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EXPLORING USER NEEDS IN AUTOMOBILES

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1. Introduction

Today's cars are highly technological machines. Long gone are the days where levers and knobs were the tools with which one could operate all of the car's additional functions. However, with time, these additional functions have gained a more prominent space in the cockpit and on the driver's priority list. Modern vehicles offer a myriad of added features including GPS, audio and video entertainment, Internet access with all that this encompasses, and even downloadable content.

As the options for interaction grow, so do the opportunities for distraction, system errors and the driver's general displeasure. Additionally the main user has to handle the task of driving, a task that is safety critical and, thus, must be given special consideration. These issues highlight an emergent need for the careful selection of added functionality and of features that can fulfill the driver's needs without compromising safety and driving enjoyment. User experience research points to the fact, that when the goal is to create pleasurable experiences the user's emotional needs are of the greatest importance [Norman 2002]. A deep and meaningful understanding of the user is imperative for any design team to provide creative solutions that, in turn, allow the user to enjoy the driving experience [Gkouskos 2012]. Nonetheless, different types of users have different types of emotional needs and priorities. Therefore, different solutions may be needed to satisfy different user categories. Vehicles are currently marketed as "sports" ,"business", or "family" oriented. But are these categories appropriate for both the general look and feel of a car, as well as for its functions, interior design and interface? In a time where car interfaces start to resemble more personal computers and less the traditional knob and lever interfaces of the past, new ways of understanding user needs must be employed. These ways cannot only come from the automotive industry or the computer industry since the product at hand is a hybrid result of the combination of the previously mentioned fields. The new challenge of investigating the user population for modern human-vehicle interaction must be tackled with methods that are able to capture the way that users experience and prioritize their needs from their vehicle interfaces.

The main approaches for user experience research are either of the quantitative kind or the qualitative kind. Structured methods that attempt to quantify data are easy to apply, but "insensitive to topics, thoughts, and feelings" [Hassenzahl and Wessler 2000], whereas more unstructured approaches such as interviews and observations lack predefined structure that make them require a "lot more effort to be put into the actual analysis of the data obtained" [Hassenzahl and Wessler 2000]. In this study, we propose and test an alternative method for capturing the user's needs as well as for grouping users with similar perceptions together.

2. Purpose

The purpose of this study is to propose an alternative method for capturing the user's needs and experiences of human machine interface design in automobiles.

3. Related work

There are several methods that can be used for understanding user needs. Most of them include some level of user involvement in the design process. Our proposed approach combines elements from the methods that are described below.

3.1 Workshops

A workshop is a type of focus group method that has many advantages in the search for user needs. Firstly, it brings designers and users together. A successful outcome requires active user participation, where both the designer and the participants can converse, as well as have influence on the outcome of the workshop. Secondly, the participants can build upon each other's knowledge and synergy effects, which lead towards new solutions that can be found. Finally, working closely with users helps the designer to focus on the users' needs instead of their own perception of a specific problem [Bruseberg and McDonagh-Philp 2001].

3.2 Future workshop

The Future Workshop method that was originally developed by Jungk and Müllert consists of several phases; mainly the *Critique phase*, the *Fantasy* or *Utopia phase*, and the *Implementation phase*. The purposes of the different phases are to address a specific problem, create a vision of how the problem might have been solved in the future, and finally, to consider how the solution can be realizable in practice [Jungk and Müllert 1989], [Apel 2004]. The setting of a future workshop supports users in imagining alternative solutions and therefore shifts focus from current problems to more creative thinking of future solutions. This shift can be valuable for example when designing a new technology [Jungk and Müllert 1989]. During the *Fantasy phase*, the participants in a Future Workshop should feel that they are working with a perfect world where everything is possible and they are not bound by the constraints in their every day life.

3.3 Scenarios

Former experience with a technology and how it is used in particular contexts might provide mental constraints for the development of new technologies, or help find new areas of use for an existing technology. Scenarios are stories that explicitly visualize typical user activities and stage a forum to discuss these activities even before the situation occurs in real life. Scenarios let designers understand how the actors or agents in the scenario will act, what they will experience, and what their goals might be. The designer can explore the different paths the actor/agent can take by using different scenarios [Carroll 2000].

3.4 Creative methods

Workshop participants may use brainstorming techniques or other creative techniques to recognize and discuss solutions suitable for a future scenario. All ideas, regardless of how far-fetched they might seem should be taken into consideration and put into a bank of ideas [Apel 2004]. From this bank, the participants can collaboratively work on new solutions.

