Using Personas and Scenarios as an Interface Design Tool for Advanced Driver Assistance Systems

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Abstract. When looking at the traditional way of conducting human factors research within the active safety area, focus often tends to be on drivers' cognitive capacities like; situation awareness, workload and behavioural adaptation. This research is of course invaluable but other important issues that tend to be forgotten are: What are the drivers' needs and how should an interface be designed to satisfy those needs? This paper describes the process of defining requirements for a dynamic graphical interface for ADAS using a rather new method, *Personas*, as a starting point in the design process. Based on the Personas different scenarios and narratives were created and used in a workshop to specify user needs and requirements in the interface design for Advanced Driver Assistance Systems.

Keywords: Advanced Driver Assistance Systems (ADAS), User Centered Design, Personas, Scenarios, Interaction Design, Traffic Safety.

1 Introduction

Advanced Driver Assistance Systems (ADAS) have the function of actively assisting the driver in avoiding accidents by providing information about current and upcoming traffic situations and helping the driver take proper actions before a potential accident occurs. In order to reach the intended safety benefits of these systems it is of vital importance that drivers understand them in order to cooperate with the vehicle and the surrounding traffic environment. This requires research on how the driver and vehicle perform in different situations. It is important to look at driver behaviour while taking physical limitations and requirements of the driver and vehicle into account. The early development and testing stages of ADAS often focus on technical aspects concerning the system implementation. This leaves questions like when, where, how and why one should present warnings to the driver to be considered later. One major issue that arises when considering how warnings best are presented to the driver in a given situation is what modality or combination of modalities to use. Also, the outlines for test scenarios are often narrowed down to measures of system performance in aspects

of the drivers' cognitive capabilities in relation to their perception of system presentation and responses. This may result in test environments lacking the naturally rich context and individual variability of the driver [12]. When looking at the traditional way of conducting human factors research within the active safety area, focus often tends to be on drivers' cognitive capacities like; situation awareness and workload [11] or behavioural adaptation [16]. This research is of course invaluable but other important issues that tend to be forgotten are; what are the drivers' needs and how should an interface be designed to satisfy these needs? An alternative approach to the traditional way of development and testing is to use a more user centered approach. A user centered approach to design basically involves finding out as much as you can about the targeted users and then use this information when designing. The idea behind this approach is that the real users and their goals should be the driving force behind the development of a product, not the technology [13]. Not knowing who you are designing for increases the risk of ending up with a product that makes nobody sufficiently satisfied [4]. According to Cooper [3] you will have far greater success if choosing to design for just one specific person, a Persona. A persona is a hypothetical archetype of real users described in great detail and defined by their goals and needs, rather than just demographics. The key is to choose the right individuals, whose needs are representative for the needs of a specific set of constituents. It is also important to know how to prioritize needs to address without significantly conflicting with the needs of the secondary users [4]. When a design team talks about users in general there is a big possibility that each team member's ideas of the user's needs and goals are quite different. The detailed description of a Persona helps to prevent this. The embodiment of the user needs and goals through personas makes it easier for the design team to know who they are designing for. It also gives them a common understanding of the users that is easier to talk about and remember than a list of features and vague descriptions of the users [2]. Grudin & Pruitt [7] has brought up issues on why scenarios are rarely used in design since they lack of empirical grounding. They suggest that grounding the scenarios in ethnographic studies, contextual inquiries, demographic data or other information directly gathered from the user would certify a sufficient level of realism. Further, Grudin and Pruitt denote that Personas is a good foundation for scenario building and data collection. Scenarios can be used in multiple ways. They may serve as starting points for group brainstorming to raise questions about which assumptions that can be made but also be used for requirement analysis for software, as partial specification of functionality, to guide design and to identify and plan evaluation tasks that can be further elaborated in a usability test etc [15]. Grudin and Pruitt [8] comments that Personas alone can aid design but that the method is more powerful when complementing other quantitative and qualitative methods rather than replacing them. This paper describes the development of a dynamic graphical interface for ADAS using Personas as a starting point in the design process. Based on the Personas, different scenarios and narratives were created and used in a workshop to gather user needs and requirements for the interface design of Advanced Driver Assistance Systems.

