Interaction-Driven Design: A New Approach for Interactive Product Development

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ABSTRACT

As a new approach to interactive product development, we found possibilities in interactions themselves as the starting point of a product development, and propose a concept of *interaction-driven design*. We focused on the movements in interactions, such as users' input behaviors and feedback movements from the system's output. In this paper, design patterns and their characteristics for three different interactive product development approaches, including our newly proposed one, were examined through an ideation workshop: 1) user-driven product development, 2) technology-driven product development, and 3) interaction-driven product development. We were able to see that results for the development of interactive products differed depending on the combining order or the linking patterns of factors such as form, function, and interaction. Interaction-driven product development opens up a wider range of linking possibilities compared to the other two approaches.

Author Keywords

Product Development, Design Thinking, Design Approach, Movement of Interaction, Interactive Product Design

ACM Classification Keywords

H.5.2 [User Interfaces]: Theory and methods

General Terms

Design

INTRODUCTION

In order for a product to be successful in the market, its distinctive factors compared to many competing products must attract consumers' interest [12]. Consumers in the past considered the functional distinctions of products to be an important factor. However, since the year 2000, functional variations of products slowly disappeared as the technical differences between companies shrank [6]. In addition, smart devices nowadays can no longer be differentiated by their appearance. They are designed with big screens, which take up most of the space, and just a few buttons. Therefore, the interactive aspect of the product has started to play a huge role as the main differentiation factor [33]. This is also the factor that determines the quality of user experience. When users are given one identical function with two different interactions, they go through a completely different experience [35]. This phenomenon can be seen in products such as iPod, Wii, and Kinect which are successful in today's market.

In the interactive product design paradigms in the field of Human-Computer Interaction (HCI), interaction is considered to be a tool for establishing a specific user goal. Researches in HCI have until now focused on how systems can "support" users in satisfying their needs [28]. Especially in the field of design in HCI, the human-centered design paradigm took the lead, and the methods used focused mostly on finding out the user's latent needs [29, 48]. These needs, found from user research, are more suitable for developing a specific service or function rather than developing the interaction capability of a product.

For this reason, interaction was considered subordinate to technology or users' actions and it has not received attention as a driving factor for product development [28]. But in recent studies, interactivity is being defined as a factor that is independent of users and technology [25]. More research is being carried out to search for characteristics related to interactivity. Interactions receiving attention in [8, 14, 16, 18, 23-25, 27, 33, 39, 43, 44, 50] are seen as non-functional aspects, and the focus of these studies is on the shape of the interaction [23].

In this context, we proposed a new design approach for designing products by exploring product functions and domain initially from proposed interaction concepts, not from user's needs or technological factors. The meaning of the concept of interaction referred to in our research will be explained later in the paper.

STARTING POINTS OF INTERACTIVE PRODUCT DEVELOPMENT

As shown in Figure 1, we defined the components of an interactive product as user, interaction, and system [7]. Traditionally, users and technology have been considered to be key driving factors of new product development [2, 45, 47, 49]. These key driving factors, called user and technology, can each show up as user needs in use context

DIS 2012, June 11-15, 2012, Newcastle, UK.

and technology which makes it possible for system. For example, the user-driven product development process starts by discovering unknown user needs as sources for design. Such methods in user-driven product development for discovering user's latent needs are being developed and used in the marketing and design fields. User-driven product development mentioned in this study refers to the product development process based on user needs rather than a method; it is not a matter of users' participation such as current definition of participatory design [17, 40, 42]. A technology-driven product development process starts by applying newly developed or invented technology to product ideation.

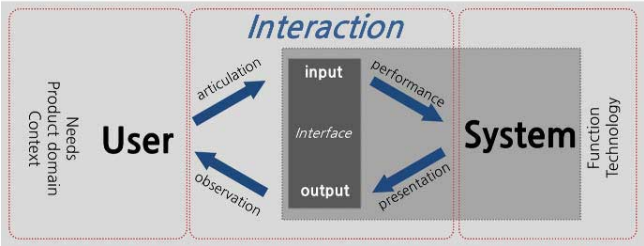

Figure 1. Structure of interactive product

An interaction, on the other hand, is being defined as an independent factor that is not a part of users' needs or technology [25]. This has opened a new approach to product development. For example, a project, developing OUI (organic user interface) [22], was carried out with the developer first asking the question "What functions will the product have when the interface is bendable, and what's the product domain?" From this perspective, there only exists a concept that implies there are deformations in the interface (interaction concept). It does not suggest what functions or what domain should be developed into a product. Technology also does not exist.

