Mode-of-use Innovation in Interactive Product Development

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Abstract

Background Mode-of-use innovation, or the innovative means by which products may be used, is considered as one lever for design-driven innovation. The current study explored how the mode-of-use concept may apply to state-of-the-art product interactions and enhance user experience, in turn providing opportunities for design-driven innovation within the interactive product space.

Methods As framework to explore the application of mode-of-use innovation in interactive experiences, we adopted taxonomy of interaction styles. Generic interaction styles in product experience were classified through two criteria; whether interaction supports explanatory or exploratory modes, and whether the product interface is discrete or composite. Adopting a research-through-design approach, two interactive mood lamps were designed, expressed as high-fidelity prototypes and used as stimuli to evaluate product experience according to different interaction styles.

Results Results indicated that the touch-free magic interaction style, an interaction providing explorative and composite modes of interaction, was initially considered more innovative in terms of mode-of-use, possibly triggered by the novelty of the interaction. However participants also expressed negative experiences in touch-free magic interactions compared to explanatory modes-of-use interactions due to poor haptic feedback and inability to intuitively understand the mode-of-use.

Conclusions Implications for understanding how mode-of-use may be applied to interactive product design are finally discussed. Although more work is required to understand how best more novel explorative interactions may stimulate initial feelings of innovativeness, caution is required in providing mode-of-use innovations that allow opportunities for clear understanding of interaction as related to function feedback, mapping well onto user expectations.

Keywords Mode-of-use Innovation, Interactive Product Design, Research-through-Design

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1. Introduction

Design-driven innovation is a strategy whereby firms may be better placed to add value to new and existing product lines (Verganti, 2008). Unlike other forms of innovation such as market-driven or technology-driven innovation, design-driven innovation aims to radical change the emotional and symbolic content of products, whereby creating new paradigms of product experience (ibid).

The example of Nintendo Wii illustrates the nature of design-driven innovation. Released in November 2006, the Nintendo Wii offered users a physical experience through its use of motion-sensitive controller technology, thus radically changing the meaning of game playing from a virtual experience accessible only by niche markets to an active, participatory experience in the real world for everyone. Technically, the ability to engage in this type of game play is provided by the Wii's motion-sensing MEMS controller. However, the technology itself was not new at the time of the Wii's release as it had been used extensively in the automotive industry. What made Nintendo Wii an example of design-driven innovation was the fact that Wii didn't merely add a new functionality to existing game consoles, but created a radically different meaning to the experience of game playing through the ways in which the system was to be used (Verganti, 2013).

In terms of a process of design-driven innovation, Rampino (2011) defines three types or innovation levers; form, technology, and mode of use (Figure 1). According to Rampino (ibid), during the creative process, designers may use these levers as means to drive a design-driven approach. The Form lever indicates attempts to provide aesthetic value by consideration of semantic attributes. In contrast the designer's use of the Technology lever provides opportunity for applying technology that is either existing or underutilized, in a new way. Mode-of-Use provides opportunities for innovative ways of using a product by exploring either interaction opportunities.

As a result of their application, the three levers have the potential to facilitate four interrelated types of innovation; aesthetic innovation, innovation in use, meaning innovation and typological innovation (Figure 1). Aesthetic innovation is concerned with the product's external appearance and resulting personality, seen prior to product interaction, while innovation in use involves the improvement or modification of the product usage. Meaning innovation indicates a changing of the emotional and symbolic aspects of a product; what the product means to the user. Finally, typological innovation involves the deviation of a product from its formal archetype.

This framework of design-driven innovation is shown in the form of a pyramid, illustrating a distinction between each types of innovation based on their higher and lower degree of novelty (Figure 1).

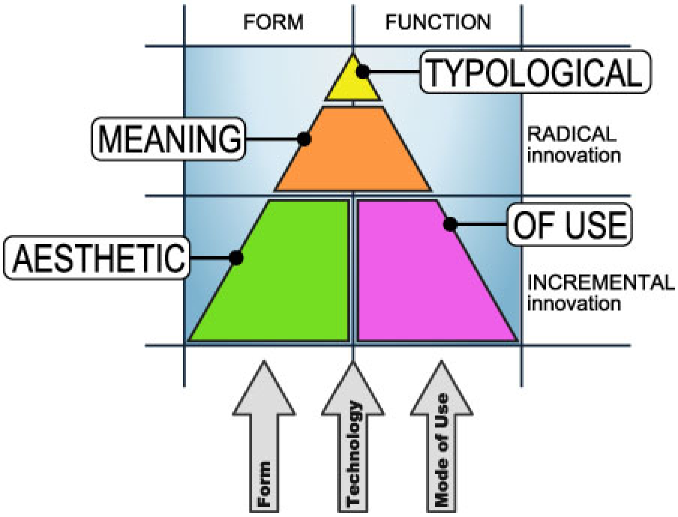

Figure 1 The Innovation Pyramid (Rampino 2011)

