Towards a Multisensory Representation of Electromobility Characteristics

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ABSTRACT

In this paper, we want to follow up the question, how characteristics of electromobility could be represented in the interior of electric vehicles (EV). For that purpose we followed a user-centered approach to collect intuitive and implicit relationships between some descriptive characters of electromobility and real materials. In a study with 13 participants multisensory 3-dimensional mood-boards representing the users' point of view were created. Participants were able to sense the materials and their structures and surfaces by vision, touch and smell. Results demonstrate an alternative approach to visualize the users' preferences for materials and show first impressions of users' associations with EVs. This can be used as an impulse for engineers and designers to fit the needs of future EV drivers when designing EV interiors.

Categories and Subject Descriptors

H.5.m [**Information Interfaces and Presentation**]: Miscellaneous

General Terms

Design, Experimentation

Keywords

Multisensory, Haptic, Materials, Aesthetic, Automotive, Electric Vehicle, User-Centered-Design

1. INTRODUCTION

Currently, the automotive industry finds itself in a sustainable structural period of transition [2]. The change of mobility has started. With it the future of mobility brings alternative fuels, lightweight constructions, driver automation and a smart vehicle, which is "always on" [10]. In the case of electric technology, this also leads to a different setup and design of the car itself [12]. Besides these novelties, the purpose of a car is perceived as more than getting from one location to another: It is a product with an emotional attraction expressing a certain kind of lifestyle [9], which is especially important for electromobility. But how do current car designs translate these modified requirements? On the one hand, customers should not be frightened with a too futuristic design. On the other hand – as the former BMW designer Chris Bangle said in a slightly provoking manner - most design teams tend not to disengage themselves from a well-known conventional design vocabulary [5]. Subsequently, in this paper we report on a new approach to augment the design of electric vehicle (EV) interiors by choosing materials which

support the customers' view on electromobility (see Figure 1). We followed a user-centered design approach and tried to answer the question if there are associations in users' minds connected to electromobility and what they look like. Results show that most participants associate the term "sustainable" with a green artificial turf. Participants argued that turf is organic and a renewable resource. In contrast, the term "innovative" is mostly combined with soft polyvinyl chloride (PVC), because this material is fascinating and not common in every-day life.
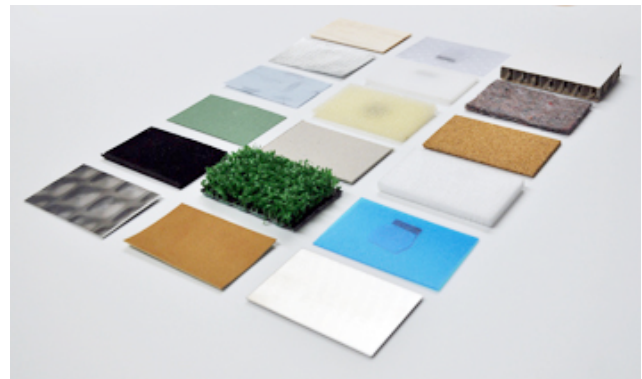

Figure 1: The collection of selectable materials

2. RELATED WORK

First of all, we will provide insights into user-centered design approaches, the usage of mood-boards and multisensory design.

To develop products with a high usability level, Gould and Lewis [4] introduced three fundamental principles. Next to an iterative procedure and an empirical concept verification by the user, they stressed the focus on users and tasks in early stages. To match needs and interests of users even better, Norman advocated a user-centered design philosophy in 1988 [15].

Participative design is an approach to support the active involvement of users in the research and design process. Participative design is part of a user centered design approach including methods such as design workshops, collages and creative toolkits. The findings can lead to inspirations for the design team or even design guidelines [13], [7].

Kansei Engineering focuses on the user as well. It translates the user's feeling into design specifications [14]. Thereby participants describe their desired product by adjectives. The so collected characteristics are translated into design parameters. This methodology should increase the chance to meet the user needs when launching a product. One important factor is that Kansei includes all senses [3]. The Kansei Engineering method can be used to capture ambiguous demands of users to design car interiors based on their associations [8].

To find out more about user requirements (e.g. opinions about a concept car´s interior quality), the user-clinic-method or car-clinic-method is applied in the automotive-industry [1]. With this method, car companies receive useful suggestions and user-associations to improve the product before launching.