2 Methods: Study 1

2.1 Personas

Every other year a pool of car manufacturers make a customer survey in order to map their customers and users. Information collected by this survey is used within design, marketing and branding and includes a large database with demographic information about costumers' hobbies, age, gender, income etc. This information collected from a major Swedish automotive company was used to delimit the user group for this study (drivers between 35-65 years of age). The information was also used in a later stage of the persona development process when adding demographic information to the created characters. A series of 14 semi-structured deep interviews were conducted (5 women and 9 men), with similar educational background and living in cities of comparable size. The subjects were between 35 and 65 years of age (M 47; SD 13) and they all had drivers' licenses. The purpose with the interviews was to gather information on the drivers' attitudes, goals, needs and behaviour. The questions used were inspired by considerations and results from earlier studies made by [9]; [19] and [18], which used a variant of the Driver Behaviour Questionnaire (originally developed by [14]). The questions were organised in four main groups: in relation to the car; distractions and secondary tasks, concerning themselves as drivers; and general questions. The interviews lasted for approximately one hour and were audio recorded with the interviewees' approval. The number of interviews was not decided in advance. Instead the interview series ended when the information from the interviews was found redundant. All interviews were transcribed on a phrase level which focuses on what principally has been said rather than on the respondents' exact words [10]. This resulted in an extensive list of expressions in a chronological order. The expressions were later revised and sorted under significant categories in a first version of a so called *Affinity Diagram* (see table 1), a technique for understanding and grouping large amounts of data (more information on affinity diagrams can be found in for example [6]).

Table 1. Some categories of the affinity diagram: (translated from Swedish by the authors)

Safety	Car-dependency	Easily influenced
Environment	Hobby mechanic	Attentive
Space favouring	Technology hostile	Analytic
Practical usage	Self-conscious	Educating
Joy rider	Absent driver	Self-confident
Confident driver	Foreseeing	Preventive
Easy annoyed driver	Competitive	Considerate

The categories derived from the affinity diagram where then used as starting points for the development of the Personas. Each category served as an attribute to different members of the Persona cast and was used to express certain personality properties that became salient, such as issues concerning attitude, safety and behaviour. Several rough Personas were created and refined as overlapping attributes were found. The expressions for each category in the diagram also functioned as the foundation for the

narrative descriptions of the personas described more in detail later. As soon as a unique Persona emerged, a photo was chosen from a public database and added to the document. This was done in order to make the Persona more tangible and easier to refine. The statistical information from the customer survey and interviews was used to give the personas demographic attributes in accordance to real facts.

2.2 Scenarios

As mentioned earlier, the Personas were the base for the creation of the scenarios. A template was used to extract the scenario information from the Personas and interviews. This structured the information and certified a minimal level of detail and attributes. The template was divided into three different parts; Outer Variables, Inner Variables, and Narratives.

2.2.1 Outer Variables
Outer variables are a revision of traditional road scenarios often used when setting technical specifications on automotive systems. Examples of these variables are information on road structure, road environment, road- and weather conditions and traffic situations. In order to find these variables, specific traffic situations had to be created. These situations also had to meet two criteria; normal driving situations (not accidents or critical incidents) and situations where one or several ADAS could come to be used.

2.2.2 Inner Variables
Inner variables were based on personal information from the Personas. Each Persona was exposed to each situation and the different characteristics of the Personas were taken into consideration when refining the scenarios. This part added information about the Personas' goals, characteristics, intentions and possible secondary tasks performed while driving.

2.2.3 Narratives
Creating the first two parts of the template resulted in a structured list of facts. To add more detail and a lively description, information from the other two parts of the scenario template was used. This was done in the form of narrative stories. These narratives were then read through and commented by four people both from the earlier interview series and people not earlier involved in the study. This was made in order to ensure that the narratives were understandable and easy to relate to.

3 Results: Study 1

3.1 Personas

The persona creation process resulted in a final persona cast of four members; Claes, Kristina, Mats and Camilla. For a full description of all Personas and scenarios, see [1].

Claes is a 64 year old man who values his family. He is an experienced driver. Other people see him as a rational, practical and self confident man with authority. He can easily get annoyed with drivers of other vehicles and believes that he is foresighted and has full control of his driving. Although he is interested in new technologies he has trouble keeping up with all the new gadgets.

Kristina is a 62 year old woman with a calm laid back attitude. She thinks that most problems will solve themselves. She is often perceived as a person with a laisser-faire attitude and sometimes even a bit nonchalant. Kristina sees her car as a means of transportation and has no interest in new technologies, especially not within the automotive area. She often talks in her cell phone while driving and sometimes she has problems staying within speed limits.

