Enhancing Interaction through Product Service Systems

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ABSTRACT
In this paper, it is discussed whether a product service system can enhance the use of a product and thereby compensate for certain features, and, if so, how this influences the interaction between user and product. This is done by reflecting on a concept developed to counter the limited mobility and flexibility of electric vehicles by engaging the users' expectations and providing services to compensate for the absence of features. Finally, the paper discusses the generality of the approach beyond the specific case of electric vehicles.

Keywords
Interaction Design, Product Service Systems, Service Design, Transportation, Electric vehicles

1. INTRODUCTION
With the rise of environmental awareness, CO2 emissions from the transport sector have become a topic of great debate.

In December 2008 the Danish government presented a long-term plan for a green transportation system called *Green Transport Vision DK*. The plan should contribute to reduce CO_2 emissions from transportation until 2020. This goal is to be achieved while maintaining high mobility in the transport sector [2]. Despite noble intentions and a strong political will to use electric vehicles, the EV has failed to take its place in our daily transportation routines. In 2010 there were 2.2 million gasoline cars registered in Denmark [3], and only 270 electric vehicles. One can conclude that as a technology the EV has not yet been fully domesticated and therefore still appears somewhat inaccessible [8]**.** In this perspective the users must first learn about the use of the technology, and familiarize themselves with it, in order to incorporate it into their existing routines.

2. METHODOLOGY
This paper is a critical reflection on the methods and their findings, as used in a bachelor thesis about the development of a concept, which counters the limited mobility, and flexibility of electric vehicles [3]. The authors collaborated with a Danish provider of electric vehicle solutions, ChoosEV. Collaborating with a company that sells EVs provides a good foundation for an ethnographic study of EV users in Denmark. The thesis describes a design process leading to a final concept, which is presented in the form of a product service system (PSS). The solution was evaluated using documented user needs, as well as feedback from the company.

3. UNDERSTANDING THE EV
The EV is currently experiencing a revival as a means of transportation. As a result its user group is still very limited and the technology has yet to prove its marked potential. Given these conditions, the users' understanding of the technology becomes essential in order to define the EV's *raison d'être* as a product.

Artifacts can be experienced in many different ways, including stimulation of the senses, assignment of meaning, and various forms of emotional responses [5]. Additionally, perceptual properties (e.g. color, shape, texture) and attributed qualities (e.g. comfortable, reliable, adaptable) can elicit feelings (e.g. curiosity, satisfaction). Madeleine Akrich [6] argues that: "*When technologists define the characteristics of their products they necessary make hypotheses about the entities that make up the world into which the object is to be inserted*". In other words, these assumptions become part of the object through a series of inscriptions, as in a script or a scenario. The interpretation of the artifact cannot be reliably controlled beforehand because users will engage in sense-making based on factors such as context, motivation, values, etc., independently of the original intentions [5].

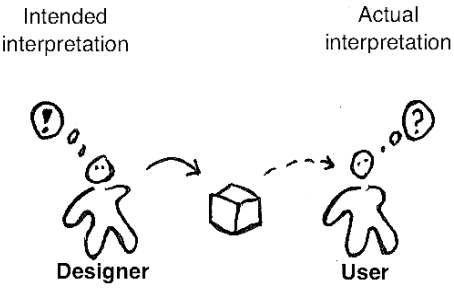

Figure 1. Designer situated on the left, user on the right and the designed artifact between them. The intentions of the designer shape the artifact and the artifact shapes interpretations, but the interpretation takes place independently of the original intentions [5].

Given the successful market penetration of the gasoline car, the users' interpretation of the EV will inevitably be based on previous activities in a gasoline car context. In the context of the daily routines for which gasoline cars are used, the EV fails. If the EV is to be a worthy competitor to the gasoline car, users must question their understanding and usage of the EV. The case study explores this by developing a PSS that stages a different interaction between user and EV.

