotion | Cognitive science | None specified | Implicitly, on a short time scale |
| Desmet (2002) | Product emotion | Appraisal theory | Momentary user responses (questionnaires) | Implicitly, on a short time scale |
| Jordan (2000) | Product pleasure | Anthropology and psychology | A number of user research methods, from momentary responses to ethnographic studies | No |
| Hassenzahl (2010) | Product interaction | Cognitive science and psychology | Momentary user responses (questionnaires) | No |
| Wright and McCarthy (2004) | Threads of experience | Pragmatist philosophy | User narratives | Yes. Few empirical examples |
| Forlizzi and Ford (2004) | Types of experiences | Pragmatist philosophy Symbolic interactionism | User narratives and interactions | No |

The work on product emotions (cf. Desmet 2002, Desmet and Hekkert 2007) uses appraisal theory to explain how emotions are related to experiencing products. Appraisal is an evaluative process describing the human's (always present) assessments of the current situation and its nature (good/bad). Based on this process, an emotional response to the situation is elicited. As this is the theoretical entrance to user experience research, the focus is thus predominantly on direct stimuli. Empirical studies typically address instantaneous emotions. The model in itself does not address time. However, the work acknowledges that there is a time-dependent process where emotions are formed. In addition, Norman's framework does not address how experiences evolve over time, although there is an implicit understanding of the importance of time for reflective design aspects. The frameworks of Desmet and Norman are thus not particularly suitable for analysing **interactive** products over time, where experiences (as well as the interface and the user) evolve over longer periods of use.

Hassenzahl (2008; 2010) places further attention on the interaction between user and product. The theoretical background is psychology and cognitive science, constituted within a tradition of controlled experiments. The construct of pragmatic and hedonic product qualities, and the users' be- and do-goals, does not address the issue of **temporal** experiences. The majority of user experience studies in this tradition are purely based on short-term interactions with products (cf. Bargas-Avila and Hornbæk 2011). As study measures are typically predefined, usually in the form of psychometric scales, the fundamental assumption is thus that the users' perspectives on important UX aspects are largely the same as the researchers' (Karapanos 2010). Suri (2002) criticises the use of measurements when there is no certainty about which variables are important to the user, as measurement intrinsically forces us to ignore some variables and emphasise others. In addition, the finer nuances of experiences can be lost. Since an experience is individual, methodology better able to address the subjective richness of experience is needed for addressing in-depth, informative values in design processes.

The work of Desmet, Norman and Hassenzahl are grounded in cognitive theories. In contrast, McCarthy's and Wright's descriptions of user experience are based on pragmatist philosophy, expanding user experience to focus on temporal and contextual factors, acknowledging the transitions between anticipated use, momentary use and use over extended periods of time. In the tradition of Dewey (2005), they reflect on the interplay between user and interactive artefact and how they are both able to influence each other as interaction takes place. However, McCarthy's and Wright's framework does not specify how UX aspects may interplay during the temporal stages, in other words what factors are important at each stage. In a design process, there is typically a need to be more specific and concrete. Research within this tradition, as well as the research of Forlizzi and Ford (2000), aims at understanding users as *individuals*, from empirical data in the form of user narratives. However, it is questionable if narratives of past experiences alone are enough for informing a design process, as it can prove difficult for study participants to express experiences in words (Sanders 2002). In addition, due to the extensive nature of the work of collecting narrative examples, very few empirical examples exist and with few examples there is a risk of 'experience paradoxes', meaning that it is possible to miss out on "...*the net of experiences encountered by different users of the same artefact*" (Pucillo and Cascini 2014). In a design process, individual experience narratives may serve as enlightening examples for design inspiration, but may not be suitable for a more aggregated understanding of UX and temporality.

The research into experiences across time (see for example Karapanos et al. 2009; Kujala et al. 2011; Bødker and Klokmoose 2012) is relevant, but also underpinned with very few empirical studies and limited to only the first weeks of usage, in other words

the initial adoption process. Another methodological issue from a temporal perspective is the lack of prospective insights from UX studies. Insights for understanding disruptive innovations, i.e. designs that create new values and may thus disrupt the market, can be difficult to elicit from retrospective and momentary methods. As design involves creating novel experiences, it would be beneficial if research was able provide information at early stages of design processes, including on products where there are no predecessors. In the automotive area, an example of this type of product is autonomous cars. Most premium car brands are in the process of prototyping autonomous cars, but none are as yet available for user studies. Still, user insights are needed even in early stages in development.

Prospective research relies on expectations of future experiences. Expectations have been found to shape later outcomes of experiences (see for example Karapanos et al., 2009; Trösterer et al. 2014) and are a recognised part of experience temporality (see for instance McCarthy and Wright, 2004). Expectations thus pose an interesting study case for temporal user experiences, in addition to retrospective studies. However, as there is a shortage of methodologies for prospective research, the area is in need of methodology development. Previous research (Brandt and Grunnet 2000; Ehn and Kyng 1991; Zhao et al. 2009) have spotlighted the difficulties as well as the value to be had in eliciting relevant responses concerning the future from study participants.

The definitions of UX that exist (c.f. International Organization for Standardization (ISO) 2010; Alben 1996) do not give a clear understanding of the topic but rather directions to the parameters that influence user experiences, such as emotions and context. In this thesis, I will follow the understanding of the **product**, the **context** and the **user** as an *individual* as formative for the user experience (cf. Hassenzahl and Tractinsky 2006). However, I add temporality to this starting point of understanding user experiences, as well as an emphasis that user experiences must be understood from the unique, individual and subjective experience (cf. McCarthy and Wright 2004) rather than measures and high-level definitions of universal human needs (in contrast to Hassenzahl et al. 2010).

Based on the frameworks reviewed, my understanding of experience is that it includes emotions and judgements, is influenced by previous experiences, and changes over time. My overall ambition, however, is not to be more precise in the definition of user experience in this stage but to allow the study participants' experiences to speak for themselves.

In summary, there is a lack of UX research for gaining aggregated *in-depth* data of users' experiences, understanding how experiences are constituted over *time*, and addressing the challenges of reaching relevant data also concerning *future* experiences, i.e. prospective research. This is especially pressing in the automotive industry, where lead times are long and there has been a long tradition of being distraction- and usability-focused rather than also *experience-focused*.

1.3 RESEARCH QUESTIONS

Based on the need to advance experience knowledge of in-vehicle systems, and the identified research needs of in-depth, temporal UX research, the following research question was formulated:

- *How is in-vehicle user experience related to **temporality**?*

To be able to answer this question, the voice of the end users must be listened to. Thus, a second research question was added:

- *What experiences do users **describe** when referring to different time frames of in-vehicle systems use – past, present and future?*

For in-depth studies of user experience at different time perspectives, methodology needs to be carefully chosen. As very little methodology for prospective use exist, methodology also needs to be evolved. This leads to a third research question:

- *What **methodology** can be employed/developed for in-depth research of subjective in-vehicle user experiences, methodology that also includes prospective temporality?*



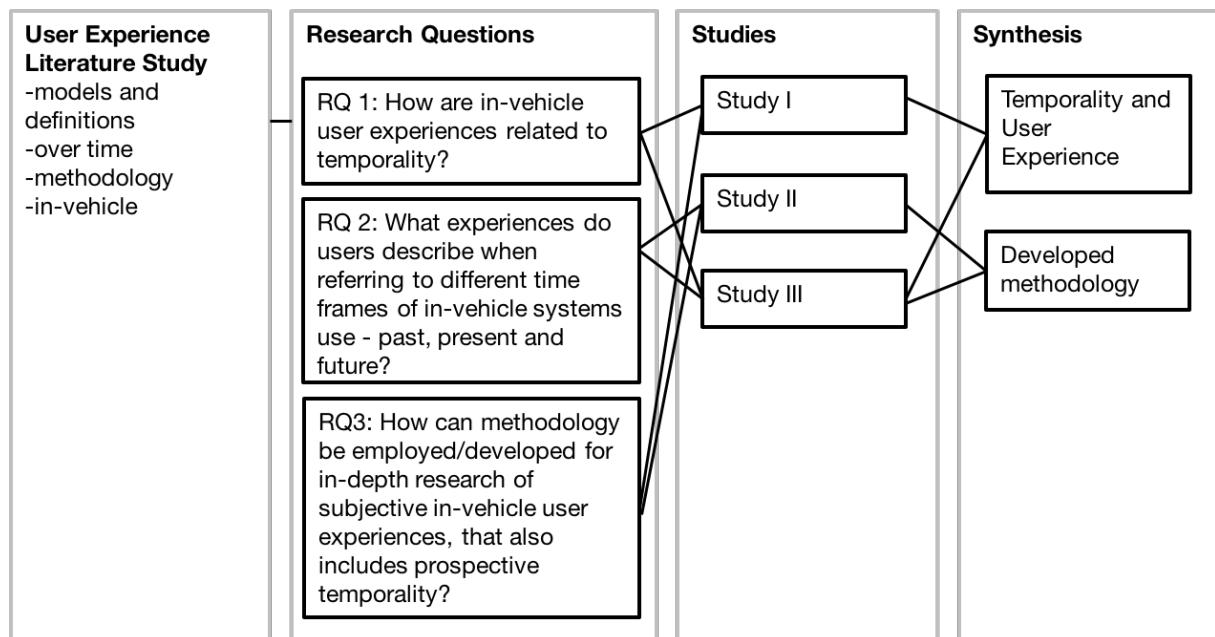
2 METHODOLOGY

2.1 RESEARCH PROCESS

To be able to answer the research questions, empirical studies of past, present and future experiences were considered crucial. Three user studies were thus undertaken to develop a more in-depth understanding of the temporality of in-vehicle UX. The studies addressed different time frames (past, present and future) to establish an overview of the temporality of user experience (see Table 2).

- The first study (Study I) was centred on retrospective and current experiences, looking back at cumulative UX to the present date (in this case between 3 months and 3 years).
- The second and third studies (Studies II and III) were prospective, researching the expectations of future user experiences of cars. The second study primarily focused on methodology development and the third study on the empirical outcomes. The two main outcomes of the research were a methodology for prospective research and a model of user experience temporality.

Table 2. An overview of the research process



2.2 DATA COLLECTION

Data collection methods are situated close to the narrative tradition of Forlizzi (e.g. Forlizzi and Ford 2000) and McCarthy and Wright (2004), to obtain in-depth data detailed enough to be of value during design processes. Methodological efforts

aimed at providing support for the participants to reflect on and express their experiences, i.e. to tackle the difficulties of expressing experiences (c.f. Sanders 2002). For the studies on anticipated experiences, the data collection methods aimed to also provide support for 'transitioning' participants to a future context; i.e. making the future context more tangible and expressible for the participants. See Table 3 for a summary of data collection methods and participant numbers.