Mats is a middle aged man (44 years old) and an early adopter of new technology. He is an entrepreneur, always is on the run. He is a self confident driver that often mistrusts others in traffic. Mats drive a lot as part of work and he is generally very interested in new technology. He has a habit of using his cell phone while driving and he also eats and smokes a cigarette during his sometimes long trips.

Camilla is a 38 year old woman. She got her drivers licence rather late in life, and does therefore not yet feel fully comfortable drivin. Other people describe her as a caring person; she cares for the environment and has a need of being in control. Camilla has little driving experience and tends to become unsure in complex traffic situations.

3.2 Scenarios

Personas were used as the base for creating scenarios. No ADAS was explicitly considered when creating the scenarios, but rather situations used were situations where ADAS may be active. The reason for this was to focus on already existing situations that the interviewees face in real traffic and not create new situations based on system technology. Described below are results from the Outer- and Inner variables followed by a description and the results of the creation process of the narratives.

3.2.1 Outer Variables

Two traffic situations were created, both on roads with high speed limits. The main difference was the level of traffic density where one situation was normal highway driving with low traffic density and the other normal highway driving with high traffic density.

3.2.2 Inner Variables

The result of adding the Personas to the road situations gave an enhanced picture of what the situations looked like based in the goals, characteristics, intentions and possible secondary tasks that were carried out by the Personas.

3.2.3 Narratives

All four Personas were given two narratives each (high/low traffic density highway driving). Below, one of the eight final narratives is presented. For a full description of all narratives see [1].

Highway Driving: Mats

Mats has been spending all morning in a meeting with an important client and the meeting took much longer than expected. Mats has just got back on the highway after picking up a burger and a cup of coffee at a fast food restaurant. He has to hurry to make his afternoon construction site inspection in time. He has never been to the site before and has therefore put in the address of the site location in his navigation system. Mats is now cruising the highway following the general traffic speed, zipping coffee, eating his burger, listening to the radio and glancing at the navigation system waiting for it to tell him when it is time to choose the next exit from the highway.

4 Methods: Study 2

4.1 Workshop

Based on the Personas and scenarios created in Study 1, a workshop on human factors, interaction design and vehicle safety was held with eight participants. Attending were three experienced system developers, two human-machine interaction engineers, one PhD student in technical psychology and two masters students in interaction design. The workshop lasted for approximately two hours and was documented both through notes and audio recordings. Participants were briefed of the recordings and told how the material would be treated confidentially. The workshop started with a PowerPoint presentation of the four Personas and a list of 15 ADAS that are already implemented or about to reach the market in the near future. Next the participants where encouraged to individually select and rank the ADAS that they believed would be relevant for each Persona. The four Personas were presented on wall-hanged posters together with the different ADAS. Each participant was given nine black stickers per Persona that they used to mark which ADAS they thought was most relevant to the Persona. There were no rules on how to distribute the stickers other than that nine stickers had to be used for each Persona. As an example, participants could mark one ADAS with 4 stickers if they thought this system was extremely relevant for that Persona. The results where then summarised and participants were asked to comment on what basis they chose the different systems and how they found the systems feasible from the Personas' point of view. These comments were noted on the Persona posters so that they would be visible during the rest of the workshop. Next, participants were divided into two groups with as equal expertise as possible between the groups to discuss two topics; 1) what information the Persona needed from the ADAS, and 2) how this information could be presented. Participants were encouraged to focus on normal day to day driving and not emergency situations. Each group received scenarios with narratives for two Personas and was given 10 minutes per scenario for discussions. After completing the session, both groups presented and discussed their results during a joint session. The results were then analysed and transcribed at a phrase level focusing on what principally has been said rather than on the respondents' exact words [10].

5   Results: Study 2

The results from the workshop showed that the four Personas had different needs, and this was reflected in what type of ADAS would be useful for them. However most of the selected systems were thought to be relevant for two personas or more. Of the eight systems that had the overall highest ranking, five systems were selected to be relevant for two Personas or more; Adaptive Cruise Control (ACC), Blind Spot Information System (BLiS), Driver Monitoring Systems (DM), Forward Collision Warning (FCW), Parking Assistance (PA). These ADAS are presented in table 2 together with the summarised ranking. Note that the highest ranking possible for a system is 72 per Persona (8 participants x 9 stickers).