3.5 Repertory grid technique

The Repertory Grid Technique (RGT) is a technique for eliciting user experiences associated with technological artifacts. The outcome of a RGT study is the repertory grid, which consists of columns of elements representing the artifacts or products being studied and rows with a repertoire of the participant's personal constructs regarding these elements, which represent the meaning and experience the participant sees in the artifact. The constructs can be elicited by showing the participant sets of three artifacts, so called triads, and asking the participant to describe how two of them share a similar characteristic that differentiates them from the third artifact. This characteristic should then be accompanied by a word or description with the opposite meaning and be put into a bi-polar scale [Fällman and Waterworth 2010]. The elements are then rated according to how much they correspond to the constructs. The relations between these constructs can be analyzed to gain insight into the

meaning that the participant puts into these artifacts, and what characterizes user experiences of a technology in a holistic way. The RGT takes into consideration both the intellectual and the emotional dimensions of user experience.
The technique is both qualitative and quantitative in nature. The procedure where the elements are rated makes it possible to conduct statistical analyses in order to map meanings among individuals or groups of individuals. A number of multivariate techniques can be used to analyze combined individual Repertory Grids to find groups of individuals with similar cognitive structures and provide insights into the understanding between user and technology or between different user groups [Tan and Hunter 2002]. Semantic analyses can be done according to the words or descriptions that make up the constructs for each participant. Constructs from all participants can be compared and classified to form groups of constructs or artifacts that seem to share the same meaning. Hassenzahl and Wessler summarize the main advantages of RGT:

- The most important advantages of RGT are (a) its ability to gather design-relevant information, (b) its ability to illuminate important topics without the need to have a preconception of these, (c) its relative efficiency, and (d) the wide variety of types of analyses that can be applied to the gathered data. [Hassenzahl and Wessler 2000, p.455-456].
- The RGT has also proven to be useful in several contexts, including clinical psychology, education and information systems, for eliciting peoples experiences and meanings [Fällman and Waterworth 2010].

4. Method - A combination of workshops and RGT

The method is decribed in an examplary study that was conducted. This study consisted of a series of four workshops that were equally divided in two locations. For each workshop, a mixture of participants was selected that included both masters students with little driving experience and professionals that have many years of experience in both driving and in design related research.
The purpose of the workshops was to create concepts of future vehicles to be used as input in the Repertory Grid Technique. All workshops followed the same outline; presentation and discussion concerning a future scenario, creation of vehicle concepts that would be suitable for this future, and finally a laddering group interview to get the information about the participants' rationale for including particular functionality in the vehicle concepts. Then the agenda started over again but for another future scenario.
These workshops build upon the Future Workshop method, but focus mainly on the future aspects and the Fantasy phase of the method. Instead of starting with criticizing current problems, as in a traditional Future Workshop, there were two different future scenarios presented to the participants. One scenario was set in an utopian future where almost everything could be considered possible whereas the other scenario was set in a dystopian future, which imposed some major limitations.
The participants' tasks were:

1. To populate the future scenario with attributes the participants find important for this scenario in order to expand the rather short description offered by the researchers and to get a common view shared by all the participants. This phase consisted of a discussion around one major topic; how are vehicles used in this future?
2. The workshop proceeded with a future vehicle concept creation phase that started with a brainwriting exercise where the participants individually wrote down ideas or desired functionalities that would be suitable for the vehicles in the current future scenario on Post its.
3. This part merged into a brainstorming task where the group together worked with the task of creating future vehicle concepts with general office supply material provided for the workshop. The ideas written on Post its were used as a base to choose which functionalities and attributes that would be included in the concept. The workshop participants were allowed to work freely with these concepts and to express themselves in whatever way they wanted. The only limitation was that the concept should be suitable for the future scenario at hand. The researchers later finalized the concepts as text descriptions so they could easily be compared to each other.

4. The last part of the workshop was a group interview guided by the laddering technique. The participants were asked about the functions and attributes of the concepts. To dig deeper into the reasons for including specific attributes, the participants' answers were followed by the question "why?" until no further reason could be found. The answer at the bottom of the "why?" ladder can give insights into the underlying need that is fulfilled by the function or attribute at hand. The results from this part was used to enrich the concepts and to ensure that they really reflected the participants meanings.