Table 3. An overview of empirical studies

| Study | Data collection methods | No. of participants (M/F) |
|-----------|---|---------------------------|
| Study I | <ul style="list-style-type: none"> • UX curve method • Reflexive photography • Contextual interview | 16 (9/7) |
| Study II | Method 1: <ul style="list-style-type: none"> • Collages and drawings • UX curves • Semi-structured interview Method 2 ('setting the stage for automotive experiences'): <ul style="list-style-type: none"> • Placement in a 'car' • Drawing • Enacting • Semi-structured interview | 18 (13/5) |
| Study III | <ul style="list-style-type: none"> • 'Setting the stage for automotive experiences' | 11 (6/5) |

2.2.1 THE PAST TO CURRENT

Expressing experiences in retrospect can be especially challenging, as the human memory produces biases in recollections. Sanders (2002) furthermore concludes:

“... There are many reasons why people say what they say, and why they don't say other things. And there are many thoughts and feelings people are not able to put into words. These thoughts include tacit or inexpressible information which does not have a chance of being expressed when using research methods that rely solely on what people say.”

It has thus been suggested that participant information is accessible in **layers** (Karlsson 1996; Visser et al. 2005), see Figure 7.

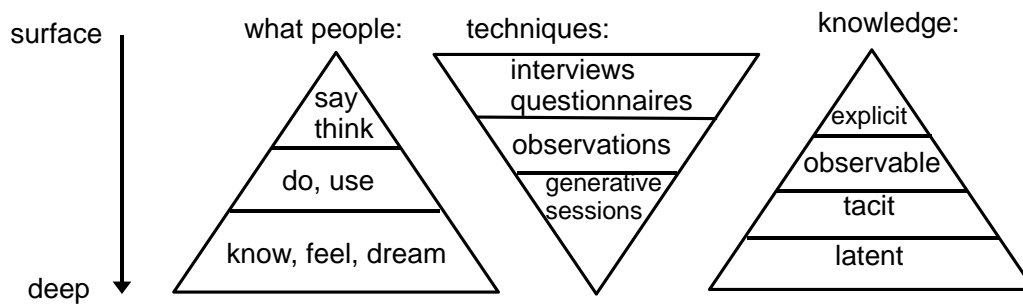


Figure 7. Different levels of knowledge about experience are accessed by different techniques, adapted from Visser et al. (2005)

In order to reach the lower levels, ‘mediating tools’ can be employed to entice reflections (Brandt and Grunnet, 2000; Karlsson, 1996; Sanders et al., 2010), such as existing objects to which to relate (e.g. product representations), as well as objects that the user can adapt or create. These can for example be cultural probes, photos and drawings. To support participant reflections these types of objects and creative elements can offer conversation stimuli as well as contextualisation, and create ways of expressing experiences other than solely depending on words. Being enabled to express visually as well as in words can aid in reflecting and expressing the subjective (Kujala et al. 2011). Roam (2011, p. 319) suggests that “...*The more we draw, the more our ideas become visible, and as they become visible they become clear, and as they become clear they become easier to discuss—which in the virtuous cycle of visual thinking prompts us to discuss even more.*” By also *doing* and *showing* user experiences, the ambition is to move beyond what first comes to mind in a conversation and establish a better understanding of the problem at hand.

Additionally, a multi-method approach was chosen to offer several entry points to discussions of experiences. Multi-method approaches can be argued to cover more aspects of the topic at hand, as each method can contribute through its specific deposition. In overview, the data collection methods applied in this thesis contained mediating tools intended to encourage reflection and contextualisation through a combination of:

- **Materialising the car** – the studies aimed for an embodied experience to aid the participant to relate to the physical space of the car. In Study I this was achieved by situating the interviews in the participants’ own cars whereas in Studies II & III a representation of the car was used.
- **Materialising temporality** – the over-time perspective was made present in the studies by visualisations of time scales and interview questions regarding user experiences across time.
- **A multi-method approach** – providing several entry points for reflection through a combination of methods.
- **The use of generative elements** – i.e. inviting the participants to express their experiences through use of creative material such as photography and drawings.

2.2.2 THE FUTURE

Research that concerns future technology faces additional problems as the *study design must support a shift in focus from the current into the future*. Available methods, both quantitative and qualitative, have been shown to have limitations for those prospective conclusions on users' responses to emerging technologies that are needed to enable a more user-centred design already from the early stages of development (see for example Zhao et al. 2009; Ehn and Kyng 1991; Brandt and Grunnet 2000; Halse et al. 2010). This calls for new user research methods that allow a **transition** from the current situation to the future possibilities of technology and that can enable researchers and designers to even "...learn something that we didn't know we needed to know" (Muller 2003), i.e. to venture beyond the expected results of the study.

Studies II and III, which particularly aimed at transporting the user to the 'future', contained the following study elements:

- **Enactment of future use**; where both body and mind are engaged in the reflective activity. It allowed a flow of interaction, eliciting information on a very detailed level. Enactment probed for expectations on different stages of the usage of the technology; i.e. not only a snapshot of overall expectations for an autonomous car, but an actual process of using and finding value in such technology during daily routines.
- **A simple and open mediating tool** – rather than an elaborate design mock-up or a finished car. Simple and open designs have been claimed to stimulate participants' fantasy to a greater extent than more developed designs (Ehn & Kyng, 1991). Similarly, consumer research has indicated that open spaces provide support to think more abstractly and freely (Meyers-Levy and Zhu 2007).
- **Generating future designs** – the participants were encouraged to engage creatively to encourage reflection, imagination and engagement. The temporal perspective was incorporated in various ways, for example through questions of what information they desired at different stages of use.
- **Relating to past experiences** – this approach was employed to anchor responses in the participants' individual perspectives, and not venture into speculations about what other users might think.

2.3 DATA ANALYSIS

Data was collected from the studies, mainly in the form of narratives, as well as the participants' drawings and photographs. The analyses of the narrative data collected in the studies were based on qualitative data analysis (Denzin and Lincoln 2005). Drawings and photographs were analysed as described in each respective study. Narrative user experience themes were firstly identified in the individuals' stories, and then in common patterns between participants. The analysis omitted experiences not related to the in-vehicle interactive systems (i.e. narratives concerning the car exterior), as well as statements that did not include any subjective qualities (i.e. recounting the car's systems without any further comments on aspects such as negative/positive values connected to this).

Finally, to create a synthesis of the findings, the outcomes of the three studies were compared in order to identify common experience aspects and to see if these aspects had a temporal dimension. This analysis too was based on qualitative data analysis (ibid) where themes were established from data categorisation. In the analysis, different experience attributes were found to be prominent in different expected stages of use, both in terms of expected and experienced use.



3 STUDIES

3.1 STUDY I (PAPERS 1-2)

3.1.1 AIM

The first study aimed at understanding long-term in-car experiences, from past experiences in retrospect to the present. From the participants' own perspectives, the types of experiences to be had in connection with in-vehicle technology were identified and the temporal transitions of user experience were explored.

3.1.2 METHOD

Three retrospective data collection methods were used in order to study the in-vehicle information systems: Contextual Interviews (Beyer and Holtzblatt 1997), the UX Curve Method (Kujala et al. 2011), and Reflexive Photography (Harrington and Lindy 1998). Questions regarding expectations, first impressions, and positive and negative experiences guided the participants to present their experience stories. The participants were asked to mark out memorable experiences over time on a positive/negative scale. In accordance with the reflexive photography methodology, interviewees were asked to take photographs that depict an experience of significant importance for them. Approximately one week before the research session, the participants in this study were asked to take photographs of aspects of experiential significance. The photos were then brought to the interview session and used as a tool during the discussion.

Sixteen participants took part in the study. The recruitment criteria specified that they should own a modern car (no older than three years and not owned by them for less than three months). The car was required to contain a high degree of interactive technology, such as hands-free phone connectivity, active safety systems and navigation systems to increase the interactive and connected attributes of the systems. The interviews were recorded, transcribed in full and their content analysed together with the experience notes from the UX curves and the photographs. A qualitative data analysis was conducted (Denzin and Lincoln 2005), where themes were coded to follow up on emerging patterns in the data analysis. As the UX curve and the photos highlighted experiences that were significant for the participants, data connected to the photos and UX curves were incorporated into the analysis and contributed to the categories and UX themes found.

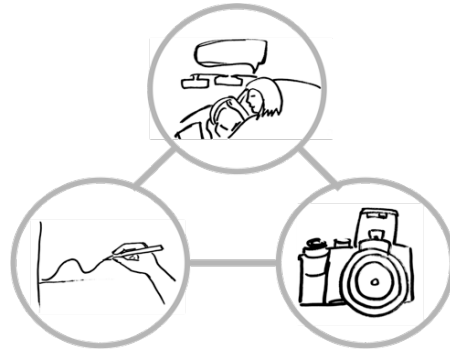


Figure 8. Triangulation of methods for accessing the in-vehicle user experiences

3.1.3 FINDINGS

The participants' user experiences clearly evolved over time as the cars were explored and incorporated into daily life. Expectations of the systems were formative for the initial experiences of use, where some (N=5) had very informed expectations, for others the cars exceeded their expectations (N=9) or they were disappointed over time (N=2). For participants with negative curve development, usability issues lowered the experience ratings after the initial often quite high expectations. For all curve trends, changes were noted in the first half of the UX curves, when the users were exploring the cars, finding shortcomings as well as benefits through active use. An example of a curve with this typical pattern of initial fluctuations is presented in Figure 9, and the overall patterns of development in Figure 10.

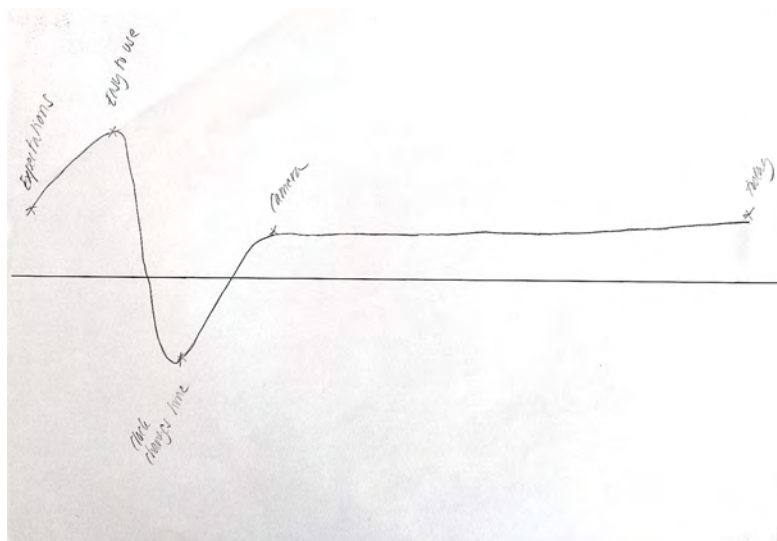


Figure 9. Example of a user experience curve.

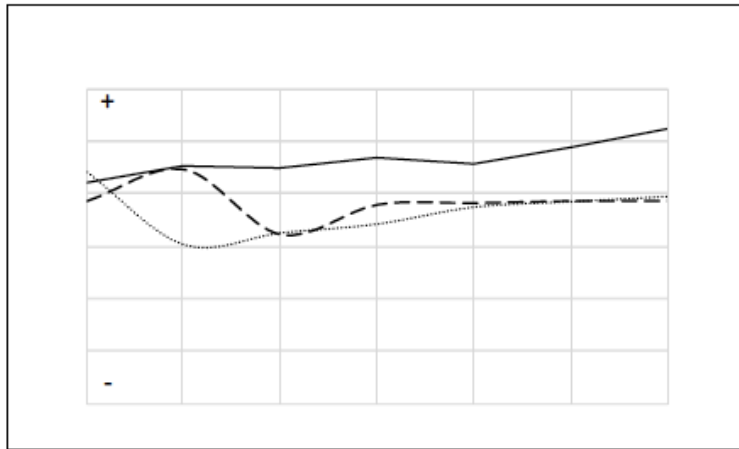


Figure 10. Calculated means of User Experience Curves.
 Negative (N=2) — Positive (N=9), ---Stable (N=5).