Comparing the Rampino model to the Vergantian (2008) perspective on design-driven innovation, among four types of innovation aesthetic innovation and innovation of use are classified as incremental, while meaning innovation and typological innovation is seen as radical (see also Verganti, 2008). Although the Rampino (op cit) system of classification is effective in starting to unpack the meaning of design-driven innovation, the model may be improved through an understanding of how the four types of innovation interact to provide opportunities for what Verganti describes as radically new innovation (Verganti 2008). The model also does not well account for relationships between the four types and the kinds of products developed. For example, how might the design of a smart-product or IoT (internet of things) device implicate a notion of mode-of-use innovation? What possible consequences does this have for endeavors towards design-driven meaning innovation for now emergent smart products?

With the current study's aim of understanding how meaning innovation may be applied within the interactive product space during design development, the mode-of-use lever appears to have most significance for the design of innovative interactions. As discussed above, mode-of-use can be described as a lever by which the designer considers how users will operate products within their socio-cultural dimensions (Rampino, 2011). A conventional example of applying mode-of-use as an innovation lever is the collapsible kitchen funnel by Norman Copenhagen (Figure 2). The funnel is able to collapse to be put away easily when not in use, thus saving draw space or space in a bag.

Figure 2 Collapsible funnel by Normann Copenhagen

However, this example, as with the Rampino study, limits the discussion to the application of the mode-of-use lever in conventional product design. Along with emerging technologies, state-of-the-art interactive products consider the product's mode-of-use as a key driver of their innovative potential. An example includes Canesta's projection keyboard, which altered the keyboard's mode-of-use compared to other products of the same use and function. Instead of employing conventional inputs such as mechanical switches, the projection keyboard uses a sensor module and projection system to generate projected images of keys. The projection keyboard is an example of Canesta's application of the mode-of-use lever as driver for innovation in developing a new interactive product.

Figure 3 Canesta's Projection Keyboard

Despite the clear parallels between the construct of mode-of-use innovation and interactive product design, current studies have not well examined the potential of the relationship to provide innovation opportunities. An analysis of mode-of-use in the interactive product space could provide the foundations for understanding how mode-of-use innovation strategies, as described by Rampino (op cit) may best be leveraged during the design and development of radically innovative interactive products.

To this end the current study examines the effect of applying the mode-of-use lever within the context of interactive products. To achieve these aims we start by defining the term interactive product and introducing the concept of interaction styles (Buur & Stienstra, 2007) as theoretical framework for our study of mode-of-use innovation within the interactive product space. We then adopt a research-through-design approach to examine how interaction styles may implicate the user experience, after which we discuss results in terms of the extent to which different interactions may stimulate feelings of mode-of-use innovation as described by Verganti (2008) and Rampino (2001). Finally we reflect on results in terms of how mode-of-use relates to interactive product design and the implications of its application as driver for innovation in the interactive product context.

1. 1. Interactive Products

The terms interaction and interface are widely used in the fields of HCI (human-computer interaction) and ID (industrial design). For his study on designing interactive products, Frens (2006) defines the terms interaction and interface as following:
-Interaction: The relation, in use, between product and its user mediated by its interface.
-Interface: Combination of the controls and feedback elements of an interactive product.

From these definitions the relationship between mode-of-use as lever for innovation and interactive product design becomes clearer. In the design of interactive products of the kind described by Frens (op cit), the means and ways through which interaction takes place have profound implications for the product experience. Based upon these existing studies, and for our purposes of exploring mode-of-use innovation in the interactive product context, we provide a definition of interactive products as products consisted of combinations of controls and feedback elements, thus highlighting the relationship between product and its use.

1. 2. Product Experience and Mode-of-Use Innovation

Desmet and Hekkert (2007) define product experience as a change in core affect, which is a combination of affective response and physiological arousal derived from human-product interaction. Taking this approach, there are three types of experience which constitute the overall product experience; aesthetic experience, experience of meaning and emotional experience. Two types of experience, aesthetic and meaning, are described as emotional triggers. From the model (Figure 4) of product emotions offered by Desmet & Hekkert (2002), we can see that experience of meaning and emotional experience are closely related.

