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Co-Design Framework for New Product Development: Case Study on a Smart-Textronics Product

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Recently, human-centred design methods have been actively considered for developing new products and services. Therefore, a new human-centred design framework for developing the smart-textronics products is proposed in this paper. The 'smart-textronics' technology has recently been popular for making people's daily life better by combining electronic components into clothes. The proposed co-design framework is composed of two phases – problem finding and problem analysis. In the phase of 'problem finding', activities of the self-immersion and co-creation are conducted through the usability test of existing similar products and the workbook in which users describe their usage activities, emotions, associated values and solution ideas. In the 'problem analysis' phase, the result analysis and online survey are carried out to frame a final design problem. Finally, the proposed framework is validated with the case study on designing the LED light jacket for bicycle users.

Keywords: Human-centred design; Co-design; Problem finding; Problem analysis; Smart-textronics products

1 Introduction

A human-centred product development approach has attracted more attention since the launch of various smart devices, because they have been successful by providing a customized experience for users. In this context, smart wearable products had been introduced about a decade ago, and smart textile, which is referred to as a combination of soft textile and smart devices, was also been of significant attention for making people's every life convenient and pleased. More recently, a concept of smart-textronics has been introduced as the new interdisciplinary paradigm comprising textiles, electronics and informatics (Gniotek & Krucinska, 2003). Products embedded with the smart-textronics technology can be applied in various situations. For example, it can provide an immediate help in a life-threatening situation for the elderly or patients with the sensor integrated in the textile that can monitor the health condition (Axisa et al., 2005). In addition, they can be used for the smart fire suit with a wireless communication and the art works with a lightening function such as the designer Moritz Waldemeyer's work (Vallozzi et al., 2010).

The smart-textronics products usually have complex characteristics because they are composed of various components to support multiple functions (Chan et al., 2012; Lymberis & Paradiso, 2008). Besides, they are supposed to be used by people for many hours of the

day, and therefore, user satisfaction should be successfully ensured to provide an appropriate user experience. In this context, researches of integrated sustainable service designs for the smart-textronics products have been considered by cooperating and ideating with experts in different disciplines (Ten Bhömer et al., 2012; Briggs-Goode et al., 2016). In addition, a future user's needs and desires for the smart-textronics products should be predicted in the framework by properly handling ambiguity. For such framework, potential users should participate in the early design stage.

To effectively involve users in the design process, various approaches have been studied such as human/user-centred design, participatory design, co-design, and so on. The participatory design approach has been popularly applied in the new product development these days. In the participatory design, key stakeholders should be involved into design process (Sanders & Stappers, 2008). Vácha et al. and Vácha and Kandusová emphasized that it was essential to actively listen and analyse users' needs and preferences by involving them and having feedbacks for the proposed solution (Vácha et al., 2016; Vácha & Kandusová, 2018) in the participatory design. The concept of co-design which emphasizes the collective creativity of designers and stakeholders who are not trained in design has been growing (Sanders & Stappers, 2008). In their co-design framework, they discussed that users should be regarded as 'experts' of the design project, not passive stakeholders, by making them actively participate in the design process. The co-design process can also be more efficiently carried out by using proper toolkits, especially in the case that participants are not experienced in the design project (Sanders & Stappers, 2008; Sanders & Westerlund, 2011). Tassi (2009) collected the comprehensive tools such as role play, group sketching, issue cards, storytelling, and so on. Sanders and Westerlund (2011) suggested the concept of co-design space where creative design toolkits or workshops can improve the creativity of stakeholders in the process of design. In addition, the concept of value and the journey map were exploited for the co-design space (Yoo et al., 2013; Reay et al., 2017).