Table 2. Summary of individual rankings for the different ADAS

Persona	ACC	BLiS	DM	FCW	PA
Claes	28	15	13		6
Kristina		12	14	22	12
Mats	19		5	18	6
Camilla		17			19
Total	47	44	32	40	43

Discussing the question about information presentation for the Personas all participants agreed on that there was a need for different levels of system transparency depending on the driver. The major ADAS requirements on information presentation for each Persona were:

Claes: Because of his interests in new technology, he should be given information of the system status. He should not be given detailed information that he may think could interfere with his way of driving. Information should be adapted to the current traffic situation.

Kristina: Kristina believes that she is always in total control of her vehicle. Therefore the ADAS should not require any interaction that is not absolutely unavoidable.

Mats: He is often stressed and distracted by secondary tasks while driving. ADAS information should therefore be presented in a way that does not interfere with these secondary tasks. Because of Mats's interest in technology, the interface should support personalisation of system settings.

Camilla: Camilla is an insecure but very careful driver. She would have most use of a transparent interface that provides her with additional information. This is totally different from Kristina who wants total control of the vehicle, and hence very little system interaction. Care should, however, be taken when presenting information to Camilla. The system should not require attention to be re-focused from the current traffic situation.

6   Discussion

One of the goals using Personas is to achieve a common understanding of the target group by getting to know the individuals in the cast of Personas. For the Personas to be useful they need to mediate the information necessary for practitioners to make reasonable assumptions about them. The target group of this study was rather voluminous (approximately three million people only in Sweden). How was it then possible to create the Persona cast from only 14 interviews? The intention was never to point out that these and only these types of drivers are represented in the target group. However, during these 14 interviews obvious patterns and dissimilarities were found within areas like; attitudes, goals, needs, and confidence. Other behavioural differences concerning normal driving, secondary tasks and distraction also emerged. More details and attributes would most certainly have been detected if the sample was larger but the interview series were considered completed when the amount of new information derived from the questions decreased. It is of course possible that the lack of new information could be caused by the preparation and conduction of the interviews. Critique may be directed towards the fact that the kind of subjective statements gathered in interviews do not show any statistical significance. This study does, however show that Personas brought up issues and considerations about ADAS that may not surface through more traditional experimental research. This is an argument for using Personas as a complementary method in system development where both human and technical aspects [8] have to be considered. The method for gathering and transcribing information during the interviews should also be discussed. The transcription of the recorded interviews was followed by the affinity diagram that were then used when naming categories and sorting information into each category. Within these categories differences emerged that could be translated into salient personal characteristics. Other methods such as observations and questionnaires could have been used to complement the interviews. It could have been an advantage to perform user observations prior to the interviews in order to note the interviewee's actual behaviour and motivations in certain situations such as highway driving or driving while performing a secondary task. Scenarios are often used in system development to show the hypothesised functionality of the system or as a tool for creating test cases. When focusing too much on the system, the description of the user tent to falter [16]. Since the scenarios have their origin in the Personas the quality of the scenarios are dependent on the quality of the Personas. It is therefore of crucial importance to develop the Personas using a sufficient amount of appropriate information [7]. We also believe that the narratives have to be accompanied by the Persona (serving as the main actor) and scenario template to be fully understood. The Personas and the scenario templates should be seen as pre-requisites for understanding the narratives. We believe that if all parts (Personas, scenarios, and narratives) are read, this would serve as a good base for discussions and workshops. When a design team talk about the users in general there is always the possibility that each team member's ideas of the user's needs and goals are different and do not overlap at all. The introduction of the Personas can potentially help prevent this by providing a common ground. According to Blomqvist and Arvola [2] this embodiment of users' goals can make it easier for a team to focus on the user and to reach a common understanding of the user. This does of course not ensure that

participants in the design teams are unbiased based on previous experiences. Team members may also have influenced each other during discussions and there is always a risk that some thoughts and ideas will no surface due to people being shy or worried about how their opinions would be received. Another potential issue is that the homogenous background (automotive industry, human factors and interaction design) of the design team might bias the discussion. This could have both positive and negative effects. On the positive side, the team members are knowledgeable on the focus area, user interfaces for systems in vehicles. On the other hand, the team may also oversee information and ideas that people with different background could have identified.

In conclusion, we do not claim to have found every aspect of individual driver differences but we believe that the uses of Personas in the methodology have brought important aspects of individual differences, and driver group differences to the surface.

Acknowledgements

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