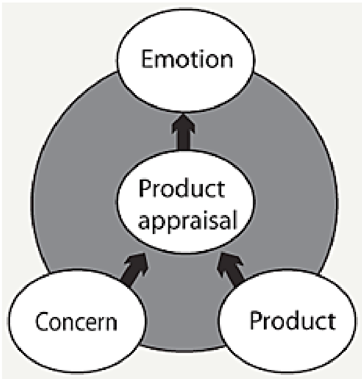

Figure 4 Basic model of product emotions (Desmet & Hekkert, 2002)

The model shows that emotions arise when users encounter products that are expected to be related to their concerns, such as his or her goals or aspirations (Frijda, 1986; Lazarus, 1991). Since the experience of meaning, or product semantics, can be recognized as harmful or not well related to the users' own concerns (Figure 4, Concerns), the meaning component of experience can trigger emotional experience. This implies that a change of product meaning can be interpreted as a change of emotional experience. Unfortunately, the model tells us less of the implications of changes in mode-of-use as described by Rampino (op cit), or implications for product appraisal and related emotional response.

As stated above, Verganti (2008) defines design-driven innovation as a radical change in product meaning. Extending this idea to our discussion of Desmet and Hekkert's (2002) model of product emotion, change in product meaning thus elicits change in the emotional experience of a product. In turn, design-driven innovation can be seen as a radical change in the emotional experience of a product.

Schifferstein et al. (2012) highlight the relationship between product experience and design-driven innovation, stating that product usage and purchase are becoming more dependent on if the product is able to elicit distinctive product experiences. Again however, little is said of the relationship between how a product is actually used and interacted with and implications for product appraisal and any resulting assessment of innovativeness.

From a methodological perspective, this relationship between product innovative and emotional response also has relevance for the current study. However, measuring attitudes towards innovativeness through self report based upon holistic assessment of existing products (see for example Kim and Self, 2013) has its limitations as methodological approach in that the product characteristics of particular concern (i.e. mode-of-use) cannot be clearly isolated for focused assessment.

Hence, in the current study, we adopt a research-through-design approach. The research-through-design method is often confused with a material representation of existing principles. In a research-through-design process the knowledge gained by the prototype leads to new information which is applicable to the product category defined before the research project. In this study, the knowledge we were trying to obtain is applicable to the category of interactive products. On the other hand, testing prototypes leads to information that is used more to refine existing products. Examples of answers sought on such processes would be, for example, the design implications for enhancing user's emotional experience, or which prototype fits well in expressing which type of emotional experience.

Therefore, we use research-through-design method and observe the product experience of users from the perspective of mode-of-use innovation through careful design of differing interactive opportunities in two otherwise identical products. We then discuss how this could relate to the application of mode-of-use innovation within the interactive product category.

The importance of understanding the relevance of innovation-of-use strategies in the interactive product space has already been of interest within the human-computer interaction (HCI) field. For example, studies have shown that the interactive quality of a product influences the emotional experience of users. For example, results from a study performed by Lim et al. (2007) illustrated that functional and interactive qualities are significant components in effecting the users' emotional experience within a given interactive product encounter. The Apple iPod, for example, created idiosyncratic emotional experiences through its unique interaction qualities that allowed users to browse music with the wheel interface for the first time. Likewise, with particular focus upon how the concept of mode-of-use innovation may drive product experience in the interactive product category, our study attempts to address the following research question:

-How can mode-of-use innovation be best applied to interactive product design as driver for innovation?

1. 3. Generic Styles of interactive products

In order to examine the potential of mode-of-use innovation as driver for innovation within the interactive space, it was first important to define product interaction as construct for the purposes of our investigation. In the field of human-computer interaction, Lim et al. (2007) proposed a comprehensive framework to describe interactivity by providing a set of interaction attributes.

Although the framework had its effect on the design of interactive artifacts (Lim, 2011), its scope is too broad for the current study as it covers various designs from GUI-based to physical-based products. The concept of design-driven innovation itself has its roots in industrial design, so in order to seek opportunities of applying mode-of-use innovation for designing innovative interactive products, the framework we use should not only be related to HCI principles but also address issues in traditional product design. Among various fields of HCI, tangible interaction seems to be best fit to the context of product design, as the terminology itself means using physical objects to interact with computer systems (Ishii & Ullmer, 1997).