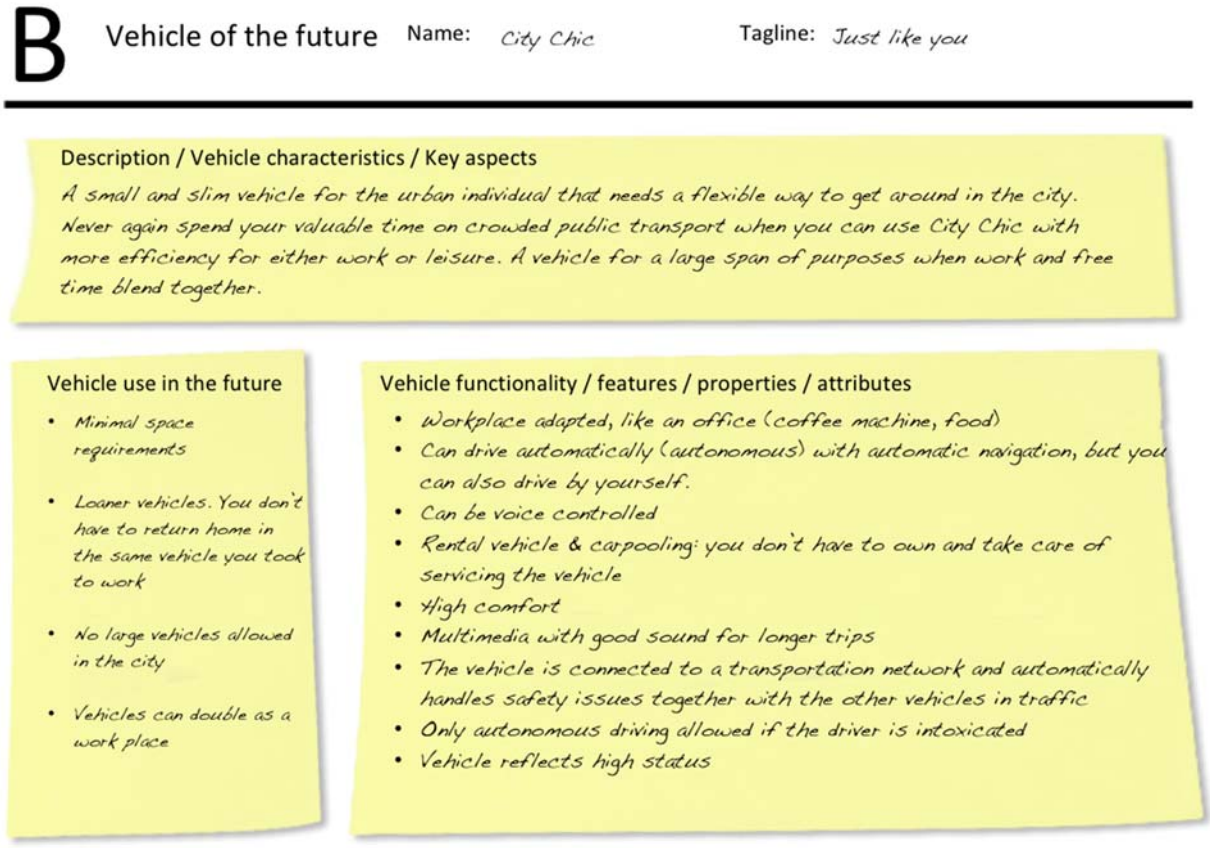

Figure 1. A sample of the vehicle concepts: The City Chic

Five of the finalized and concepts (Figure 1), were used as input in the RGT in order to elicit users' personal constructs regarding the future vehicles, and to compare as well as group these concepts according to their attributes. This part of the study was in the form of a web survey. The survey was sent out to people with a driving licence. Since this was a preliminary collection of data, no further criteria was used for participant selection. In accordance to standard RGT procedure the RGT participants were displayed a random set of three concepts and were asked to group two of the concepts that shared a similar characteristic. Then they were asked to name that characteristic as well as its opposing force. After repeating this process for five iterations, the participants were asked to rate all the elements according to how much they correspond to all of the constructs that they had used for the triads. Preliminary results from 10 participants have been collected and analyzed.

5. Data analysis and results

The data analysis followed the methodology of Fällman and Waterworth [2010]. The aim of the analysis was to discover patterns or similarities between the participants personal constructs regarding the future vehicle concepts. Therefore, all participant level data was merged into one larger repertory grid with a total of 50 constructs.

Webgrid version 5 was used for the data analysis. The constructs from all participants were compared and placed in groups that showed statistical similarities based on their rating patterns with cluster

analysis according to the FOCUS algorithm [Shaw 1980] The constructs in these groups can be regarded as representing the same dimension of meaning related to the vehicle concepts [Fällman and Waterworth 2010]. This process resulted in 3 groups made from 25 constructs, which are presented both in a FOCUS graph that displays the unique dimensions of how the participants have experienced the vehicle concepts, and a PrinGrid map, which uses Principal Component Analysis to show how the vehicle concepts relate to each other, when the axes are defined by the 3 groups of constructs.