Based on the findings, a number of experience *themes* were identified for the in-vehicle systems:

- *The car as a caretaker* – The participants enjoyed the feeling that the car was taking care of their safety and needs, while also providing convenience. The experience of the caretaking car was created by features such as the seat-belt tightening in sharp corners. Active safety and convenience systems were appreciated for saving the driver and passengers from dangers and inconvenience.
- *The car as a space for relatedness* – The in-vehicle systems of the car provided an opportunity for relatedness to other people, outside the car, easily accessible through smartphone integration. Participants also connected to passengers in the car through shared in-car activities, often enabled by the in-vehicle systems, such as listening together to music, podcasts or audio books.
- *The car as a space for stimulation* – The discovery of new functions and the utilisation of the interactive systems available in the car were a source of stimulation for the participants.
- *The car as a space for transition* – Time spent in the car was used as an opportunity to prepare for the next stage in the participants' lives. During commuting, the in-vehicle systems were thus an important part of the everyday life puzzle of activities, providing a window for reflection, planning and distancing. The use of the car as a transitional space was accomplished for instance by preparing for work through taking work-related calls during the drive to work, and by catching up on e-mails, for example at traffic lights.

Three principal aspects of the findings were found to be formative for the *long-term* user experience of in-vehicle systems:

- *Influence of other products* – Firstly, it was evident already from the start of the interview sessions that it was impossible to distinguish experience stories of the in-vehicle system from those that also concerned the participants' phones and other connective technology. All participants had in-vehicle systems that were connected to smartphones, and these units became intertwined from the users' viewpoint.
- *Influence of new behaviours* – Secondly, new behaviours emerged over prolonged use. These new behaviours considerably altered the experience over time. Examples of such behaviours were the use of hands-free phone, working in the car and using apps for monitoring the car from home.
- *Influence of social settings* – Thirdly, a striking number of experience stories concerned social aspects of using in-vehicle systems, i.e. how they were experienced when in contact with other people. Only focusing on one person's solitary experiences of the technology would limit UX knowledge.

The results underscore that as it is not possible to give an informed evaluation of a product from initial, momentary use, it does not appear feasible to separate other products and people from the research of the user experience. There is thus a need for a methodology that can provide further understanding of these aspects.



3.2 STUDY II (PAPER 3)

3.2.1 AIM

The second study targeted methodology for researching user experience *expectations*. As an empirical study case of user expectation methodology, the study was directed at future users' expectations of autonomous cars. Autonomous cars have been present in fiction since the 1930s (see for example Keller, 1935), fascinating their audiences, but they are not yet a reality for consumers. This is set to change very quickly indeed; for example, in 2015 Google had completed 1 Mkm of accident-free autonomous driving (Google 2015) and most premium car brands are in the process of prototyping such cars. The subject itself is currently attracting considerable interest from the public as well as the media (see for example Bilger, 2013; Vanderbildt, 2012), making it an iconic and interesting prospective case study of user expectations.

As several studies have demonstrated, when it comes to problems associated with investigating 'the future' (Brandt and Grunnet 2000; Ehn and Kyng 1991; Zhao et al. 2009), method development is needed. This study's aim was to contribute to methodology for prospective user experience research.

3.2.2 METHOD

Two different qualitative approaches for exploring users' expectations of future automotive technology were applied in two sub-studies (Studies A and B) and the outcomes were compared. Both studies were conducted in an informal and spontaneous manner, with the focus on method exploration and experimentation. The data collected from the studies were mainly in the form of notes from the user narratives, but also in the form of drawings and collages. The data analysis was based on qualitative data analysis (Denzin and Lincoln 2005). As the aim was to stay open to unexpected themes the analysis was not directed towards predefined categories, but used conventional qualitative content analysis where themes were established directly from data categorisation and grouping (cf. Hsieh and Shannon 2005). Outcomes were compared in relation to the type of UX aspects found in the respective study data.

STUDY A

Study A encompassed nine participants, six men and three women, and took place in a Copenhagen shopping mall. Mediating tools, or 'props', were used in the form of collage material of existing car models, car concepts and images of Copenhagen. The participants were asked to choose one type of car that represented their vision of autonomous driving. They were also requested to choose one cityscape in

Copenhagen that was of particular importance to them, and note down how they expected this to change with the introduction of autonomous driving. In addition, they were encouraged to draw or narrate any activities, car designs and city changes they thought autonomous driving would bring about (see Figure 11 for an example). The participants were also asked what an imagined journey back home with the autonomous car would be like, in order to tie the responses to their own personal needs. The semi-structured interview posed questions about the value of autonomous cars, worries, activities and expected design changes.

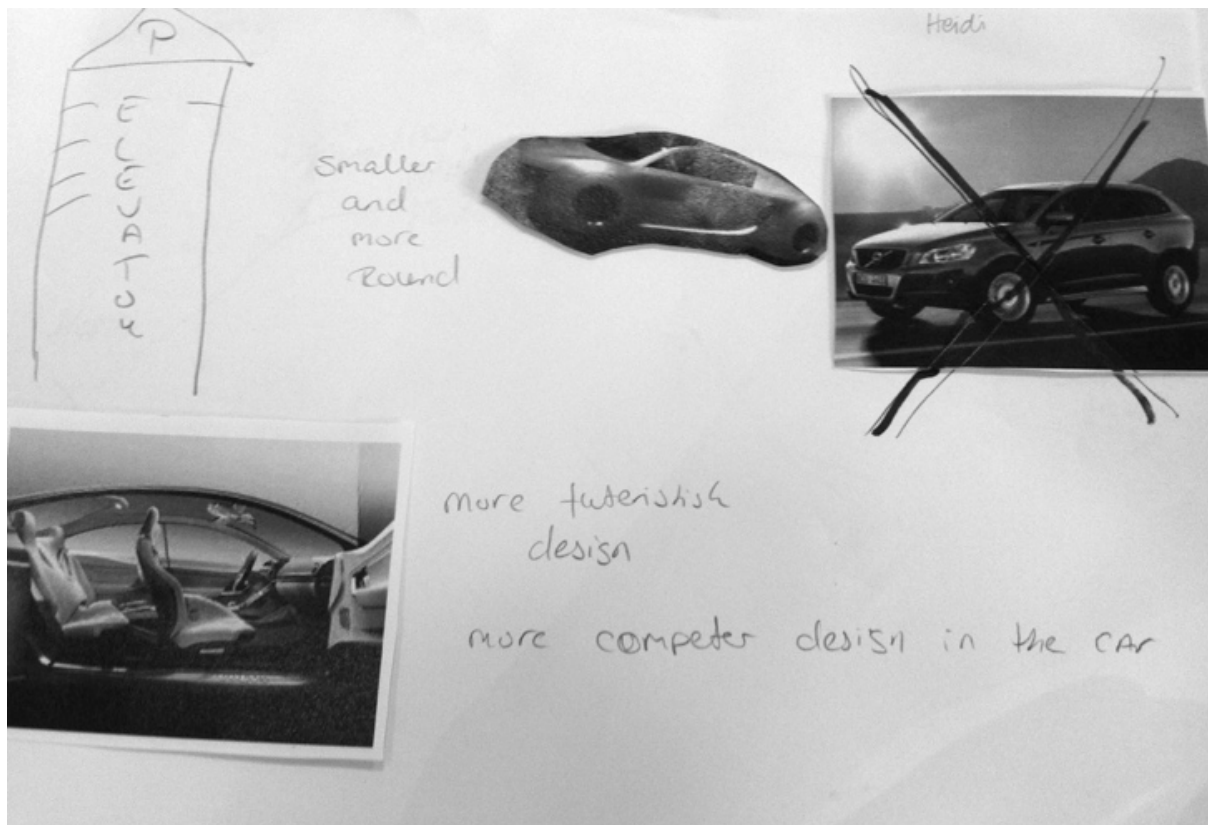


Figure 11. One of the Study A participants' drawings, showing a futuristic car interior and exterior design, as well as automatic parking garages.

STUDY B

In Study B, a total of nine persons participated (seven men and two women) in the study that took place in Sweden. The methodology's starting point was to evoke reflections on emotions and experiences in relation to autonomous cars.

Relating to proficiencies that evoke emotions, film and theatre have an inherent power to convey the experiences of others. This power is particularly strong in Lars von Trier's film 'Dogville' from 2003. The representation language is limited to a minimal design with white lines on a concrete floor representing walls and objects. The audience has to imagine what is not there in this minimalistic setting, and use of the audience's imaginative power results in a strong, artistic film. Building on this, the methodology

developed includes enactment of future experiences, supported by a minimalistic representation language in terms of a car drawn with chalk and four chairs (see Fig. 12), giving the methodology the name **'Setting the stage for future automotive experiences'**. The participants were passers-by, single or in groups, invited to take a seat in the 'car' and asked to imagine and design an autonomous car. They were encouraged to use the chairs and chalks to re-design the 'car'. A semi-structured interview was held, focused around expected experiences in autonomous cars, such as emotions in the car, worries, values and how they expected the car space to change with the introduction of autonomous cars. The participants were asked to perform and explain how they expected to experience the car during usage. The drawings from each participant were not erased between the sessions, so they also collectively built upon each other's ideas. Again, photos and notes from the narratives were taken during the session.



Figure 12. Sample photographs from study B.

3.2.3 FINDINGS

Content analysis revealed that Study A provided information on social implications, trust and everyday activities in autonomous cars whereas Study B provided further

details about interaction and interior design expectations, as well as trust and anticipated activities (see Table 3).

Both methodologies resulted in a deeper understanding of the participants' expectations. Nevertheless, the results differed in terms of content and level of detail, thus contributing to our knowledge of how different studies of the same topic can elicit different types of data (Table 4). For example, Study B resulted in more elaborate and in-depth reflections on the participants' trust, and expectations regarding interaction and interior car design. Study A, on the other hand, provided more information about how the technology would shape everyday life. In Study B, the participants' placement in the 'car' appeared to create a situation to enact and anticipate future use; the participants were able to express themselves more precisely and informatively about interactions with the car. Less preconceived ideas about the technology (for example of 'flying cars') were aired in Study B, and more informative specifics about the designs and expected interactions were expressed. The enactment of future experiences thus turned out to result in more reflections on use and acceptance, in accordance with previous research into studies of future technology (Brandt and Grunnet 2000; Ehn and Kyng 1991). Enactment also gave the possibility of examining expectations of the flow of interaction events, rather than a snapshot of expectations on an overall level (as in Study A).