4. TRANSFORMATION FROM PRODUCT TO PRODUCT SERVICE SYSTEM

As stated before, the activity and knowledge associated with the use of a product can only be perceived through the inscription in the product, because the interaction between user and designer takes place using the product as media. By constructing a product service system that encompasses the EV, a more direct interface can be set up between designer/company and end-user.

A product service system is defined as: a marketable set of products and services capable of jointly fulfilling a user's needs. For the end-user it can deliver new patterns of usage, lifestyle, purchasing and flexibility [7].

The PSS enhances interaction between the different parties by combining the product as an artifact with the service that the product provides to the user. The company retains ownership of the product and instead provides what matters to the user – the actual functionality from the product [8]. How this is done for the EV is explained later.

The ideal of PSS development is that all three stakeholders – customer, company, and society – benefit from the service system's ability to improve the product's performance throughout its lifecycle [8]. This paper will not specify how the company and society benefit from the service system; instead it will focus on the interaction between user and PSS, and on how the PSS engages the users' understanding and expectations of the EV.

5. THE CASE STUDY - THE EV

When studying the selection and design of available EVs, it becomes evident that the vehicle designers in-scripted the EVs with the intentions of providing personal transportation, protecting the environment, and decreasing societal dependence on fossil fuels [2].

The amount of energy produced by gasoline is much higher compared to a battery of the same weight and size, thereby reducing the distance an EV can travel before depletion. Additionally, an infrastructure that would permit EVs to recharge as easily as gasoline cars is not yet available. When compared to the gasoline car, the lesser flexibility and mobility of the EV becomes its *Achilles heel*.

The case study includes user studies that enable the uncovering of realistic user scenarios for the EV. Existing users of older EVs and ChoosEV's converted 2009 Citroën C1s were interviewed. Their use of the vehicles was documented using the master/apprentice method [9]. The vehicles were also tested during a weekend to ensure that the authors experienced the 'EV feeling' firsthand. The findings including both user needs and observed problems, and were structured using an infinity diagram; these were used to evaluate the developed concepts [9]. The important findings are:

Range: The limited range and the lack of public charging stations cause the user to doubt the EV's ability to reach a desired destination. When driving, the absence of easily intuited information about range causes a fear of not being able to achievable sudden and unusual driving needs.

Charging time: Charging a battery takes more time than transferring fuel from a gas station to a car [2]. The EV must be regularly recharged to a level sufficient to guarantee that the minimum needed range is reachable.

EVs are associated with positive attributes as well as negatives: the low requirement of maintenance caused by fewer moving parts will minimize the upkeep; users need only remember to recharge the EV.

5.1 The need for services

The inscriptions and attributes have resulted in a very distinctive image of the EV; it is important to engage this perception and interaction when creating a solution. To address this, users were asked to participate in the process using the 'design game' method [9]. During the session, the users played through several scenarios, thereby reflecting on important design criteria.

Engaging the users in the design process revealed the problem to be doubt as to whether or not a destination is reachable. This problem can be solved with technological solutions such as development of batteries with higher capacity and building a new infrastructure of charging stations. However, the problem can also be viewed as letting the users take full advantage of the offered mobility. There is no need to worry about the range if the destination is reachable. However, if the user requires high flexibility during a trip, i.e. the ability to visit multiple locations or make course changes, this should be supported. The user requires more information about the handling of the EV served in a usable format. In this way, the user is not simply an observer monitoring the battery gauge, but instead actively participates in utilizing the mobility. Users will be engaged in the EV driving experience, and will feel in control.

The solution is an interactive driving experience using a service system that handles inputs and outputs to and from the user at the right time. This should not only heighten the usability of the vehicle, but also refine the user experience. The users' interaction with the system should also recreate a *feeling* that is in accordance with their perception of the vehicle. The vehicle should be simple, but also futuristic, fun, and enjoyable to use. This is achieved by creating a PSS centered on the actual value provided by the EV: namely, easy transportation while redefining the user experience of driving.