Studies regarding user's operation of artifact and its efficiency (i.e. usability) and how they can affect user's aesthetic experience were performed by various HCI researchers (see for example Hassenzahl, 2004). Nevertheless, given that mode-of-use is a lever by which designers consider the user's way of operating a product within their socio-cultural context, the socio-cultural dimension was left unaddressed.

Hence we decided to adopt the notion of interaction style. Interaction style can be defined as a mode of interaction between human and machine based on a particular technology, and it also encompasses the user's sociocultural context. Because style is a person's predisposition to act in a certain way, the context stands forth as a style defining factor (Øritsland & Buur, 2000). For this study, we used Buur & Stienstra's (2007) framework of generic interaction styles as the framework stems from Øritsland & Buur's work (ibid) and provides working definition for each interaction styles.

To this end, Buur & Stienstra (ibid) define pairs of dichotomous interaction styles among interactive products:

-Explanatory vs Exploratory

Explanatory designs provide directions for goal achievement. Exploratory designs focus on playful interaction rather than the goal itself. The volume control button on a TV's remote controller can be seen as explanatory interaction design, while gestural control in the Nintendo Wii is exploratory, providing opportunities for more playful interactions. .

-Discrete vs Composite
Discrete interactions provide links between one control and one function. Composite interactions have general controls to access various functions. Traditional radio controls, with their different knobs are used to adjust volume and sliders to select radio channels can be seen as discrete interaction design. A smartphones home button, with its various functions could be seen as composite.

With these criteria, the generic interaction styles of interactive products can be categorized as following:

-Tangible Control (discrete/explanatory)
The interface consists of several, discrete controls. The spatial arrangement of these support product understanding.

-Elastic Play (discrete/exploratory)
Specific controls for specific functions. The interface consists of a wide variety of general control types. Interaction supports physical input and feedback. Learning to interact with the product requires both cognitive and embodied understanding. One example would be a turntable and mixer for DJs. They contain a variety of sliders and knobs for certain functions. Operationprovides idiosyncratic style and experience. Also, users have to grow his or her cognitive and motorsensory skills to successfully interact with the mixer and controller.

-Rhythmic Logics (composite/explanatory)
Interaction requires a cognitive understanding of the product. Input is a rhythmic sequence of simple actions, button tapping for example. Interaction focuses on efficiency and feedback is digitally mediated. A good example for this interaction style would be a touch-screen interface in a smartphones. When seeing a picture with a phone, users swipe the screen to move on to next picture, spreads the screen with fingers to enhance, and pinches the screen to dehance. All control is a sequence of touching screen with fingers.

-Touch-free Magic (composite/exploratory)
The product reacts in surprising ways. The controls themselves may not have one clear identity. The product supports an exploratory mode of interaction, may move and respond physically, but with no tactile feedback.

The current study compares two types of interaction styles: Tangible Control (TC) and Touch-free Magic (TfM). An example of TC interaction is seen in Elecom Shining Bluetooth Speaker by Elecom (Figure 5).

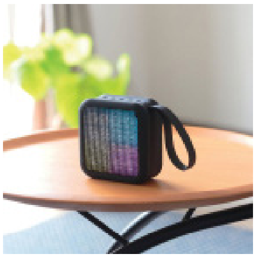

Figure 5 Elecom Shining Bluetooth Speaker by Elecom

The Elecom speaker utalises a visual effect, with buttons mapping onto each of the product's functions. This then provides opportunities for direct information related to the product's use. A further example of the Touch-free Magic interaction style is The Cloud, designed by Richard Clarkson Studio (Figure 6).

Figure 6 The Cloud by Richard Clarkson Studio

The Cloud is a music-activated visualizing speaker with a motion-triggered lightning & thunder performance. It employs embedded motion sensors for its lightning and thunder. In the current study we use the concepts of Tangible Control (TC) and Touch-free Magic (TfM) as constructs to define interaction types in our investigation of mode-of-use innovation within the interactive product space.

2. Methods

2. 1. Experiment Design

An experiment was designed to measure participants' emotional experience according to the two different interaction styles of TC and TfM. Adopting a research-through-design approach, an interactive product (mood-lamp) was designed and prototyped. In order to examine the influence of interaction styles (TC vs. TfM), a version of the lamp was designed according to a TC interaction, with a second identical lamp developed and prototyped with an interaction based upon the TfM construct.

The interactive mood lamp was chosen for the stimuli to examine implications of interactive control for use experience. Through the interaction participants were able to control color (red to blue) and brightness (high/low). As such, each of the two product stimuli was designed according to the two interaction styles.