Table 4. Study approaches and outcomes in Study II

| | Method combinations | Outcome | Recommended study focus |
|----------------|---|---|---|
| Study A | <ul style="list-style-type: none"> • Drawing • Collaging • Interview | <ul style="list-style-type: none"> • Information about the cityscape and society changes • Information about activities and emotions • Information about "flying cars" • Information about trust | <ul style="list-style-type: none"> • Autonomous cars expected effects on society and infrastructure • Autonomous cars expected effects on family/social situations • Trust |
| Study B | <ul style="list-style-type: none"> • Placement in the 'car' prototype • Drawing • Enactment of interaction and activities • Interview | <ul style="list-style-type: none"> • More precise information • More detailed information about activities • More focus on the in-car environment • Focus on interaction flow • Information of trust | <ul style="list-style-type: none"> • Autonomous cars expected effects on a personal level • Car design implications • Interaction-design implications • Trust |



3.3 STUDY III (Paper 4)

3.3.1 AIM

The third study aimed at understanding experience expectations, in other words by means of prospective research. The research in the study also used autonomous cars as a case study, with the aim of further understanding how user expectations can be studied, especially highlighting the temporal, contextual, rich and highly personal aspects.

3.3.2 METHOD

In the second study, 11 Los Angeles drivers took part. The study made use of the 'Setting the stage for future automotive experiences' method (Pettersson 2014) developed in Study II to support user reflections on the temporal experiential dimensions of expectations. The participants were asked to sit inside a 'car' outlined on the floor in a room (Fig. 13). They were first asked about their current daily commutes, anchoring any stories in the participants' personal perspectives. They were then encouraged to imagine and enact a routine drive in an autonomous car, engaging both body and mind in reflections of expectations on different stages of usage; i.e. initial use and long-term routines. The placement in the 'car' was intended to offer contextualisation of the on-road, in-car context, allowing actions to be enacted as they would be performed in a real car. In addition, questions were posed concerning topics such as expected value, emotional responses and attraction, and how this would change over time. The participants were also asked to rearrange and/or remove seats and make drawings of any desired design changes. The sessions were individual, video- and audio-recorded and the audio-recording transcribed in full. As in previous studies, a qualitative content analysis was carried out (Denzin and Lincoln 2005).



Figure 13: The Stage before, during and after study.

3.3.3 FINDINGS

The possibilities for the participants to express and reflect supported by the mediating tools and the inclusion of the temporal dimension appeared useful to gain rich and experience-related data. Future projections of experiences were narrated by the participants, while maintaining a tangible link to their personal situations and needs.

For instance, the participants had high expectations of a smarter, more efficient and relaxed life in the autonomous cars. Before actually daring to use the technology, they expected to make acquaintance with autonomous car through the media, social connections, on the road and in showrooms. This phase was experienced as formative to the later decision to trust the technology; it was apparent that expectations were not formed in isolation, but were heavily influenced by social and media influence. Attraction was expected to also arise from favourable aesthetics and novelty.

The participants all expected to eventually become engaged in using autonomous cars, although there were differences between participants of the expected time to gain trust. In expectations concerning active usage, the participants related to previous use of other technology, ease-of-use and stimulation. This included clear feedback and intuitive handling, but also the freedom of not having to control functionality (unless specifically requested).

In addition to expectations on active use, autonomous cars were expected to make a tangible difference in the user's life. This could for example be in the form of introducing valuable new habits and routines during the daily commute, even impacting where to live. The meaning of the in-vehicle context was the expectation to transform, from a place where control is extremely important, into a place for being able to completely immerse in selected other activities, while being transported. The car was expected to create a better bridge between work and home life, bringing relief from unwanted emotions. All participants felt there was massive value to be found in autonomous driving, which could to a large extent be explained by a traffic situation like the one in Los Angeles. Many of the participants were in need of relaxation in everyday life; a time to break away and shut off from the world, in the long run creating a better bridge between work and home life. Efficiency shaped a large part of the attraction, such as being able to simultaneously travel and work or relax. A summarising image of values is presented in Figure 14.

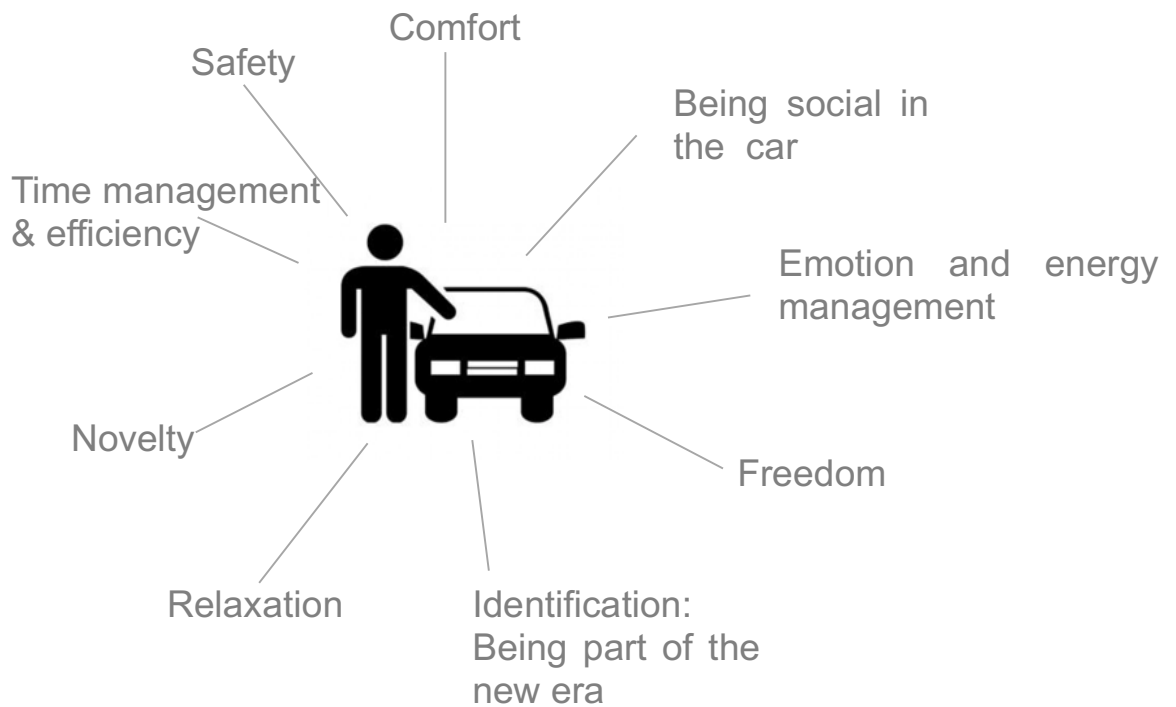
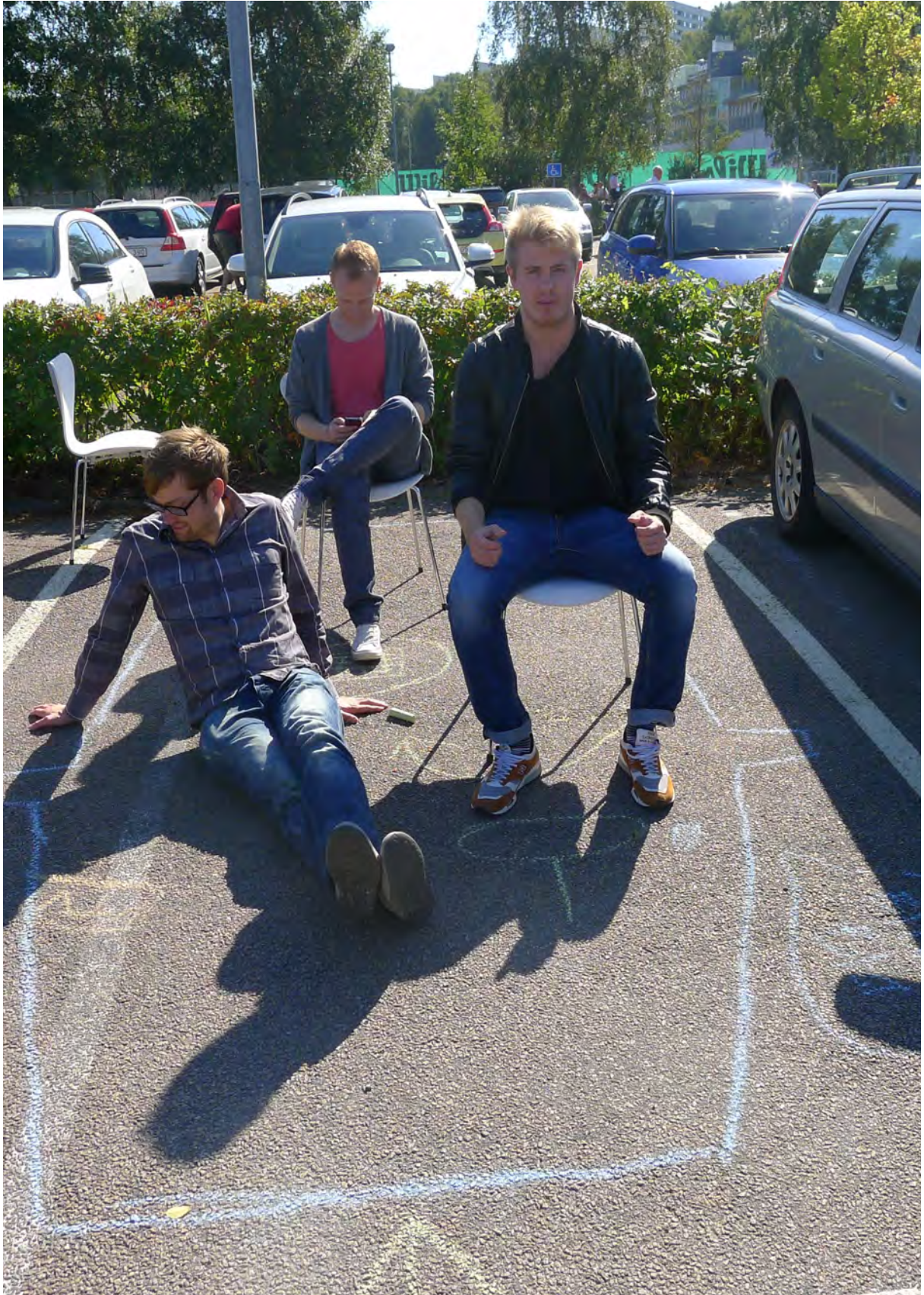


Figure 14. Values of the autonomous car expressed by the participants.

In summary, a temporal dimension of the expectations was found, from attraction, through use, to the transformation of the daily use of cars. This held similarities to the over-time patterns found in Study I, and a joint analysis of the two studies was undertaken, presented in the next chapter.



4 RESULTS

4.1 A TENTATIVE MODEL OF UX TEMPORALITY

The studies investigated users' past to present and future experiences of in-vehicle systems. Even so, overlapping themes were found, such as information about what made/would make the participants *attracted* to the car, how they experienced/would experience *use* and how they had seen/expected to see their habits and relation to the car and its systems *transform* over time. Based on the narratives, these themes could be arranged in a temporal sequence. The sequence can be described as *Acquaintancing*, *Using* and *Transforming* (see Fig. 15). It is a temporal sequence, where one sequence is needed to be satisfactory enough for the user to engage in the next. Rejection took place when use had not been/was expected not to be attractive enough during *Acquaintancing*, or had/would lead to an unsatisfactory use situation or not contributing value over time. In accordance with this, the model highlights the procedure for user experience; movement from one stage to another is achieved if the previous stage was satisfactory enough.