Although significant efforts have been made to develop design methods making users actively participate in the design process, a detailed methodological framework for effectively discovering potential needs and wants of users have not been sufficiently explored. This framework is of much significance to define design problems for products and services considering a great deal of user experiences and associate contexts such as smart-textronics products, which are of major concern in this paper. Therefore, we develop the novel systematic co-design framework where users can actively participate for an effective development of new smart-textronics products. The proposed framework consists of two main phases – 'problem finding' and 'problem analysis'. The problem finding phase has two sub-steps such as 'self-immersion' and 'co-creation'. In this phase, the workbook is prepared as a toolkit for users to be immersed into certain usage situations and to ideate fragmentary, yet very insightful, solutions. The workbook guides participants to describe their usage activities, emotions, pain points, values, functions and possible solutions. In the phase of problem analysis, the user analysis and problem framing are conducted in the step of 'results analysis', and the 'online survey' for possible users is conducted after developing the questionnaire on the proposed product ideas. Finally, the proposed co-design framework is applied to designing the LED light jacket for bicycle users as a case study.

2 Co-design Framework

The schematic view of the proposed co-design framework is given in Figure 1. As can be seen in Figure 1, the framework is composed of four steps such as self-immersion, co-creation, results analysis and online survey. The steps of self-immersion and co-creation are carried out in the phase of 'problem finding', and the results analysis and online survey are conducted in the phase of 'problem analysis'.

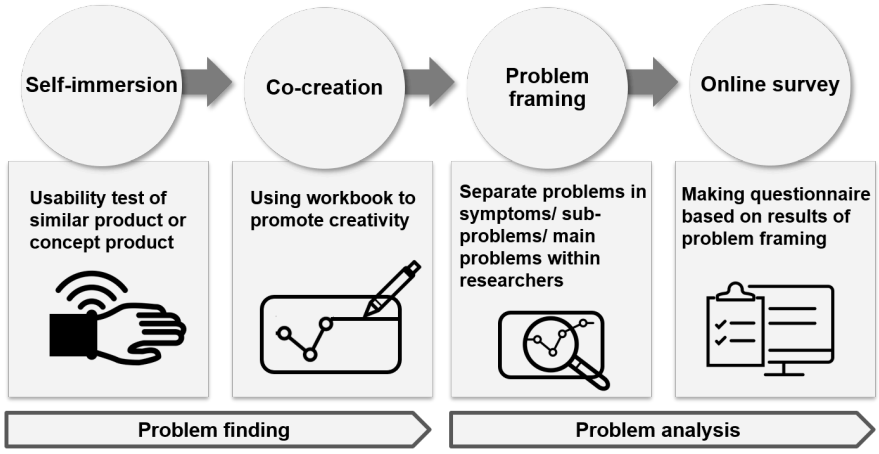

Figure 1. Schematic view of the proposed co-design framework

In the self-immersion step, 1:1 in-depth interview is mainly carried out for participating users. In particular, the usability test on existing similar products is considered to immerse users in usage situations. In the co-creation step, the workbook is developed, and participants are asked to fill out the workbook. The workbook includes two parts: (1) journey map, activity and emotion and (2) value and ideation. In the first part, users are asked to describe activities in a sequential manner when using the products. Then, they denote their emotional status for each activity node with possible reasons. Besides, users' pain points should be described with their significance levels. In the part of value and ideation, users can play a role of product developer by relating value words with their activities and pain points and coming up with desired functions and possible solution ideas. The value words can be selected from the E3 value framework which had been proposed by Cho et al (Choe et al., 2010). In Figure 2 and Figure 3, the snapshots of the parts 1 and 2 of the workbook are given.