Tangible Control (TC) (Figure 7) interaction style with the purpose of giving information for successfully carrying out certain functions. For this purpose, two knobs to control brightness and color were applied to the interactive mood lamp.

Figure 7 Designed stimuli for TC (Tangible Control)

Touch-free Magic (TfM) (Figure 8) a design with a minimal user interface and interaction with unpredictable feedback was incorporated into the prototype stimuli.

Figure 8 Designed Stimuli for TfM (Touch-free Magic)

Participants were asked to interact with the two stimuli, record their emotional experience and, finally, engage in a short interview session.

2. 3. Method of measurement

A questionnaire consisting of 14 types of positive and negative emotion scales based upon PrEmo (Desmet, 2003) was used to gather response data from participants. The tool, based upon a previous study by Desmet, Porcelijn & van Dijk (2007), measured the participants' product experience. Responses were recorded through 5-item Likert scales (i.e. 0: "I do not feel this", 1: "I feel this a little", 2: "I feel this somewhat", 3: "I do feel this", and 4: "I do feel this strongly"). In order to examine the effect of each interaction style on the product experience, participants were asked a set of open-ended questions to gather rationales behind their Likert-scale responses. Figure 9 illustrates the questionnaire used in the study.

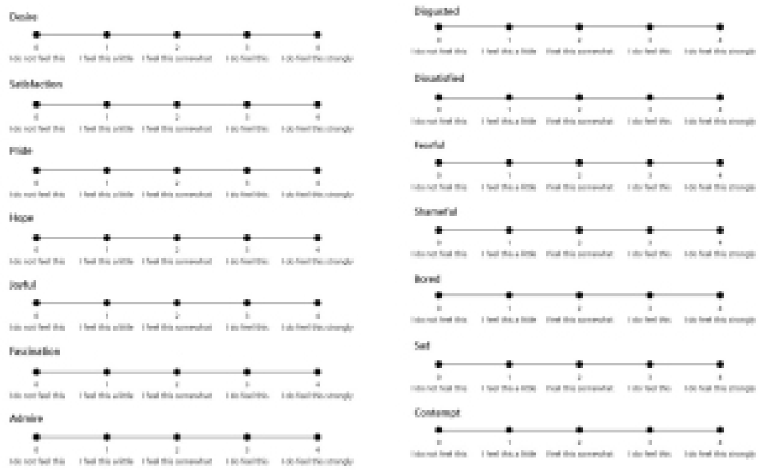

Figure 9 Survey questionnaire

2. 4. Participants & Procedure

A total of 20 subjects participated in the study (n=20). Student participants were recruited from the authors' research institution, varying in their majors to limit the influence of educational background. The average age of participants was 24, with a range of 20 to 28. The sample group consisted of 9 males and 11 females. Figure 10 shows the procedure for the experiment.

Figure 10 Procedure of experiment in brief

Participants were first provided the two prototypes in random order. For each prototype they were given two minutes product interaction time. Participants were then told to fill in the questionnaire and record their responses using the Likert scale response items. Upon completion of the first session, participants were given a short break and the process repeated. After the participants completed the interaction with both designs, they engaged in an interview session to discuss their response to the Likert-scale questionnaire. These sessions typically lasted five to ten minutes (Figure 11).

Figure 11 Photo of experiment session

3. Results

3. 1. Quantitative Comparison

The participants' responses to emotional experiences for each of the two types of interaction style were summed and mean values calculated. Figure 12 illustrates positive emotional experience according to each type of interaction styles. The vertical axis provides results as mean scores, derived from the sum Likert-scale response across the 20 participants. The horizontal axis shows the seven positive response scales included in the survey (see also Figure 9 above).