Figure 2. The FOCUS graph

The FOCUS graph allows for 3 main clusters of constructs to emerge when selecting a 86% threshold level of regarding two constructs as similar. This means that for two constructs to belong in the same cluster, they must have at least an 86% consistency in their ratings. Moreover, the same constructs were plotted using PCA at a PrinGrid graph [Figure 3]. There are a few preliminary results that can be inferred from the PrinGrid map. Firstly, the map accounts for 88,2% of the variance (63.5% on the X axis and 24.7% on the Y axis), and secondly, none of the elements fall near the center nor too close to each other. This highlights that the participants were able to find constructs that showcase some of the more diverse features of the concepts, since the concepts scored very differently on the constructs. Furthermore, the concepts were different enough for participants to compare. The clusters encompass values that could be important to specific groups of participants. More specifically, each cluster in the FOCUS graph indicates a group of people for which the constructs that are included in that cluster are important personal values when it comes to vehicles.

6. Discussion

The purpose of this study was to construct and test a method for eliciting and exploring people's semantic structures, their latent emotional needs regarding automotive technology, and assessing their experiences with particular vehicle concepts and vehicle technology.

The Repertory Grid Technique is a theoretically grounded and structured research tool that produces both quantitative and qualitative data. The results consist of personal constructs that describe the elements in the study, which represent personal concerns and what the user thinks is important, as well as a rating of all the elements in the study according to how much the elements are described by these

constructs. The rating procedure allows for statistical analyses that render groups of both constructs and elements that can show patterns shared among different participants or elements.