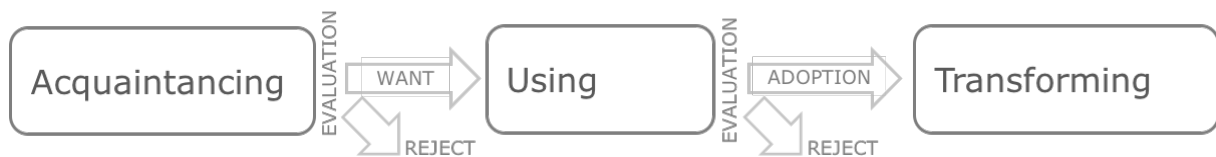


Figure 15. The tentative model of User Experience Temporality describing 'acquaintancing', 'using' and 'transforming'.

In the narratives certain ascribed product features were emphasised in the different stages. Furthermore, other aspects than the in-vehicle systems' attributes influenced the experiences, for instance social relations, expectations derived from other products, earlier interactions and established routines connected to the in-vehicle systems and daily habits. The experience attributes that were influential across time are summarised in Table 5 and are developed further below. The attributes are not to be seen as absolute, as they may differ with individuals and products. The table is rather to be seen as a snapshot of the pattern emerging in these specific studies.

Table 5. User experience sequences

| | Aquaintancing | Using | Transforming |
|------------------|-------------------|-------------------------------|---------------------|
| Aspects of UX | Aesthetics | Ease of use | Habits |
| | Functionality | Stimulation | Attachment |
| | Novelty | Previous | Meaning(fullness) |
| | Social influences | experiences of other products | Self-identification |
| | Trust building | Trust | ... |
| | ... | Aesthetics | |
| | | Social relatedness | |
| | ... | | |

The first sequence, ***Aquaintancing***, defines the stage where the user got/gets to know the in-vehicle systems before actual use. In both studies, a number of aspects were found to be influential, such as perceived novelty (cf. Desmet 2002), aesthetics and functionality. A more complex interdependency was found to influence the 'want' for the systems than what Norman (2004) refers to as visceral aspects. In both studies it was also observed how acquaintancing was heavily influenced by social factors, such as friends talking about the technology in the car, interacting with salesmen or reading about it in social media. The acquaintancing phase set the expectations for later UX: in Study I the expectations influenced the outcomes of later experiences; in Study III this phase consisted of vividly imagining future use where the expectations contained both 'be-goals' and 'do-goals' (cf. Hassenzahl et al. 2008). If the car was/will be found attractive enough to make the user trust and want the car, this 'want' was/would be the lever that would enable actual use.

The second sequence, ***Using*** the product in an everyday-life context, contained elements such as ease-of-use (cf. Norman, 2004; Hassenzahl et al. 2008), stimulation (cf. Hassenzahl et al. 2008) and also building trust in the car by interacting with it and its systems. An important aspect is that this sequence in itself contained temporal dimensions, i.e. stimulation and trust had/were expected to evolve over time, something which is overlooked in most user experience studies (cf. Bargas-Avila and Hornbæk 2011). In Study I stimulation represented encountering new and sometimes unexpected features over time, such as updateable interfaces offering continuous

stimulation. In addition, aesthetics was part of this sequence, as in the former sequence of acquaintancing. In Study III stimulation signified initial confirmation of the novelty of the autonomous car, but also (over time) liberating the user to be entertained by non-car-related activities. In both studies, trust referred to predictable, transparent and reliable functionality but in Study III trust was further highlighted as a precondition for use, and was expected to grow over time. A use situation where these aspects were satisfactory was/would be the next lever into the next experience sequence.

The final sequence, **Transforming**, describes the possibilities of how the car made/will make a long-term difference to the user, through new behaviours, habits and assigned meaning of the car. This sequence encompasses the aspects of user experiences that are primarily established over prolonged use, i.e. identification, meaning and attachment. This is also the sequence where the car transformed/was expected to transform everyday life. In Study I, this was exemplified by the changes in work, leisure and social routines that the in-car technology offered, such as taking part in phone meetings in the car or calling one's mother on the way home from work. Habits took time to evolve, based on the affordances of the interface, the users' changing needs and values as well as the changing context, and the product's functionalities. In Study III, the autonomous car held far-reaching expected possibilities of a less stressed, more efficient life in and with cars, even expected to influence where to live and work. In-car design clearly plays a part in shaping these habits, for example by the enclosed space where phone calls are made with the ability to speak freely, with good sound quality, while still being efficient in terms of transporting oneself. Similarly, the way an autonomous car is designed will also be essential for the habits that evolve, for example a very remote steering wheel will likely furthermore distance the user from the driving task, whereas a detailed, informative interface might be difficult to disconnect from, and so on.

Although similarities do exist in terms of addressing goal fulfilment between the temporal model presented in this research and other UX models, this 'transformative' aspect of experiences extends the taxonomy of user experience; in other words, goals are never set and stable, they are continuously evolving in phases that embody different characteristics.

4.2 A METHOD FOR STUDYING PROSPECTIVE UX

Previous research revealed that there was an identified need to develop prospective design study methodology. The aim was to 'move' the study participants into an appropriate time-frame, i.e. neither distant 'sci-fi' nor to incremental design changes on an existing car. For this reason, the 'Setting the stage for future automotive experiences' method was developed in Study II. Study III put the methodology to use, adding the full journey of a work commute instead of fragmented instances of interactions and activities during the journey. The temporal perspective included the interval of leaving home through to the destination, as well as how the participants expected usage to transform over time.

Based on the aim to engage and contextualise the participant, as well as overcome some of the difficulties for study participants to verbalise their experiences (Elizabeth Sanders 2002) they were invited to enact, create and talk about future use in an open, simple representation of a car (cf. Ehn and Kyng 1991; Halse et al. 2010).

The methods feature a number of steps, as described below.

- The participant is asked to sit inside a car outlined on the floor. After a short introduction to the study, he/she is asked about the current daily commute, to anchor the responses in the individual's life. The participant is then encouraged to imagine a routine drive in an autonomous car. The placement in the 'car' allows actions to be carried out as they would be performed in a real car and the participant is encouraged to act out future use, for example activities expected to be undertaken in an autonomous car, and expectations from interactions with the car.
- The participant is also encouraged to rearrange/remove seats and make drawings of any desired design changes. In addition to this, questions concerning topics such as expected value, emotions and attraction, and how this would change over time, are posed during the process.
- Material is collected on video and analysed through qualitative content analysis (Denzin and Lincoln 2005) combined with Visser et al's description of analysing generative methods for user studies (Visser et al. 2005). The analysis focuses on the narratives, without hypothesising before starting the data exploration. A first summary is made directly after the session, and is then developed after transcription of the videos. Themes are identified, such as emotions and concerns from each stage of use. The process is iterative and explorative.

5 DISCUSSION

The research set out to develop an in-depth understanding of users' specific experiences from using in-vehicle systems, and the temporal dimensions of these experiences.

There are several similarities between the findings presented here and previous UX research, including factors such as ease-of-use, stimulation, aesthetics, and identification (c.f. Desmet and Hekkert 2007; Desmet 2002; Norman 2004; Hassenzahl 2010; Forlizzi and Ford 2000). When analysing the collected user narratives, the stories reveal a number of intertwined factors and a rich depth of detailed descriptions regarding experiences, extending well beyond the interaction between user and product. Influences on daily life and habits create a more far-reaching and multifaceted picture of experience, compared to the UX studies that focuses on momentary experiences and/or measurability (cf. Korber and Eichinger 2013; Körber and Bengler 2013; Hassenzahl et al. 2003). What users appear to talk about when relating to experiences of use are not only for instance cases of emotions and experiencing ease or difficulties in use, but rather *how daily life is shaped around the technology* over time. This can be argued to create an extended *taxonomy* of user experience, extending the focus from direct interactions (cf. Desmet 2002; Norman 2004; Hassenzahl 2008) to how use also influences every-day life. What Hassenzahl (2008) describes as 'be-goals' of a product are not set and stable; instead, in the studies reported here the goals were found to be/were expected to transform. Thus, 'be-goals' as such cannot be studied once in the usage of a product and then be regarded as comprehensively covered, as there is clearly a dialectic relationship between product and user extending beyond the momentary experiences of user-product interactions. For example, the technology offered by a car may come to influence daily practices such as social routines, or even choices such as where to live. These user experience aspects extend well beyond sensory and interaction dimensions, thus moving from a micro-level on which the user experiences the product through his/her senses, and cognitive and emotional responses to interaction, into a 'macro-level' where the product plays a part in transforming the user's activities and choices.

Next, the most significant of the aspects that extend the taxonomy of user experience are discussed, that is to say *temporality*, the *ecological influence* from social contacts and connected products, and *prospective* research.

5.1 TEMPORALITY

UX temporality of interactive products can be seen as a dialectic process where both the user and the product change each other over time. Of course, not all products reach the level of complexity where mutual change is possible, but for a highly technological and complex context like in-vehicle systems, this becomes relevant.

The temporal perspective in this thesis moves beyond initial adoption during the first few weeks as found in previous temporal UX research (cf. Karapanos et al. 2009; Bødker and Klokrose 2012; Hasan and Chandra Gope 2013). Although not part of previous research, the established routines and habits were important aspects in the user stories (both concerning past and future), touching upon experiences such as being efficient and social an everyday life. Studying only the first weeks of use can be argued to miss out on results that become more evident and emphasise others that may change over longer periods of time. For a product like the car, the context of use may change over longer time periods than weeks, by experiencing driving in different weather conditions, longer holiday trips, changing social settings and so forth. In the first empirical study, many such long-term aspects were addressed by the participants in the interviews. I argue for entering a deeper level of study approach and analysis, providing more details to designers, than for example addressing how the importance of hedonic and pragmatic aspects change over time (cf. Kujala et al. 2011; Hasan and Chandra Gope 2013).

In addition to the retrospective aspects of user experience, the research contributed to the formation of prospective UX research methods. The results in Study I indicated that expectations are part of shaping the user experiences. Studies II and III add prospective methodology and empirical examples of how expectations can be researched. The findings of Study III provided not only rosy, distant views of an idealised future (cf. Zhao et al. 2009), or were limited to design suggestions based on current contexts and use (cf. Visser et al. 2005). Future projections of experiences were narrated by the participants, while maintaining a tangible link to their personal situations and needs. The enactment and the drawings prompted a rich flora of narratives, continuously making participants realise more of their motives, needs and concerns. By also breaking down the temporality of prospective user expectations into sequences, I suggest that designers and researchers can be helped in understanding and approaching experiences at different stages already at early stages of development. By also letting prospective research involve the mundane, routine of future experiences, products may be better suited for the everyday life of which they will be part. Experience research tends to focus on direct interactions and stand-out experiences, but also encompassing future everyday routines and the

mundane would be beneficial. A novel artefact must be able to satisfactorily move from the novel and exciting to the everyday and familiar.