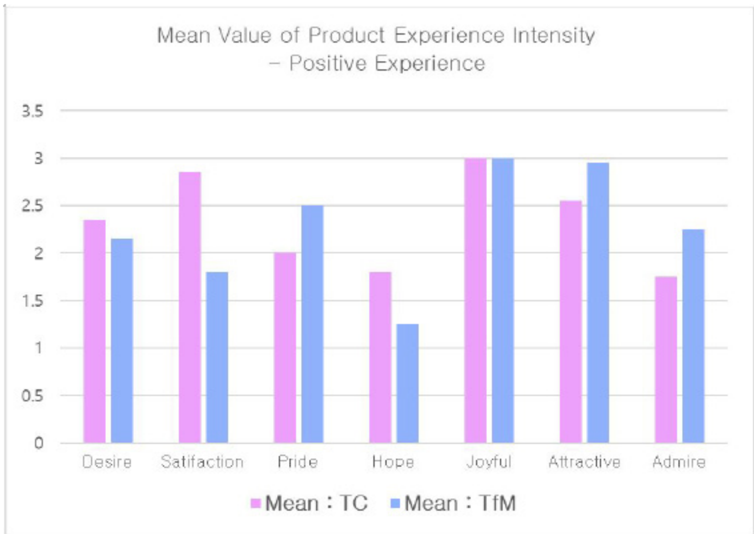

Figure 12 Mean value of positive product experience

As can be seen from Figure 12, The TC (tangible control) product interaction type received a higher mean score for response items: Desire, Satisfaction and Hope. In contrast, the TfM (touch free magic) attracted higher mean responses for items: Pride, Attractiveness and Admire. Of the TC interaction's higher Mean response scores, Satisfaction received the greatest difference (TC, m=2.85, TfM, m=1.8), followed by Hope (TC, m=1.8, TfM, m=1.25). This would indicate the TC interaction type provided a more satisfying mode-of-use compared to TfM interaction. Moreover, the TC interactive type also appeared to provide greater opportunities for feelings of 'hope' in interaction compared to the TfM interactions. For the higher Mean response scores of TfM interaction, Pride (TC, m=2.0, TfM, m=2.5) and Admire (TC, m=1.75, TfM, m=2.25) received the greatest difference, followed by Attractive (TC, m=2.55, TfM, m=2.95).

Figure 13 shows the mean values of negative emotional experience for each interaction style. Likewise, the vertical axis provides mean scores from the sum of Likert-scale responses from participants, while the horizontal axis shows seven negative response scales included in the survey.

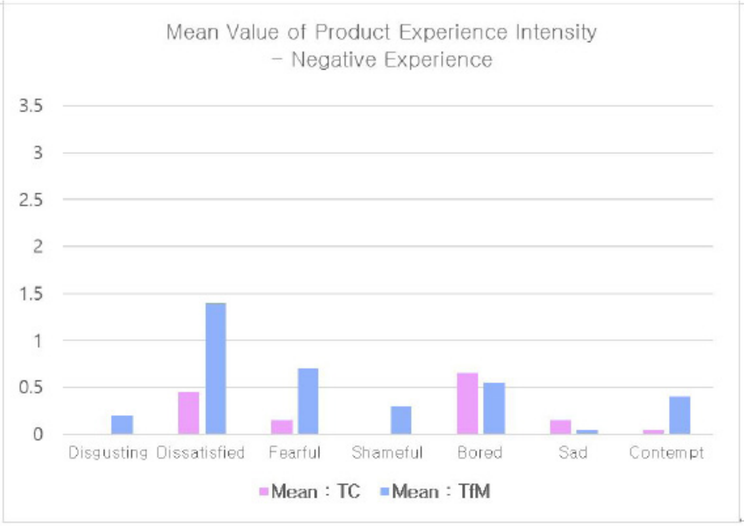

Figure 13 Mean value of negative product experience

As can be seen in Figure 13, The TC product interaction type received a higher mean score for response items Bored and Sad. However, the TfM interaction style attracted higher mean responses for the majority of items: Disgusting, Dissatisfied, Fearful, Shameful, and Contempt (Figure 12). Of the TC interaction's higher Mean response scores, Bored received the greatest difference (TC, m=2.85, TfM, m=1.8), followed by Sad (TC, m=1.8, TfM, m=1.25). This would indicate the TC interaction type elicits boredom compared to the TfM interaction. Moreover, the TC interactive type also appeared to also elicit a 'sad' response compared to the TfM interaction.

On the other hand, of the TfM interaction's higher Mean response score for Dissatisfied received the greatest difference (TC, m=2.85, TfM, m=1.8), followed by Fearful (TC, m=1.8, TfM, m=1.25). This would indicate the mode-of-use of TfM interaction type was dissatisfying for users compared to TC interaction. Moreover, the TfM interactive type also appeared to provide participants with a greater fear of mode-of-use misleading the product.

3. 2. Comparison of Interactions in Positive Product Experience

A Mann-Whitney U Test was conducted to see whether there was a significant difference in positive product experience between TC and TfM interaction styles. For each of the 7 attributes of positive product experiences, interaction styles were independent variable, and the intensity of positive product experience was dependent variable. For the significance value gained from Mann-Whitney U Test, the exact significance value was used, since the asymptotic results may not be valid. The result showed that, among 7 attributes, there was a significant difference in Satisfaction ($U=75$, $p<0.01$), or that the intensity of Satisfaction was significantly higher in TC (tangible control) interaction. The rest of the attributes tested showed no significant difference between two interactions.