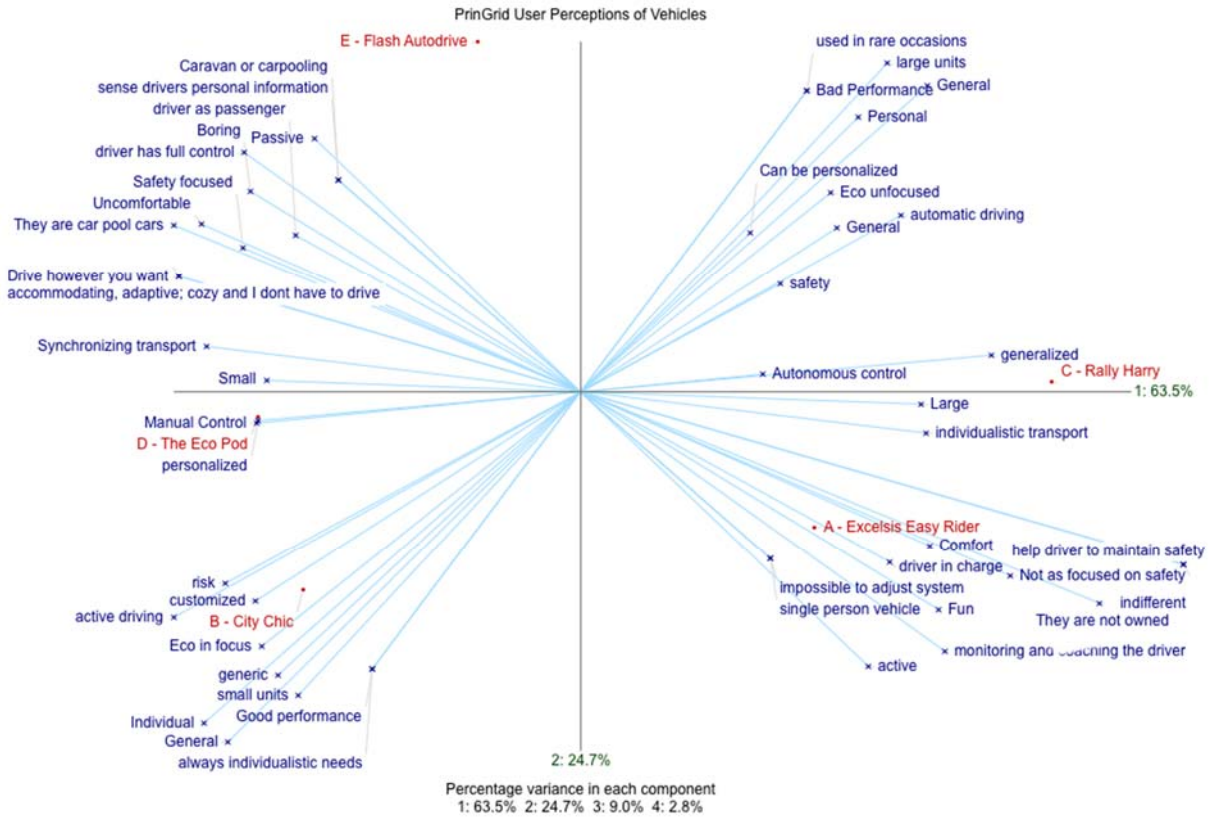

Figure 3. The PrinGrid map

The construct clusters in Figure 2 reflect aspects that the participants find especially important, and can, therefore, be used as focal points in a design team's user identification phase. There are versions of the RGT method, where either elements or constructs, or both, are fixed and chosen by the researcher. If the participants had chosen elements entirely by themselves, the risk would be that they would only relate to their bounded rationality, which is limited by the participants' previous information and cognitive limitations. This particular RGT study is designed to minimize researcher bias since the participants are the ones who have constructed the elements and have chosen the personal constructs. Thus, the results mostly represent the participants' mental models and meaning and do not reflect the researchers opinions.

In order to get a clearer picture into the user's needs and values regarding automobiles the future workshop technique was used as a way to generate elements for the repertory grid. The workshops seem to be a valid method for eliciting input for a RGT study. When the input is based upon the participants work and ideas, it should reflect current issues in vehicle driving and what the participants themselves find important and not just the reseachers own perception. Since all the workshops in this study generated similar, or at least comparable results, it could be seen as an indication that they would be usable for the next step in the study. Therefore the outcome of the RGT is solely dependent on the user and the input elements are also user generated and thus reflect a researcher-independent opinion. If existing products on the market would have been used as elements, the RGT would have given a valuable insight in the user's thoughts about these products, but nothing about why these products were chosen or whether they represent a particular need among the users. In design work, there is often a need to start by diverging the area of interest before it is converged into a solution. Workshops guided by future scenarios where chosen as an appropriate method to generate participatory input for the RGT because of the ability to set the participants' creativity free and to focus on broader issues that are agreed upon within the workshop.

The results of a RGT study are heavily dependent upon the elements in the study and all results are also only relative to these elements. An interesting extension would be to compare RGT studies with different elements to see whether the personal constructs can be generalized or if they are totally dependent of the elements. This study is however believed to give an insight into people's experiences in using vehicles.
The choice of conducting the RGT part as a web survey was due to several reasons. Firstly, the simplicity and low cost of distributing the survey to different subject groups. Secondly, a web survey makes it completely researcher unbiased and ensures that all data from all participants are collected in the very same way. A shortcoming is that the researcher's role as a moderator disappears and that there is no way to infer the participants meaning by reading between the lines if the participant uses vague expressions. In a web survey, the researcher cannot answer questions that might be necessary for the participant to complete the study, but on the other hand this might impose some of the researcher's own thoughts into the data. Another trade off of using a web survey is allowing the participants to complete the study in the convenience of their own home, which may reduce the pressure that is caused by a lab setting. However, there is no control over surrounding conditions and possible distractions that the participant may face in their own space. It is, though, believed that it is acceptable to take such a risk since minimizing experimenter effects and stress from a lab setting was preferable for the purpose of the current study.
The preliminary data collected from 10 participants highlights certain emerging constructs and groups of users that have comparable ways of categorizing vehicles. With an added number of participants, more constructs might emerge, and a clearer picture of the different user groups that shape up the automotive user population can surface.
The participants were shown randomized triads of elements five times, so each participant could only consider a small part of all possible triads. However, in the end, all possible triads should have emerged within the group of participants. With an added number of triads shown to the participants, the study would have taken more time and the participants may have had difficulties in creating more relevant constructs as the study progressed.

7. Conclusion

The combination of the Workshop method and the Repertory Grid Technique can be useful during a design process where the users experience of the product is sought for or if the designed product should be experienced in a particular way. The resulting user categories can guide the work of automotive designers who aim at creating a pleasurable and customized user experience. Other methods that seek the users needs often involve expert evaluations or expert opinions that may be heavily biased towards the experts' own beliefs. In contrast this method offers both the participatory element of the future workshop, where the designers can directly converse with the users, and the repertory grid, which allows for a look into the users needs, wishes, and desires in an way that minimizes external influences and experimenter bias. The workshops produced five futuristic text based vehicle concepts that were very suitable as input to the RGT part of the study since they were different from each other but also comparable. The current study also managed to find three distinct groupings among the participants' constructs, which according to a PCA analysis explain a very large part of the variance. These clusters can be seen as an indication of three aspects that would be important for different groups of automobile drivers. The proposed method can yield relevant and important user data that can lead a design team into creating appropriate design solutions that address the user's needs in a meaningful way.

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