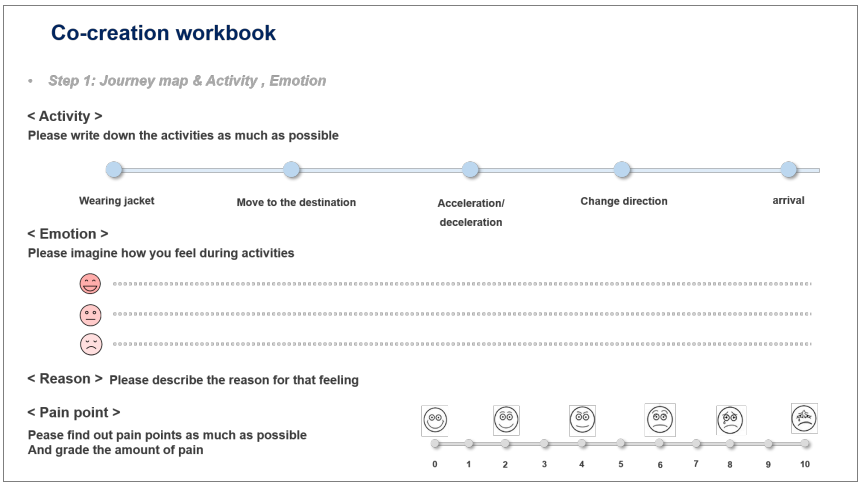

Figure 2. Snapshots of the workbook – part 1

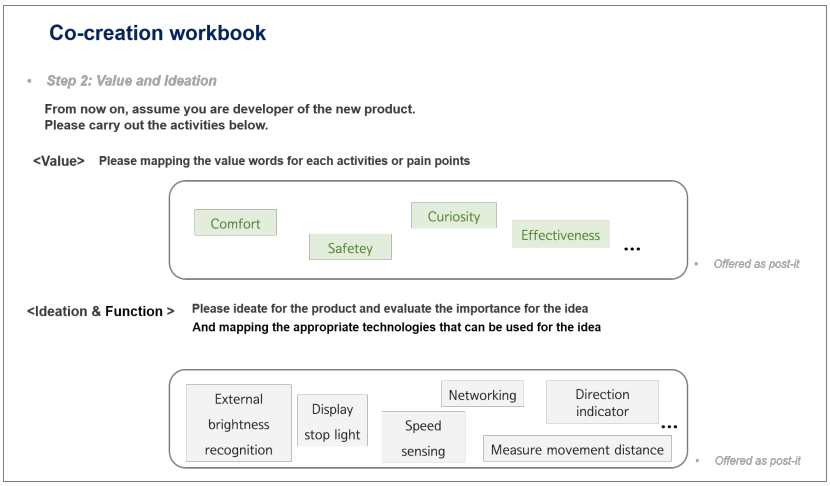

Figure 3. Snapshots of the workbook –part 2

After the above-mentioned steps, two steps – the results analysis and online survey – in the phase of problem analysis are carried out. The data obtained during the problem finding phase are processed and analysed in the step of results analysis. In this step, the user analysis and problem framing are carried out. In the user analysis, several user groups are identified based on characteristics of the participating users, and in addition, their product creativity scores are compared and analysed. The product creativity score is composed of three dimensions including the centrality (attraction), desire and importance which are associated with customer satisfaction and purchasability (Horn and Salvendy, 2006). Afterwards, the problem framing is proceeded via the classification scheme of symptom, sub-problem and main-problem by multiple researchers having heterogeneous knowledge and experience (Frishammar Johan et al., 2016). Then, their individual work is aggregated and further discussed, and the integrated problem is framed and defined. Lastly, the questionnaire is developed by addressing important issues raised in the problem framing step, and the online survey is conducted for many unspecified users to get suggestions of the final conceptual product idea.

3 Case Study: LED Highlight Jacket for Bicyclers

In order to validate the proposed co-design framework for the smart-textronics product development, the case study on the LED highlight jacket for bicyclers was conducted. The LED highlight jacket has been mainly used for bicycle users to enhance their convenience and safety. In the meantime, the company tries to improve its design and function by actively integrating smart-textronics technology to further enhance user satisfaction.

3.1 Problem finding: Self-immersion and Co-creation

We recruited 6 bicycle users having diverse experiences in terms of the frequency and duration of cycling and number of people riding a bicycle together, and so on. The 1:1 in-depth interview was conducted for each user. During the interview, the usability test on the existing LED jacket and the co-creation activity with the workbook were conducted. Figure 4 shows the photo of the step-by-step sequence of the usability test and one of users wearing the LED jacket during the test.