Mood-boards or image-boards are well-known design tools to visualize mental connections. They help to capture the mood of the user group, provide a source for inspiration and are very important for developing a product-language, which users can understand [6]. Woelfel et al [21] used mood-boards as a visualization tool showing the mental connections of workshop-participants to a certain topic. Participants received 200 pictures and had to decide for only five of them to finally arrange a mood-board. Visualizing information with this approach was perceived as very helpful. Schmitt and Mangold [18] used a multisensory 3D-Model to understand the experiences of customers even better. Important for them was to use realistic stimuli addressing multiple senses.

Schifferstein and Cleiren [19] analyzed pros and cons of product experiences by comparing unimodal and multimodal information. One result was that multimodal stimulation seems to make the identification and evaluation of objects easier.

In this paper we report on our approach trying to combine parts of the above mentioned methods. It is our goal to visualize mental connections to a certain aspect – in this case electromobility – including not only the sense of vision but also of the touch and smell.

Figure 2: Participant arranging materials to a mood-board

3. CHARACTERISTICS OF E-MOBILITY

More than 20 studies and articles about electromobility were screened to find specific advantages or characteristics. E.g. Peters et al. [16] describe EVs as "...sustainable and energy-efficient means of transport". In the UC Davis MINI E Consumer Study [20] participants "desire for a vehicle that is both environmentally friendly and fun to drive". Especially "the intersection of clean and fun" belongs to the "emerging areas of value for consumers". In a study by the Fraunhofer Institute ISI [17] participants rated environment-friendliness ("Umweltfreundlichkeit"), low noise level ("Geräuscharmut") and innovativeness ("Innovativität") as relevant advantages of e-mobility. Krems et al. [11] localize two needs EVs can satisfy,

green driving ("grünes Autofahren") and driving pleasure ("Fahrspaß").

We chose the following selection of six positive characteristics, electromobility is connected to:

- Sustainable
- Energy-Efficient
- Clean
- Low-Noise
- Innovative
- Driving Pleasure

4. METHOD

We conducted an initial study with 13 participants (three female) with an average age of 22 years ranging from 19 to 27. The participants' task was to choose materials (see Figure 2) that they associate with the mentioned characteristics of electromobility.

All samples were provided by a sample box ("Modulor Musterkiste") containing 199 materials. We asked participants to select six out of 18 pre-selected materials (see Figure 1). Next, they assigned each material to one of the characteristics of electromobility shown on the multisensory mood-board. During the procedure, we asked participants to think-aloud about their emotions and explain details about their choice.

As a final step they commented on the completed mood-board (see Figure 3).

The characteristic terms of electromobility and the provided material selection were randomized for every participant according to a latin square.

5. RESULTS

'Innovative' was associated by 68% of the participants with Plastics (most frequent: soft polyvinyl chloride (PVC), 46%) because it was "novel and had a cool look" to most of them.

'Sustainable' was associated with a green artificial turf (material group: Textiles, Leather, Artificial Leather) by almost half of the participants (46%). Comments on this were that "it is organic and green is the color of sustainability".

For the characteristic 'Clean' the preferences were split between aluminum sheet (38%; because it is "easy to clean"; material group: Metal) and balsa wood (30%; because it is a natural product; material group: Wood & Cork).

Table 1: Frequency of Associations with electromobility by material group in percent

Material group	Frequency
Paper, Light & Strong Cardboard	9 (11.54 %)
Fleece Material & Felt	3 (3.85 %)
Wood & Cork	10 (12.82 %)
Textiles, Leather, Artifical Leather	16 (20.51 %)
Plastic & Rubber	34 (43.59 %)
Metal	6 (7.69 %)
Total	78 (100 %)

'Energy-Efficient' was associated by most of the participants (54%) with Plastics (most frequent: polystrol rigid foam, 23%). The reason for this was mainly "because of its heat insulation and low weight". Another 31% associated Paper, Light & Strong Cardboard (most frequent: comb-board, 23%), because of their production process using low energy and recyclable materials.

'Driving-Pleasure' was associated either with Metal (38%; most frequent: aluminum sheet, 23%) or with Artificial Leather (23%). The given reasons for the former are that the majority of sports cars are made of lightweight material like aluminum. The given reason for the latter is that the interior of cars associated with driving pleasures most of the times contains leather.

