Towards Designing Experiences for Advanced Driving Assistance Systems

Martin Knobel[1,2], Felix Schwarz[1], Henri Palleis[1,2], Josef Schumann[1]

[1] BMW Group Research and Technology, Hanauer Straße 46, 80992 Munich, Germany
[2] Ludwig Maximilians University Munich, Amalienstraße 17, 80333 Munich, Germany
{Martin.Knobel, Felix.Schwarz, Henri.Palleis, Josef.Schumann}@bmw.de

Abstract. This paper describes a workflow for designing experiences while interacting with an advanced driver assistant system. Future driver assistance systems that utilize sensors and Car2X-communication in order to detect threats in the car environment can help the driver to avoid collisions. To increase the acceptance of such a system, the interaction between the driver and the system should be able to generate positive experiences. To generate those experiences, a story-based design workflow was used. Concepts created with this workflow should be able to address specific psychological needs of the driver. The implementation of this workflow revealed different schemes of positive experiences during driver interaction in critical situations.

Keywords: user experience, ADAS, emotional design, experience design, human machine interaction.

1 Introduction

Advanced driver assistant systems (ADAS) support the driver to avoid collisions. Therefore, ADAS inform, warn and take over parts of the driving task [1]. According to Schmidt et al. [2] this requires amongst others the driver's trust, because he has to cede control. Low trust, resulting e.g. from an earlier experience of failure, can lead to disuse of the system [3]. Trust also depends on the design of the human-machine interaction (HMI) [4]. Until now HMI of ADAS is focused on functional aspects [2]. Here developers are facing the following dilemma [5]: on the one hand, the reliability of ADAS increases with the approach towards the conflict and the amount of time available to interpret the situation. On the other hand the driver should be supported as early as possible to avoid annoying warnings or take-overs. A design which supports positive experiences should allow an earlier and subsequently more frequent assistance with better trust calibration [4] as well as an increase of the acceptance of the system.

To create those positive experiences and avoid the disuse of ADAS, one has to understand the driver and his goals and motives while driving. Kaptelinin and Nardi describe in [6] a hierarchical organization of goals in three levels (i.e. be-goals, do-goals, motor-goals). The middle level contains do-goals which state what the driver wants to attain, like driving home. The do-goals motivate motor-goals which describe

defined actions, like breaking or steering. Methods like usability concentrate only on motor- and do-goals [7].
In contrast, user experience (UX) focuses on the topmost level of this hierarchical organization of goals, the so called be-goals like being competent or being secured. Be-goals aim at fulfilling psychological needs[1] which can be triggered through designed experiences during interaction with a product (e.g. a car) in a certain context [7]. Therefore, in the design process one has to identify specific psychological needs which can be important while interacting with ADAS. Based on these needs, experiences for ADAS are designed with a story based approach (see Gruen et al. [8] and Hassenzahl [7]).

2 Methods

In order to develop a driver assistance concept capable of generating positive experiences, a design workflow that contains five steps is used (see Fig. 1).

Fig. 1. The five steps of the design workflow.

I. Positive driving experiences that emerged from critical situations were collected during interviews. For this purpose, an interview concept consisting of four parts was developed. During the first part the participants were asked for their most important positive experience in the context of driving. In the second part the interviewees were asked for experiences that made them feel strong, capable or proud. The third part aimed at situations during which a co-driver generated a positive experience and during the fourth part they were asked for experiences related to specific driving scenarios. By varying the context of driving situations throughout the interview, relevant experiences were collected without influencing the interviewees' perception of the subjective relevance of their experiences. For every experience, associated feelings and emotions were collected with a PANAS-based questionnaire [9].
II. An analysis of the interviews was carried out to identify *UX schemes* based on fulfilled psychological needs [10]. A UX scheme integrates several actual experiences and their specific psychological needs, describing the essence of these experiences.

[1]According to Sheldon et al. there are 10 psychological needs [10]: autonomy, competence, relatedness, self-actualization-meaning, physical thriving, pleasure-stimulation, money-luxury, security, self-esteem and popularity-influence.

III. A *UX story* was written for every identified UX scheme with the goal to tell a fictional story of a positive experience created by interacting with the potential concept for ADAS. The UX story should already contain first abstract design implications and is the basic communication tool within the UX design team. All future design decisions should conform to it.
IV. For each UX story a *UX storyboard* was created in order to illustrate the chronological order of the single interaction steps described in the associated story. The UX storyboard allows for a quick visual communication and contains involved needs and emotions for every depicted interaction step. Additionally, by sketching out the interaction ideas on paper, first design ideas were shaped.
V. Defined design ideas were implemented in a simple driving simulation based on the traffic scenarios described in the UX stories. With these mock-ups, first concept ideas can be experienced and evaluated through agile testing.

3 Application of the Method

I. Eight interviews with experienced drivers were conducted. Thirteen relevant experiences were collected from these interviews.
II. The collected experiences were analyzed and grouped according to the fulfilled psychological needs. Three UX schemes were identified. The first scheme summarizes positive experiences based on competence. The essence of the involved experiences is the early detection and avoidance of potential threads. Concerning an HMI concept for ADAS capable of delivering such an experience, the idea of extended senses was developed. The second scheme is based on security and describes positive driving experiences due to supportive alerts of the co-driver. As an HMI concept the idea of a virtual co-driver was developed. The third scheme is based on competence again, but with a focus on thinking and caring for other road users. In this case, the idea for an HMI concept was an external warning possibility.
III. UX Schemes were embedded in narrative fictional stories. These schemes describe the positive experience of a character generated by the interaction with the ADAS.
IV. The UX storyboards [cf. 11] were drawn on paper each containing nine sketches, a describing text and a table with the associated needs, feelings and emotions.
V. Finally, several mock-ups were created in order to draft and evaluate concrete design concepts. They were implemented as audio-visual animations.

4 Discussion

Two different psychological needs (i.e. security and competence) in positive experiences emerging from critical driving situations were identified that have different design implications. Addressing the psychological need of security (according to Sheldon et al. [10]), ADAS will act as an attentive co-driver. Therefore they support as early as possible in order to prevent the driver from threats and uncertainties. Addressing competence, ADAS have to be designed differently. Here it is important that the competence remains with the driver and is enhanced unobtrusively. The systems should take over driving tasks as late as possible, allowing the driver to be independent as long as possible.
In future work, prototypes will be created and evaluated. The evaluation will focus on need fulfillment and the evocation of emotions during interaction.
Finally, the identified challenges with this UX design workflow (lack of standardized UX methods, applicability of the mentioned psychological needs in automotive context, optimization of the efficiency of the workflow) will be analyzed.

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