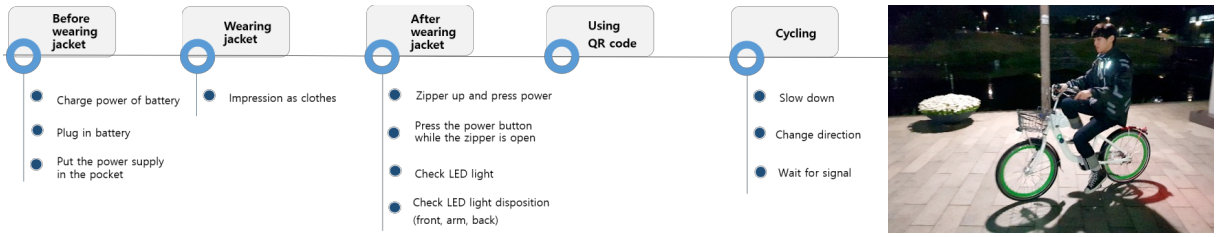

Figure 4. Photos of the sequence of the usability test (left) and the users wearing the LED jacket (right)

After the usability test, the users were asked to make scenarios by conceiving additional activities during usage of the LED jacket and to denote their emotional status at each activity node with needs and wants during the co-creation part 1 – journey map, activity and emotion. In the part 2 – value and ideation, the users were asked to map value words to each activity and pain point. In addition, they ideated additional functions and associated possible solutions. They also expressed significance levels of the pain points and the value-function-idea sets. Figure 5 shows the snapshot of the results of one user during the co-creation step. In Figure 5, the red-coloured activities are added ones, and the emotional status for each activity node is given. As can be seen in Figure 5, the user addressed several key needs such as the impossibility of a simultaneous operation of the bicycle gears and LED controller, the complicatedness for installing and recharging the jacket before, the difficulty in washing the jacket, and so forth. In order to resolve such needs, the user emphasized the values of convenience and comfort, and he addressed the functions of motion detection and ventilation. Then, the ideas of a goretex textile for effective ventilation, a provision of left/right direction signals with automatic detection of a bicycle rider, and a connection between a bicycle and an LED controller have been come up with.