A valuable next step would be to employ the findings presented here in design work and further explore their applicability. The proposed model is based on two studies and further research is needed to confirm the relevance of the sequence and to develop on the aspects that should be considered in each phase. The first study describes how behaviours and experiences change over time, suggesting there are limitations to what can be understood in one instance of time. This is of course also true for prospective scenarios; there is no one single, stable version of future experience. Nevertheless, since designers need to suggest versions of the future experiences, doing so with an informed user perspective is desirable. In addition, the tentative model can help researchers as well as designers reflect on what aspects of user experience can be accessible at what point of development. In the prospective study case of autonomous cars, and likely also in the case of other interactive products, designers need to actively support the transition from initial use to long-term use, especially considering the habits evolving around the technology, thus creating a bridge between novelty and the every-day.

5.2 THE ECOLOGICAL INFLUENCE ON UX

Not only stories about “the thing and I” (cf. Hassenzahl 2004) were found, but rather stories about “the things, *others and I*”. The research encountered an ecosystem of users, things and contexts in the user stories. With the introduction of a new car with new functionality, new behaviours, needs and challenges were/were expected to be established in relation to the in-vehicle systems over time. As well as other technology, all three studies pointed towards the importance of **social** influences on user experience. The empirical data indicated a clear difference to the ‘single product - single user’ perspective to be found in many experience frameworks (cf. Hassenzahl 2008; Desmet 2002; Norman 2004). The importance of social experiences and the lack of work in the automotive industry with social experiences are evident (for further argumentation, see Knobel, 2013; Tscheligi et al. 2011). No artefacts exist in a vacuum, yet models and methodology linger heavily in a perspective of single users interacting with single products. This further emphasises the importance of broadening the taxonomy of user experience as mentioned earlier, and highlights how research that takes into account the whole ecosystem of interrelated users and things would be beneficial in the UX field.

In light of the narratives collected in this thesis research, omitting the social aspects would mean significantly reducing the perceived positive and negative experiences

of interactive technology, both the positive and the negative ones. One cannot fully understand user experiences of inter-connected products from a single-user perspective, as other persons have such prominent positions in and for the experiences. Within the space of a car, this means a shift from a predominant driver-focus within research to a more inclusive focus on in-car experiences which thus far have been largely lacking in automotive research. An evolved understanding of the social use of cars, as well as other products, is needed in future user experience research. In other domains than the car, primarily that of mobile phones, the huge impact of pervasive social functionality has been recognised (see for example Srivastava, 2005). The car is probably no exception and is likely to undergo important changes in social possibilities and behaviour due to technology development.

In the first empirical study (Study I), the participants' in-vehicle systems were connected to smartphones (in all but one case), typically connected to a number of linked applications. In addition, other technological equipment such as computers were used in the cars. These products influenced the user experiences to be had, and the aspects of experience that were influenced by other people and products were aspects that typically gained increasing influence after some time of use (for instance requesting more stimulation over time after comparing the in-vehicle systems to the phone's updateability or adapting usage behaviour to social situations). This might be one of the reasons why this type of ecological influence is overlooked in user experience research, as well as the time and effort it takes to study interrelated experiences. However, during work on this thesis, research addressing these issues was identified, such as the research concept of 'Product Ecology' (see for instance Forlizzi 2007; Forlizzi 2008; Jung et al. 2008; Bødker and Klokmoose 2012; Nardi and O'Day 1999). The framework expands on the social and interrelated nature of user experiences and dates back to the 1980s and an interest in introducing concepts from biology into design research, more specifically Gibson's work on the Ecological Theory of Perception (Gibson 1966; Gibson 1979). The origin of the term "ecology" is related to the dimensions of diversity, urgency and evolution in a product ecology over time, just as in nature (Nardi and O'Day, 1999); in other words, an ecosystem is never fixed since it undergoes continuous changes. The research also draws on Social Ecology Theory (Forlizzi, 2008), which focuses on the holistic, dynamic relationship between individuals and social contexts. The product ecology approach has been presented as essential in particular for analysing experiences with intelligent, connected products as these experiences are highly interrelated, social and complex (Forlizzi, 2008; Jung et al., 2008). Within a product ecology approach, according to Forlizzi (2008) a *product* (and/or system of products), a *person* (or people), *activities* and a *context* (in place and time) are to be researched, mainly by collecting qualitative data through ethnographic methods, for example. As a framework, Product Ecology appears to be a promising, yet still rather unexplored, approach to understanding the influence of other products and people in relation to the user experience. Further

work would be needed to develop appropriate methodology directed at researching such complex systems, within reasonable time and effort scales. In the empirical studies undertaken, more directed inquiries about the relationships between systems and products in the car would have been beneficial, as the discussion that existed around relationships between products gave valuable information about the user's experience of and with the products. One direction for further research would be to develop tools for researching and understanding social and product contextual influences on user experience and the ecology approach could be one way of addressing this.

5.3 THE USER PERSPECTIVE

User experiences are not always easily accessible, as they may be "hidden" in everyday life. The approach in this thesis uncovered also the experiences that may not be considered outstanding instances of experience, but rather a part of the everyday flow of events. In the studies, the participants' own reflections on experience were packed with information, and involved much more than reflections on direct interactions or positive/negative judgements. Expectations, emotions, contextual influences was shaping the experiences, as well as time were. I thus consider user experience as multi-layered (as some aspects of experience were more easily elicited than others) and rich (could not be fully understood by ratings). After encountering the users' perspectives of user experience it is still clear that experience is a very broad phenomenon with very loose boundaries. However, different temporal stages hold different characteristics, and dividing it into temporal sequences makes experiences more accessible. Furthermore, as well as including emotions, judgments and the influence of previous experiences, the research especially emphasizes the need to consider influences from the product ecology (especially social connections) and the routines and habits that evolves (or do not evolve) around the products. As expectations, as found in other research (Kujala and Miron-Shatz 2015), plays a role in shaping later experiences, it makes sense to include them in the study of experience.

5.4 UX METHODOLOGY

User experience is a large topic and requires different sets of tools and methods depending on the specific purpose. There is no one, uniform method that can be used for all situations, products and people; the application of a method is always in relation to what is needed at the point of research or development. This becomes further evident when considering the empirical data that resulted in the presented model:

not all of the experience aspects can be addressed in any one specific instance. Some experience aspects are primarily accessible during that specific time of use (or before use). Given the research approach to user experience as being temporal, rich and subjective, experiments involving the study of momentary experiences were not employed in the thesis studies. Measuring experiences at one limited interval of time would have missed out on the larger perspective of experiences, such as the influence from the product ecology. Retrospective research is thus relevant and needed. Having said that, retrospective studies do not address the forward-looking possibilities of user studies, of value when designing for the future.

Next, the data collection methods in specific are discussed, and how they can be employed during a development cycle.

5.5 DATA COLLECTION METHODS

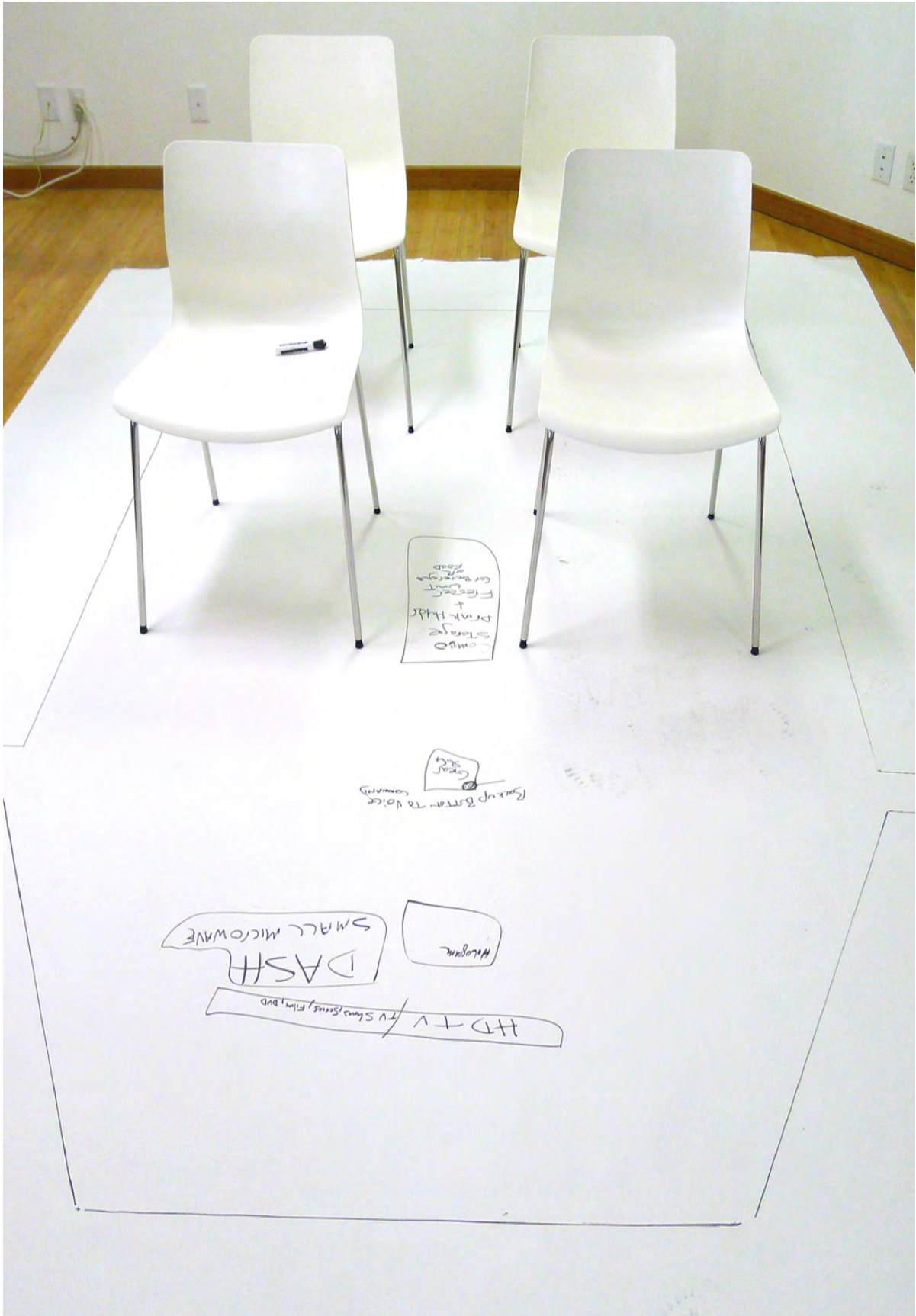
The methodologies in this thesis are all located within the qualitative rather than quantitative domain. As opposed to measuring pre-defined measurements, narratives can be used on a detailed level, adding sufficient subjective richness to address specific design problems along a design process, i.e. not only knowing *that* an interface may have good/bad usability (or whichever experience aspect is addressed), but rather *why* that is so. However, as experience narrative examples are highly qualitative and rich, and therefore often limited in number, they are charged with creating 'experience paradoxes', meaning that it is possible to miss out on "*...the net of experiences encountered by different users of the same artefact*" (Pucillo and Cascini 2014). In Study I, a somewhat 'discounted' retrospective user experience research approach was thus chosen in order to collect information from 16 users. Participants were asked to reflect on previous use in order to collect a larger number of narratives during a shorter period of time. The mix of methods employed appeared helpful in giving several entry points and possibilities for reflection on the topic. The narrated experiences were more nuanced than approaching experience on a higher level (cf. Hassenzahl, Diefenbach, and Göritz 2010); primarily addressing high level user needs such as 'relatedness' may be too vague to be effectively used in a design process, whereas a higher level of subjective richness may aid in being more precise when designing for experiences.