Likewise, a Mann-Whitney U Test was also conducted for the negative product experience indicators to see whether there was a significant difference between TC and TfM interaction styles. Each interaction styles were assigned as independent variable whereas the intensity of negative product experience was dependent variable for each 7 attributes of negative product experiences. Likewise, the exact significance value was used for the result of the Mann-Whitney U Test as asymptotic result can cause statistic errors.

Result again showed that there was a significant difference in Dissatisfaction ($U=86$, $p<0.01$) and Shameful ($U=150$, $p<0.05$). In other words, the intensity of both Dissatisfaction and Shameful was significantly higher in TfM interaction. The rest of the attributes showed no significant difference between the two interactions.

To further examine statistically significant differences, the qualitative data gathered through final interview was analyised. The qualitative data was useful to see rationales behind participant responses, as the emotional experience itself can emerge from factors besides the interaction style.

The majority of participants gave higher scores for TC in item Satisfaction and higher scores for TfM for Dissatisfaction, which means they found TC more satisfying and felt more dissatisfied with the TfM interaction.

Subject 16 was satisfied with TC interaction's natural mode of operation and gave higher scores in Satisfaction, commenting, "I feel more satisfied with this because the interaction is more natural". On the other hand, Subject 16 commented on TfM interaction as, "This shows less credibility than the one with the knob (TC)." exhibiting dissatisfaction with the interaction. Subject 18 also graded TC's Satisfaction higher because of its intuitive mode of use, commenting "I feel more satisfied with this because it's more intuitive." However, Subject 18 was less satisfied with TfM interaction, commenting, "In order to interact with this you have to think a bit. That's making me feel less satisfied."

Another emotional attribute that showed significant difference was Shameful, which was relatively high in TfM interactions. "I felt ashamed because when I first got this, I didn't know what to do with this." Subject 13 commented that the ambiguous functionality of TfM interaction makes users feel ashamed, while the functionality of the TC counterpart is clearly expressed with its knob controls. Subject 16 also commented about the shameful emotion emerging from TfM interaction, insofar as he doubted whether the product would function properly or not make users ashamed. "If I ever buy this (TfM) that would look pretentious and silly, because buying this is like spending money on something that's doubtful whether it would work or not."

4. Discussion and Conclusions

This paper has attempted to explore how mode-of-use innovation may be best applied to interactive products to trigger meaning innovation. In a research-though-design approach, two different interaction styles TC (tangible control) and TfM (touch free magic) were designed, prototyped and employed as stimuli in an empirical study. The two different prototype stimuli, with corresponding embedded interaction styles, were used to derive emotional responses from participants through five-item Likert-Scale questions. Qualitative data was also gathered through interview at the end of the empirical study. Statistical values of emotional response to each of the two prototyped interaction styles were compared and results tested through a further statistical analysis. The implications of statistically significant differences between the two interaction types in terms of Likert-scale responses were further explored through the qualitative data.

Result showed that, of positive emotional attributes, TC interaction elicited responses indicating a higher degree of satisfaction, hope and Desire. In contrast the TfM interaction elicited responses indicative of greater pride, attractiveness and Admiration. In terms negative emotion, TC interaction attracted responses indicating greater bored and sadness, while the TfM interaction suggested an increased intensity of disgusting, dissatisfied, fear and Contempt compared to the TC interaction. Further analysis was conducted to test for statistically significant difference in participant responses towards the two interaction styles. Among the aforementioned emotional response items, the TC interaction showed significantly higher satisfaction, while the TfM interaction indicated significantly higher responses for the emotion indicators of dissatisfaction and shame. This parallels the result from the comparison of mean values. Among the positive emotions response items, satisfaction showed the greatest difference in mean, while among negative response items, dissatisfaction indicated greatest difference between the two interaction styles.

These results indicated that whether the interaction style gives users satisfaction may be a key criteria for appraising mode-of-use innovation within the interactive product context. That is not to say that satisfaction is not important to other product categories, only that it may be of particular importance in situations requiring interaction with interactive products and devices.