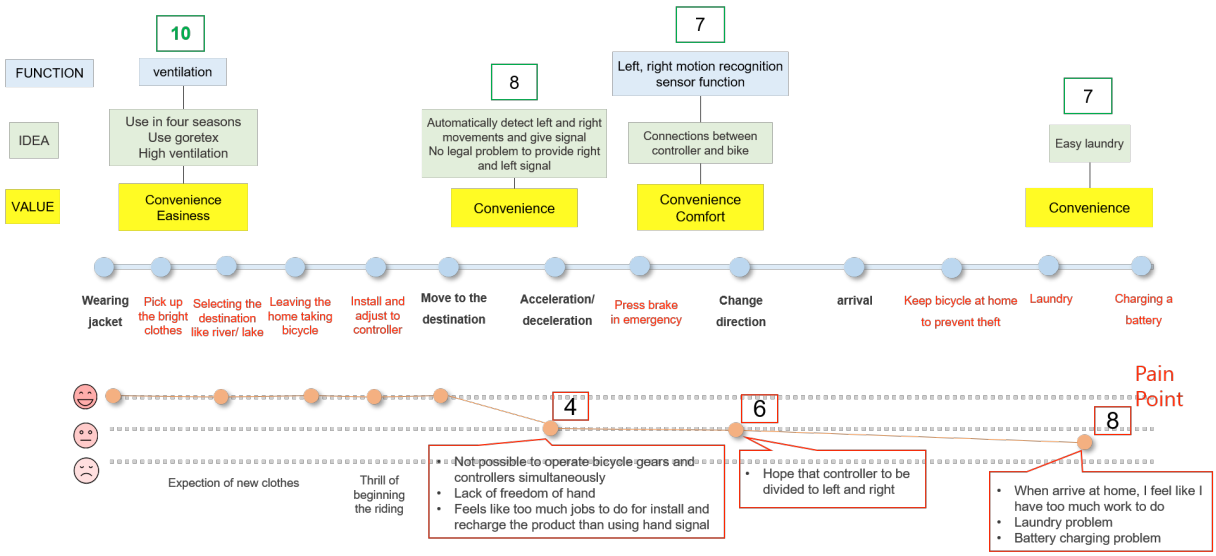

Figure 5. Snapshot of the results of one user during the co-creation step

3.2 Problem analysis: Results analysis and Online survey

In the results analysis, the user groups were identified based on characteristics of the participating users. Table 1 shows the identified user groups and their summarized characteristics. As can be seen in Table 1, three user groups were categorized.

Table 1 Three user groups identified from the user analysis

Group	Users	Characteristics
People who participate in the bicycle club	C, E	• Ride a bicycle once or twice a week, and ride it for more than 3 hours at a time • Socialize with the people of the club • Sensitive of design when buying bicycle clothes • Have various bicycle accessories
People who ride a bicycle alone everyday	D, F	• Ride 1~3 hours on weekdays evening or on weekends • They use it when commuting • They need clothes to protect themselves at night while riding alone
People who ride a bicycle often	A, B	• Often ride for 20 min to 2 hours on the weekdays or weekends • They usually cycle at late night

In the problem framing step, three researchers analysed the data obtained from the users, and the final main problem was defined by using the symptom-sub problem-main problem structure. Figure 6 shows how the final main problem was identified in this step.

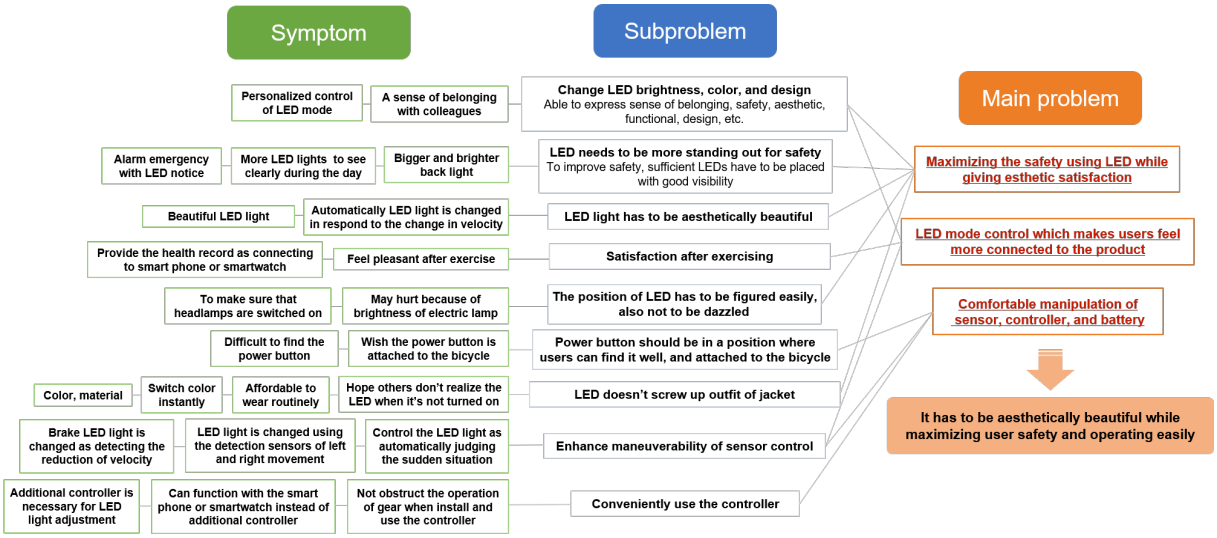

Figure 6. Schematic view of the final main problem definition in the problem framing step