When it comes to exploring the past, memory is a deceitful tool; what we remember is not an unbiased report of the happenings at the time. However, tools can be used to help users reflect more on the experiences and make them surface. Furthermore, what a user remembers forms a basis for further decisions for purchasing and recommendations (Kujala et al. 2011). Performing user research on a longitudinal

scale, studying it as it emerges, requires considerable effort and time, parameters that are typically not realistically available in a design or research process. In the studies for this thesis, several aids were used to entice the memory; contextual interviews, reflexive photography and UX curves. In addition, the temporal focus of the methodologies was not only a way to find out more about the temporality of user experience, but also worked as a tool for eliciting further experiences (see Huang and Stolterman 2014, for a related example). When addressing the experiences of the past to the present, a rich flora of experience aspects can be found, such as the transformation of habits over time, attachment, identification, ease-of-use, aesthetic experiences and so forth.

5.6 PROSPECTIVE METHODS

As regards the studies concerning future use, the use of reflective, generative methodology in the 'setting the stage for future automotive experiences' method was essential, as it is easy to fall into over-estimation, difficulties in expressing experiences or only reflecting on today's technology when participating in prospective research. In the studies, participants were continuously found to engage in further reflections when in the process of being creative. However, not all participants were very apt at expressing themselves in drawings, and methodology evolution of how this can be addressed would be of value. The situatedness in the 'car' appeared to support the user in relating to in-vehicle experiences. This and the enactment were the main differentiators between the approaches employed in Study II, and formative for the results. This resonates with Brandt's and Ehn's earlier research (Brandt and Grunnet 2000; Ehn and Kyng 1991) on how acting and open, simple objects can encourage users in addressing the experiential aspects of future use. The methodology developed in this thesis further expands on the *journey* aspect of experiences; how experiences unfold over time. Thus, the 'setting the stage for future automotive experiences' method adds to the range of methodologies for prospective research. As experience aspects develop over time (with new behaviours and habits introduced) it is not to be seen as a blueprint of the coming experience, but as a starting point for the journey of future experiences.



6 CONTRIBUTION

The work was grounded in an in-vehicle development setting, with the aim of finding out:

- How are in-vehicle user experiences related to **temporality**?
- What experiences do users **describe** when referring to different time frames of in-vehicle systems use - past, present and future?

How can **methodology** be employed/developed for in-depth research of subjective in-vehicle user experiences, which also includes prospective temporality?

Key findings:

A methodology for prospective UX research was developed and employed in the thesis, called 'setting the stage for future automotive experiences'. This, in addition to the other employed generative and mixed methods, serves as an example of possibilities for an in-depth approach to understanding experiences, including the forward-looking prospective. In an automotive development process with long lead times and a heavy focus on momentary studies, this is needed.

Based on the user narratives, the thesis presents a model including the sequences of *aquaintancing*, *using* and *transforming*. In summary, it is suggested that the technology needs to successfully *attract* the user, fulfil needs concerning *usage* situations, and finally *make a difference* in the user's life. The three sequences identified in the model are connected to different experience aspects (such as aesthetics, social relatedness, ease-of-use, stimulation, trust and attachment). The experiences are clearly not stable over time, but evolve as behaviours and needs evolve in concert with employing new functionality and an ever-changing product ecology. This points towards a need for a more deliberate addressing of temporality in experience research and industry. By breaking down the temporality of user experience into sequences, it is suggested that designers and researchers can be helped in understanding and approaching experiences at different stages.

The model, which places emphasis on the transformative aspects of using artefacts over time, expands the taxonomy of user experience from direct experiences to also encompass experiences that change daily life over longer periods of time. Furthermore, the 'ecological influence' on user experiences was evident in the user stories, originating from the users' social networks and from other products. A more complex relation was thus found than is typically present in UX theory and empirical research. The research points to a need to expand research tools and frameworks to further include ecological factors.

6.1 NEXT STEPS

The methodologies used in this thesis primarily serve design during the early phases of design or when researching products already on the market, but there is also a need for in-depth evaluation studies of products on the way to completion. Looking at reviews of existing UX evaluation methods (Bevan 2009; Kaisa et al. 2008; Vermeeren et al. 2010; Varsaluoma and Sahar 2014), there is a lack of subjective richness and addressing temporality and ecological influence in the evaluative user methods. This lack serves as my departure point in the next phase of my research, after the licentiate degree. The insights from the in-depth research will be used as a foundation to also move into formative UX methodology, employing UX evaluation methodology in order to shape designs during development.

7 REFERENCES

- Alben, Lauralee. 1996. "Defining the Criteria for Effective Interaction Design." *Interactions* 3.3: 11–15.
- Bargas-Avila, Javier A, and Kasper Hornbæk. 2011. "Old Wine in New Bottles or Novel Challenges." In *Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems - CHI '11*, 2689–98. New York, New York, USA: ACM Press.
- Bevan, Nigel. 2009. "What Is the Difference between the Purpose of Usability and User Experience Evaluation Methods." In *Proceedings of the Workshop UXEM*. Vol. 9.
- Beyer, Hugh, and Karen Holtzblatt. 1997. *Contextual Design: Defining Customer-Centered Systems*. Interactive Technologies. Elsevier Science.
- Bilger, Burkhard. 2013. "Auto Correct Has the Self-Driving Car at Last Arrived?" *The New Yorker*, November.
- Bødker, Susanne, and Clemens Nylandsted Klokmose. 2012. "Dynamics in Artifact Ecologies." In *Proceedings of the 7th Nordic Conference on Human-Computer Interaction Making Sense Through Design - NordiCHI '12*, 448–57. New York, New York, USA: ACM Press.
- Brandt, Eva, and Camilla Grunnet. 2000. "Evoking the Future : Drama and Props in User Centered Design." In *Proceedings of Participatory Design Conference (PDC 2000)*, 11–20.
- Buchenau, Marion, and Jane Fulton Suri. 2000. "Experience Prototyping." In *Proceedings of the Conference on Designing Interactive Systems Processes, Practices, Methods, and Techniques - DIS '00*, 424–33. New York, New York, USA: ACM Press.
- Denzin, Norman K., and Yvonna S. Lincoln, eds. 2005. *The Sage Handbook of Qualitative Research*. Thousand Oaks, California: SAGE Publications.
- Desmet, PMA. 2002. *Designing Emotion*. Delft: TU Delft.
- Desmet, PMA, and Paul Hekkert. 2007. "Framework of Product Experience." *International Journal of Design* 1 (1).
- Dewey, John. 2005. *Art as Experience*. Penguin.
- Ehn, Pelle, and Morten Kyng. 1991. "Cardboard Computers: Mocking-It-up or Hands-on the Future." In *Design at Work, Lawrence Erlbaum Associates*, 169–95.
- Fallman, Daniel. 2008. "The Interaction Design Research Triangle of Design Practice, Design Studies, and Design Exploration." *Design Issues* 24 (3). MIT Press: 4–18.
- Forlizzi, Jodi. 2007. "How Robotic Products Become Social Products." In *Proceeding of the ACM/IEEE International Conference on Human-Robot Interaction - HRI '07*, 129. New York, New York, USA: ACM Press.
- Forlizzi, Jodi. 2008. "The Product Ecology: Understanding Social Product Use and Supporting

- Design Culture." *International Journal of Design* 2 (1). Taipei: Chinese Institute of Design.
- Forlizzi, Jodi, and Katja Battarbee. 2004. "Understanding Experience in Interactive Systems." *Proceedings of the 5th Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques*. Cambridge, MA, USA: ACM.
- Forlizzi, Jodi, and Shannon Ford. 2000. "The Building Blocks of Experience: An Early Framework for Interaction Designers." *Human-Computer Interaction* pp (6). ACM: 419–23.
- Gibson, James J. 1966. *The Senses Considered as Perceptual Systems*. Westport, CT: Greenwood Press.
- Gibson, James J. 1979. *The Ecological Approach to Visual Perception*. Boston: Houghton Mifflin.
- Google. 2015. "Google Self-Driving Car Project." <https://www.google.com/selfdrivingcar/>. 2015-12-03
- Halse, Joakim, Eva Brandt, Brandon Clark, and Thomas Binder. 2010. *Rehearsing the Future*. Danish Design School Press.
- Harrington, Charles and Ingrid Lindy. 1998. "The Use of Reflexive Photography in the Study of the Freshman Year Experience." *Journal of College Student Retention* 1 (1): 13–22.
- Hasan, Zahid, and Rathindra Chandra Gope. 2013. "Dynamics of User Experience (UX)." *International Journal of Computer Applications* 81 (16): 18–24. doi:10.5120/14207-2443.
- Hassenzahl, Marc. 2004. "The Thing and I: Understanding the Relationship between User and Product." In *Funology*, edited by A Blythe Mark, Overbeeke Kees, F Monk Andrew, and C Wright Peter, 31–42. Kluwer Academic Publishers.
- Hassenzahl, Marc. 2008. "User Experience (UX): Towards an Experiential Perspective on Product Quality." In *Proceedings of the 20th International Conference of the Association Francophone d'Interaction Homme-Machine on - IHM '08*, 11–15.
- Hassenzahl, Marc. 2010. "Experience Design: Technology for All the Right Reasons." *Synthesis Lectures on Human-Centered ...* 3 (1): 1–95.
- Hassenzahl, Marc, Michael Burmester, and Franz Koller. 2003. "AttrakDiff: Ein Fragebogen Zur Messung Wahrgenommener Hedonischer Und Pragmatischer Qualität." In *Mensch & Computer 2003*, 187–96. Springer.
- Hassenzahl, Marc, Sarah Diefenbach, and Anja Göritz. 2010. "Needs, Affect, and Interactive Products – Facets of User Experience." *Interacting with Computers* 22 (5): 353–62.
- Hassenzahl, Marc, Markus Schöbel, and Tibor Trautmann. 2008. "How Motivational Orientation Influences the Evaluation and Choice of Hedonic and Pragmatic Interactive Products: The Role of Regulatory Focus." *Interacting with Computers* 20 (4-5): 473–79.
- Hassenzahl, Marc, and Noam Tractinsky. 2006. "User Experience-a Research Agenda."