5.2 Describing the solution

The PSS changes ChoosEV's role from selling EVs to leasing them to companies. ChoosEV sells transportation as a service while simultaneously offering a way to protect the environment, and decrease dependencies on fossil fuels.

The PSS offers trips in an EV instead of an actual vehicle. This means that user will book trips rather than choose specific vehicles. Interaction between user and EV takes place primarily in an application that runs on mobile devices. The user interface conveys information to and from the EV, to support the user's activities with the EV. It handles most of the interaction between user and vehicle, such as booking the trip, choosing an EV with a fitting battery capacity, unlocking the car, recharging the vehicle, etc. It uses visible functions and feedback to enhance the experience, e.g. instead of showing the battery level as percentage, the range is shown on a map or as a distance in km, and the user can book trips based on contact information, as a point on a map, or as an address.

From the users' point of view, the driving experience is composed of three steps; by using the framework of a music player – i.e., play, pause, and stop – the user is able control the trip in a very simple and intuitive manner. The trip is composed of three steps:

Get the right vehicle: The system rearranges bookings between the EVs, selects a vehicle according to the user's driving needs, and ensures the destination is reachable. Users will no longer be in doubt because a suitable vehicle is chosen for them. Before driving, users are able to view related trip data and check if a new destination or detour is possible. The user initiates the trip by pressing 'play' in the application.

Drive safely: While driving, the app visualizes the route and the area, indicating the option to make impulsive decisions. This recreates the feeling of freedom that a gasoline car provides. When the user wants to park, the vehicle switches to a pause mode. Since the electric motor only uses power while driving, the pause metaphor is very much applicable.

Park and charge: When the journey has ended and the vehicle is returned to the company, the trip can be ended – but only if the vehicle is set to charge. The important task of recharging the EV is ensured in a non-intrusive way, and hopefully will quickly become routine. In this way new practices and interactions are formed.

Figure 2. The user interface for the described solution

The PSS simplifies the use of the EV and restores the feeling of being in control instead of being subject to shortages, literally placing the user in the driver's seat.

6. DISCUSSION

In the case of the EV, it is possible for a PSS to add value by providing services to compensate for the absence of features. The application transforms the complexity of driving an EV (compared to a gasoline car) into a simple experience where focus once again is on what adds value: the fun of driving. From the user's point of view mobility and flexibility are greatly simplified, and the EV's features are made tangible.

In the case of the product alone, the designer decides how the user will interact with the product; this requires that the user behave and think like the designer envisioned or otherwise misuse the product.

In the case of the EV, the designer makes data accessible; however, users must accept this data as relevant and useful information before it can actively create a purpose for them. The PSS lets the users decide how to use the EV by supplying information in many different ways.

According to McAloone and Myrup [9], it is attractive from a user's point of view to transform a product into a PSS if it:

> *(i) Adds more value than normal product ownership (measured by level of prestige, ease of ownership, price, total cost of ownership, etc.)*
>
> *(ii) Gives greater degrees of freedom than a traditional product (ease of upgrading, guaranteed take-back of goods, possibility to focus on core business, etc.); and/or*
>
> *(iii) Includes greater elements of choice to the user.*

The described PSS does not solve the problems with the EV, but rather changes the EV/user interaction. It does not literally add functionality to the product but increases the awareness on use, context, etc. and makes the product more accessible and easier to incorporate into the existing routines.

A PSS allows for an easy way to provide the actual functionality of a product, and enables value-adding properties. In this way a PSS is able to add value to a product which has difficulty providing value on its own. However, adding more intelligence and information cannot solve or hide shortcomings in functionality. The technology has no value *per se*; hence, the solution to improve the user experience of a product is not to force a technology to solve a problem that it is not meant for, but to realize and emphasize what adds value for the user.

7. CONCLUSION

The exploration of the interaction between user and EV clarifies value-adding properties of the EV and allows a framing of this property in a product service system. New interactions are formed between user and EV using services in a PSS which qualifies the use of the electric vehicle. A PSS is concluded to be able to add value to a product by providing features as services and enhancing the interaction.

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