If satisfaction is derived from a usefulness appraisal (particularly within the interactive product context), a nonconscious evaluation of an event as to whether it supports or obstructs users in achieving their goals, appears critical to the perceived success of the interaction. As Desmet (2011) indicates, products can be appraised as helpful for reaching these goals, but if the sequence or relationship between interaction and resulting product reaction is hindered, users can experience frustration (Desmet, 2011). While intuitively, the TfM interaction was new to the participants compared to TC, this newness may not have translated into feelings of satisfaction as it hindered the participant’s ability to achieve their interaction goal.

Those considering mode-of-use, as described by Rampino (2008) as approach to drive innovation in the interactive product space, would do well to consider the particular requirement of interactions to achieve a desired product reaction unambiguously, and as related to the user's assessment of usefulness.

The statistical data further illustrated the finding that participants perceived the TC interaction as more helpful in achieving the pragmatic goal of elimination and variation in both intensity of light and color. This was compared to the TfM's more impeding interaction. The qualitative data from the interview supported this as participants complimented TC's intuitive mode-of-use while commenting that TfM was an interaction that one has to "think a bit about" in order to achieve its purpose.

The interaction of TfM, intended to give awe and surprise through its mode of interaction, as its name "touch-free magic" suggests, also hindered and frustrated the participants. From these results it can be inferred that, in the application of mode-of-use innovation in the interactive product context, particular consideration must be made to how novel and unique interactions must be balanced through clear understanding of how interactive opportunities achieve a desired product function.

Another finding from our results is that although ambiguity could intentionally be imposed upon an interaction, such attempts can also be considered as inappropriate. For example, results showed that the item Ashamed is significantly higher in the TfM design compared to the TC interaction. Participants gave the response in the interview session that the TfM's affordance being hidden for the sake of awe and surprise rather baffled them, hence blaming the potential of making users "look pretentious and silly". This indicates that pursuing solely surprise through interaction style also runs the risk of resulting in a product that is assessed as inappropriate in its use. This may also be compounded by the fact that interactive products often quickly evolve in their methods of interaction. Within this evolution, understanding interactions becomes of paramount important to users due to the pace of change. Experiential qualities of products are becoming more important for market success, and therefore companies may innovate their business by aiming to deliver specific experience (Schifferstein, Kleinsmann & Jepma, 2012). Concentrating upon mode-of-use innovation through new interaction styles may appear at first an effective way to embed mode-of-use innovation within interactive products. However, this approach can also lead to frustration and ultimately the evaluation of a product that is more gimmick than innovation.

In this study, we discussed how the mode-of-use lever can be best applied to trigger design-driven innovation in the interactive product context. For this, prototypes were built according to the generic interaction styles and users' emotional responses were sought. Since innovativeness is a holistic notion which encompasses all three levers mentioned (form, technology, and mode-of-use) assessing the holistic innovativeness of interactive products may be harder to focus on the effect of particular lever. This study therefore measured the multitude of qualities associated with mode-of-use innovation instead in order to isolate the effect of particular attributes (i.e. mode-of-use.).

However to extend this work into holistic innovativeness of interactive product requires further research, as HCI researchers also have provided related works on the remaining two levers (for example, Djajadinigrat et al.[2000] mentions appearance as one requirement of aesthetic interaction.).

Despite our results, the study has some limitations. For example, the emotional response obtained from the study may be time sensitive. That is, emotional responses to certain products could change over time, and users may feel unexpected emotion from their product usage. The time dependent nature of emotional experience was not accounted for in the current investigation.

Moreover, the framework used in this study leaves room to be revisited. Buur & Stienstra's (ibid) framework of generic interaction style is primarily focuced upon the analysis of the history of interactive styles, starting from products in the 1930s to contemporary interactive products. Therefore it successfully bridges HCI principle and traditional industrial design. However, it has the limitation that emerging interactive technology cannot be taken into account as it relies on historical analysis. Extending their methodology to state-of-the-art interactive products could provide a more precise framework.

Although the study of use innovation within the interactive product space remains a work-in-progress, results provide certain implications for knowledge of use innovation (basic) and helpful considerations for designers in practice (application). To provide interaction designers a guideline for innovative interaction design, further studies are now required to examine the effect of interaction styles upon design-driven innovation. For example, how do other interaction styles implicate responses towards use and function when applied to interactive products? What role does experience (of interaction) have in defining a response (positive or negative) to interaction and what effect does this have for feelings of innovativeness? How can mode-of-use innovation best be achieved within the context of interaction design, considering its requirement for clarity in terms utility and function? By carrying out this research designers will be better able to navigate the often contradictory requirements of expected functionality and unexpected novelty within the design of more innovative interactive products.

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