The questionnaire for an online survey was created by considering the main problems that were defined in the previous step. The questionnaire was composed of total 28 items altogether. Among them, 16 items were extracted from the results from symptom-sub problem-main problem analysis. In addition, 9 items were obtained from the analysis on usage patterns of the users and 3 items were evaluation questions on the overall concept. The online survey was conducted for 23 respondents, and the results for 16 items that were extracted from the problem framing are given in Figure 7. As can be known from Figure 7, three insights having more than 4 points were obtained such as “affordable design to wear routinely”, “Not interfere with gear operation when using the LED controller”, and “alarm emergency with the LED notice”. Others having scores between 3.5 and 4 were also seriously considered for the product refinement and development. Finally, they were transferred to the company for the development of an advanced LED highlight jacket with the smart-textronics technology.

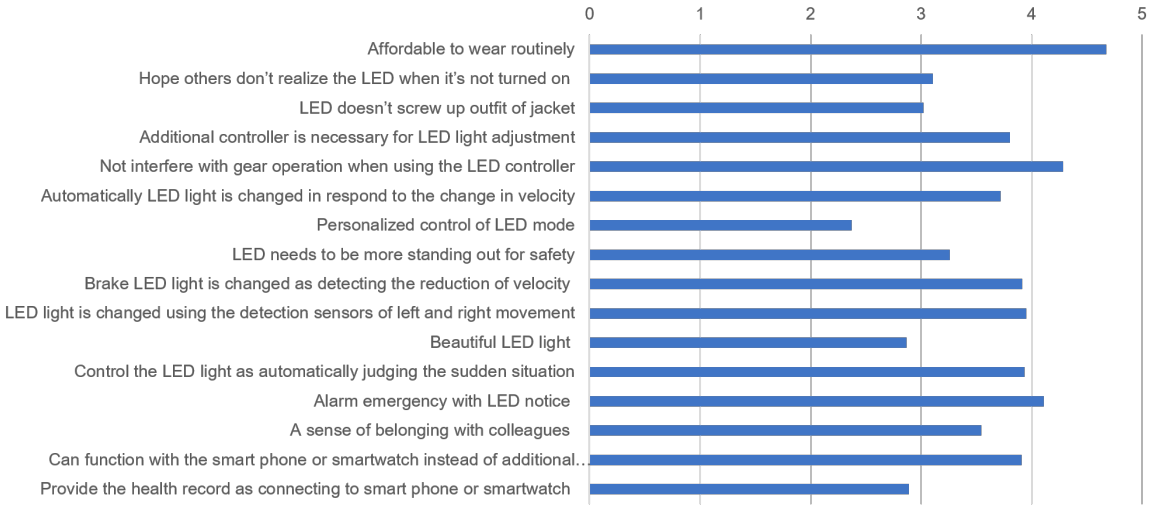

Figure 7. On-line survey results in the problem framing step

4 Concluding Remarks

In this paper, the new human-centred design framework for a new product development was proposed by considering co-creation between designers and users. Two main phases – problem finding and problem analysis – are included in the framework. In the phase of the problem finding, the self-immersion and co-creation steps are considered to make the users deeply involved in the usage situation and ponder pain points, values, functions and possible solutions with the 1:1 interview and the developed workbook. In the phase of the problem analysis, the critical main problems are identified based on the user analysis and problem framing. Then, the questionnaire is developed based on the results from the problem framing, and the online survey is conducted. In order to investigate applicability of the proposed framework, the case study on the LED highlight jacket for bicycle users was conducted. The results were transferred to the company for advancing the current LED jacket by adding insightful issues that were extracted from the users. Therefore, the case study showed usefulness and applicability of the proposed framework for an early development stage of the smart-textronics products. As a future work, the company will produce the new LED jacket based on the results from the case study and the usability test will be carried out to validate the proposed co-design framework.

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