- Behaviour & Information Technology* 25 (2). Taylor & Francis: 91–97.
- Hsieh, Hsiu-Fang, and Sarah E Shannon. 2005. "Three Approaches to Qualitative Content Analysis." *Qualitative Health Research* 15 (9): 1277–88.
- Huang, Chung-Ching. 2015. "Describing and analyzing interactive experience over time" Indiana University.
- Huang, Chung-ching, and Erik Stolterman. 2014. "Temporal Anchors in User Experience Research." In *Proceedings of the 2014 Conference on Designing Interactive Systems - DIS '14*, 271–74. New York, New York, USA: ACM Press. doi:10.1145/2598510.2598537.
- International Organization for Standardization (ISO). 2010. "ISO 9241-210." *Ergonomics of Human System Interaction - Part 210: Human-Centred Design for Interactive Systems*.
- Jacoby, Jacob, and Jerry C. Olson. 1974. "An Extended Expectancy Model of Consumer Comparison Processes." *Advances in Consumer Research* Volume 01: 319–33.
- Jordan, Patrick. 2000. *Designing Pleasurable Products*. Oxon: Taylor & Francis.
- Jung, Heekyoung, Erik Stolterman, Will Ryan, Tonya Thompson, and Marty Siegel. 2008. "Toward a Framework for Ecologies of Artifacts: How Are Digital Artifacts Interconnected within a Personal Life ?," 18–22.
- Karapanos, Evangelos. 2010. "Quantifying Diversity in User Experience." *American Anthropologist*.
- Karapanos, Evangelos, Jhilmil Jain, and Marc Hassenzahl. 2012. "Theories, Methods and Case Studies of Longitudinal HCI Research." *CHI '12 Extended Abstracts on Human Factors in Computing Systems*. Austin, Texas, USA: ACM. doi:10.1145/2212776.2212706.
- Karapanos, Evangelos, Jean-Bernard Martens, and Marc Hassenzahl. 2012. "Reconstructing Experiences with iScale." *International Journal of Human-Computer Studies* 70 (11). Elsevier: 849–65.
- Karapanos, Evangelos, John Zimmerman, Jodi Forlizzi, and Jean-Bernard Martens. 2009. "User Experience over Time: An Initial Framework." *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. Boston, MA, USA: ACM.
- Karlsson, MariAnne. 1996. *User Requirements Elicitation-A Framework for the Study of the Relation between User and Artefact*. Göteborg, Sweden: Chalmers University of Technology.
- Keller, David H. 1935. "The Living Machine." *Wonder Stories*.
- Knobel, Martin. 2013. "Experience design in the automotive context" Ludwig-Maximilians-Universität München.
- Korber, M, and Armin Eichinger. 2013. "User Experience Evaluation in an Automotive Context." In *Intelligent Vehicles Symposium (IV), 2013 IEEE*, 13–18.

- Körber, Moritz, and Klaus Bengler. 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*, 194–201. New York, New York, USA: ACM Press. doi:10.1145/2516540.2516555.
- Kujala, Sari, and Talya Miron-Shatz. 2015. "The Evolving Role of Expectations in Long-Term User Experience." In *Proceedings of the 19th International Academic Mindtrek Conference on - AcademicMindTrek '15*, 167–74. New York, New York, USA: ACM Press.
- Kujala, Sari, Virpi Roto, Kaisa Väänänen-Vainio-Mattila, Evangelos Karapanos, and Arto Sinnelä. 2011. "UX Curve: A Method for Evaluating Long-Term User Experience." *Interacting with Computers* 23 (5). Elsevier B.V.: 473–83.
- Kujala, Sari, Virpi Roto, Kaisa Väänänen-Vainio-Mattila, and Arto Sinnelä. 2011. "Identifying Hedonic Factors in Long-Term User Experience." In *Proceedings of the 2011 Conference on Designing Pleasurable Products and Interfaces - DPPI '11*, 1. New York, New York, USA: ACM Press. doi:10.1145/2347504.2347523.
- Managh, Geoff. 2015. "The Dream Life of Driverless Cars." *New York Times*, November 11.
- McCarthy, Peter and John Wright. 2004. *Technology as Experience*. United States of America: The MIT Press.
- Meyers-Levy, Joan, and Rui Juliet Zhu. 2007. "The Influence of Ceiling Height: The Effect of Priming on the Type of Processing That People Use." *Journal of Consumer Research* 34 (2). The Oxford University Press: 174–86.
- Muller, MJ. 2003. "Participatory Design: The Third Space in HCI." *Human-Computer Interaction: Development Process* 4235: 1–70.
- Nardi, Bonnie A, and Vicky O'Day. 1999. *Information Ecologies: Using Technology with Heart*. MIT Press.
- Norman, Donald. 2004. *Emotional Design: Why We Love (or Hate) Everyday Things*. NY: Basic Books.
- Ortony, Andrew, Gerald L. Clore, and Allan Collins. 1988. *The Cognitive Structure of Emotions*. Cambridge: Cambridge University Prortess.
- Ortony, Andrew, Donald A Norman, and William Revelle. 2005. "Affect and Proto-Affect in Effective Functioning." *Who Needs Emotions*, 173–202.
- Pettersson, Ingrid. 2014. "Setting the Stage for Self-driving Cars: Exploration of Future Autonomous Driving Experiences." In *European Conference on Human Centered Design for Intelligent Transport Systems*. Vienna.
- Pitts, Matthew J, Lee Skrypchuk, Alex Attridge, and Mark A Williams. 2014. "Comparing the User Experience of Touchscreen Technologies in an Automotive Application." In *Proceedings of the 6th International Conference on Automotive User Interfaces and Interactive Vehicular Applications*, 1–8. ACM.

- Pucillo, Francesco, and Gaetano Cascini. 2014. "A Framework for User Experience, Needs and Affordances." *Design Studies* 35 (2). Elsevier Ltd: 160–79. doi:10.1016/j.destud.2013.10.001.
- Roam, Dan. 2011. *Blah Blah Blah: What To Do When Words Don't Work*. Portfolio. pp .319
- Rodrigue, Jean-Paul. 2016. "The Geography of Transport Systems." *Dept. of Global Studies & Geography*, Hofstra University, New York, USA. <https://people.hofstra.edu/geotrans/eng/ch6en/conc6en/commutingtimeeurope.html>. 2016-01-20
- Roto, Virpi, Effie Law, Arnold Vermeeren, and Jettie Hoonhout. 2011. "User Experience White Paper. Bringing Clarity to the Concept of User Experience. Result from Dagstuhl Seminar on Demarcating User Experience, September 15-18, 2010
- Sanders, Elizabeth, Eva Brandt, and Thomas Binder. 2010. "A Framework for Organizing the Tools and Techniques of Participatory Design." In *Proceedings of the 11th Biennial Participatory Design Conference*, 195–98. ACM.
- Sanders, Elizabeth. 2002. "Special Section: Ethnography in NPD Research. How 'Applied Ethnography' can Improve Your NPD Research Process." *Visions Magazine*. Mount Laurel, NJ: Product Development and Management Association.
- Sanders, Elizabeth. 2002. "From User-Centered to Participatory Design Approaches." In *Design and the Social Sciences: Making Connections*, 1–8. London: Taylor & Francis.
- Silverstone, R., and L. Haddon. 1996. "Design and the Domestication of ICTs: Technical Change and Everyday Life." In *Communicating by Design: The Politics of Information and Communication Technologies*, edited by R. Silverstone and R Mansell, 44–74. Oxford: Oxford University Press.
- Soro, Alessandro, Andry Rakotonirainy, Ronald Schroeter, and Sabine Wollstädter. 2014. "Using Augmented Video to Test In-Car User Experiences of Context Analog HUDs." In *Proceedings of the 6th International Conference on Automotive User Interfaces and Interactive Vehicular Applications - AutomotiveUI '14*, 1–6. New York, New York, USA: ACM Press. doi:10.1145/2667239.2667302.
- Srivastava, Lara. 2005. "Mobile Phones and the Evolution of Social Behaviour." *Behaviour & Information Technology* 24 (2): 111–29. doi:10.1080/01449290512331321910.
- Suri, Jane Fulton. 2002. "Designing Experience: Whether to Measure Pleasure or Just Tune in." *Pleasure with Products: Beyond Usability*, 161–74.
- Tiger, Lionel. 1992. *The Pursuit of Pleasure*. Transaction Publishers.
- Trösterer, Sandra, Daniela Wurhofer, Christina Rödel, and Manfred Tscheligi. 2014. "Using a Parking Assist System Over Time." In *Proceedings of the 6th International Conference on Automotive User Interfaces and Interactive Vehicular Applications - AutomotiveUI '14*, 1–8. New York, New York, USA: ACM Press. doi:10.1145/2667317.2667327.

- Tscheligi, Manfred, Alexander Meschtscherjakov, and David Wilfinger. 2011. "Interactive Computing on Wheels." *Computer* 44 (8): 100–102. doi:10.1109/MC.2011.246.
- Väänänen-Vainio-Mattila, Kaisa, Jani Heikkinen, Ahmed Farooq, Grigori Evreinov, Erno Mäkinen, and Roope Raisamo. 2014. "User Experience and Expectations of Haptic Feedback in in-Car Interaction." In *Proceedings of the 13th International Conference on Mobile and Ubiquitous Multimedia*, 248–51. ACM.
- Väänänen-Vainio-Mattila, Kaisa, Virpi Roto, and Marc Hassenzahl. 2008. "Now Let's Do It in Practice: User Experience Evaluation Methods in Product Development." *CHI '08 Extended Abstracts on Human Factors in Computing Systems*. Florence, Italy: ACM.
- Vanderbildt, Tom. 2012. "Let the Robot Drive: The Autonomous Car of the Future Is Here." *Wired*.
- Varsaluoma, Jari, and Farrukh Sahar. 2014. "Usefulness of Long-Term User Experience Evaluation to Product Development: Practitioners' Views from Three Case Studies." In *Proceedings of the 8th Nordic Conference on Human-Computer Interaction: Fun, Fast, Foundational*, 79–88. ACM.
- Vermeeren, Arnold P O S, Effie Lai-Chong Law, Virpi Roto, Marianna Obrist, Jettie Hoonhout, V Kaisa, #228, and nen-Vainio-Mattila. 2010. "User Experience Evaluation Methods: Current State and Development Needs." *Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries*. Reykjavik, Iceland: ACM. doi:10.1145/1868914.1868973.
- Visser, Froukje Sleeswijk, Pieter Jan Stappers, Remko Van der Lugt, and Elizabeth Sanders. 2005. "Contextmapping: Experiences from Practice." *CoDesign* 1 (2): 119–49. doi:10.1080/15710880500135987.
- Visser, Froukje Sleeswijk. 2009. *Bringing the Everyday Life of People into Design*. TU Delft, Delft University of Technology.
- Watson, D, L A Clark, and A Tellegen. 1988. "The Structure of Mood Change: An Idiographic/nomothetic Analysis." *Journal of Personality and Social Psychology* 43: 111–22.
- Wright, Peter, Jayne Wallace, and John McCarthy. 2008. "Aesthetics and Experience-Centered Design." *ACM Transactions on Computer-Human Interaction* 15 (4): 1–21. doi:10.1145/1460355.1460360.
- Yogasara, Thedy, Vesna Popovic Kraal, Ben J., & Chamorro-Koc, Marianella. 2011. "General Characteristics of Anticipated User Experience (AUX) with Interactive Products." In *Proc. of IASDR2011*, 1–11.
- Zhao, Min, Steve Hoeffler, and Darren W Dahl. 2009. "The Role of Imagination-Focused Visualization on New Product Evaluation." *Journal of Marketing Research* 46 (1): 46–55.