'Low-Noise' was associated with Plastics (45 %; most frequent: polyerthan light-foam, 23%) or with synthetic needle-felt (23 %; material group: Textiles, Leather, Artificial Leather) or with natural cork (15 %; material group: Wood & Cork). For all of these, participants assumed a high noise restraining quality.
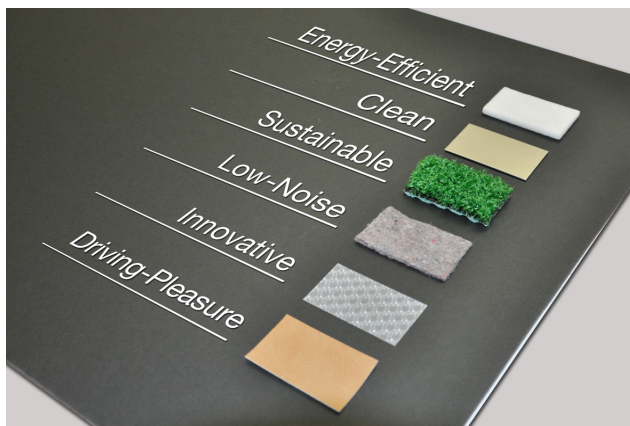

Figure 3: One exemplary multisensory mood-board. The participant chose the material polystrol rigid foam for the characteristic 'Energy-Efficient', the aluminum sheet for 'Clean', the artificial turf for 'Sustainable', the synthetic needle-felt for 'Low-Noise', the 3D soft-PVC for 'Innovative' and artificial leather for the characteristic 'Driving-Pleasure'

6. CONCLUSION AND FUTURE WORK

The aim of this study was to develop a new method to visualize users' associations and preferences of material regarding electromobility. The results show that there is a great variation in the degree of agreement about associated materials.

Participants seem to have a clear view about what materials represent concerning the characteristics 'Innovative' or 'Sustainable'. 'Innovative' was clearly associated with Plastics, especially 3D soft PVC. This material seems to be seen as cool and novel. For example, one participant noted: "the material is not common, looks innovative because of that, I have never seen it before". Another one stated: "looks cool, is novel and modern". 'Sustainable' was associated by most of the participants with artificial turf because of its green color and organic character. Most statements for 'Sustainable' were in the manner of the following: "looks like grass, like sustainability and future".

The associations for the other characteristics were mixed. For 'Clean' and 'Energy-Efficient', participants either thought about the appliance in the car or about the production process. For example in case of 'Clean', Metals are seen as clean because they are easy to clean, but balsa wood was also associated, because it is a natural product. In the same manner, 'Energy-Efficient' is either represented by Plastics, because of the assumed high heat insulation in the car, or by Light & Strong Cardboard, because of its energy saving production process. For example, one participant said about the comb-board "looks as if it is recyclable or was already recycled once".

The associations with 'Driving-Pleasure' are strongly influenced by the materials used in sports cars, e.g. aluminum for the chassis and leather for the interior. For instance: "Cars that are a pleasure to drive have always somewhere leather in them".

For the last characteristic, 'Low-Noise', materials that are assumed to be noise dampening were chosen, e.g. plastics or synthetics.

The given reasons for the choices reveal a first impression of how associations are formed and can be categorized into roughly three categories: the first category are associations based on the look (Innovative, Sustainable), the second category are associations based on the production process (Energy-Efficient, Clean) and the third category are associations based on the appliance in the car (Driving-Pleasure, Low-Noise, Energy-Efficient, Clean). Although, boundaries are not clear, as Energy-Efficient and Clean fit into two categories. However, the interpretation of the results has to be done with care as the sample size of the initial study was small and the range of participants' age was low. More studies with larger sample sizes and more representative samples should be conducted to confirm or revise the results and to clarify how and why associations between material and characteristics of electromobility are made.

The multisensory mood-boards (see Figure 3) can be seen as a tool to communicate associations users have with electromobility. The aim of this paper was not to identify special lightweight materials that could be introduced in electromobility. Instead, the multisensory mood-boards underline the importance of visualizing the users' preferences as a thought-provoking tool for knowledge generation in industrial design.

By the decision to choose real materials, we want to emphasize the importance of tangible expressions. This approach could include, besides the visual perception, also the senses of touch and smell.

For representative results of the visualized characters of electromobility it would be reasonable to repeat this study in a larger context in the future. The tool could be applied and verified to other topics as well.

Furthermore, it would be interesting to conduct a second study using only paper-based pictures instead of real materials to see if there are any differences in the participants' associations. This would be a follow-up on an interesting approach from Schifferstein and Cleiren [19] that analyzed the experiences with products using only one modality. This could be especially interesting for the materials that are associated with a characteristic because of their look.

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