Now, it is possible to see that there are three starting points for new product development: user's needs, technology, and interaction concepts. In this study, the three approaches were defined as follows:

- User-driven product development: Starting point of product development was led by analyzing the user needs from their context.
- Technology-driven product development: Starting point of product development was led by possibilities of technological implication.
- Interaction-driven product development: Starting point of product development was led by exploring product opportunities through interaction concepts.

The way we define it, interaction-driven design, has served as an implicit approach within the HCI practice for quite some time. We believe that it is important to make this approach explicit as a way to improve research, to strengthen the rigor and discipline in the research, and as a way to make a common research approach visible and recognized.

In this study, in order to explore the potential of interaction-driven design, through extensive workshops, differences among the design processes led by three types of starting points were examined.

STARTING WITH INTERACTION

Definition of interaction as movement of interaction

As shown in Figure 1, we view interactive products as a cyclic process where users and systems have conversations. An interaction carries the basic components—i.e. user and system—and, input and output. Also, the input and output transformations occurring between each factor are defined as articulation, performance, presentation, and observation.

Articulation is an action by users to the interface where users use the function of a product. Performance is a process where interface delivers the stimuli to the system from users. For instance, it can be explained by the signal delivered from a remote controller to a television. Articulation and performance are considered as an input in interaction. In contrast, the rest of the elements are considered as an output. Presentation is a process where a system delivers the result to the output device, and observation is a process where users recognize the stimuli from the output device [7].

Because the definition of interaction covers all phenomena between systems and users, inputs and outputs, it was necessary to clarify the idea of interaction by breaking it down and subdividing it. According to Lim, et al. [25], interaction in the field of HCI was being discussed in the following four categories; (1) interface styles, such as WIMP (widows, icons, menus, and pointing device), (2) forms of interface devices, such as tangible interface and graphic user interface, (3) actions that are supported by interfaces, such as instructing, conversing, navigating, and browsing, and (4) object-based concepts, such as spreadsheet applications designed by following traditional ledger sheet forms. We focus on the principle that most products are tangible and that nature requires one to hold them, move them and operate its functional parts [14]. This tangible characteristic is a very important factor not only for interaction but also in using the product itself. Among various interaction factors, this characteristic is closely related to a form and an action. In order to learn relationship among functions, forms, and actions, Jensen et al. [16] suggested that considering user actions first would be a good strategy. Because this study pays attention to these possibilities, actions that are supported by interfaces can also be seen to fall within the definition of interaction.

Interaction as we are defining it in this study has the following three characteristics. First of all, interaction in this study has a non-functional perspective, because we are designing products by exploring product functions and domain initially from proposed interaction concepts.

Secondly, it deals with movements related to both users' actions and the system's ability to respond to the users' actions. Finally, it is independent from the media that represent these movements. These movements can be expressed in any forms of physical materials or visual graphics.

Based on these characteristics, interaction is defined from the perspective of the action which controls the interface. In other words, interaction is defined as movements, such as a user's input behavior in an interaction, and the system's output, known as feedback. Examples of this meaning of interaction can be shown as follows:

- Movement of user actions (articulation and observation in interaction): a user action for using a system or a service, and the user's input behavior in the interaction with the system or service.
- Movement of a system (performance and presentation in interaction): movement from the mechanical structural parts of a product, movement from the material of a product as feedback.

Many studies on movements in a non-functional interaction are being carried out in the field of aesthetics of interaction (choreography of interaction). According to Djajadiningrat, et al. [9], these studies are being carried out in a few directions. They include the studies that focus on the narrative aspects of movements by using interactions as carriers of ludic value [32], the aesthetic aspects of users' physical actions (movements) [5], and the meaning of products' movements [20]. These studies have different purposes and processes than our study, which will use movements of interaction as the starting point of new product development, and to search for ideas about new product categories and functions.

Related Works

Although interaction has not been clarified as the starting point of product development, cases and methods where interaction was the core of the product development process have been found. Current interactive product design cases and methods (Table 1) can be categorized in several approach-categories. The first category is to find new interaction styles for current function (e.g. rich interaction, interaction relabeling, product personification method, hands-only scenario, designing behavior in interactions). The second category is to find needs and interaction styles from reenacted users or use contexts (e.g. extreme characters, experience prototyping). The third category is to find needs using new technological factors (e.g. technology probe). The fourth category is to find user values with designed products (e.g. design by tangible stories). The fifth category is to identify interaction qualities (e.g. interactivity attributes, soft(n)). The final category is to design from specific interaction qualities (e.g. rhythm as a starting point for design, El Ball del Fanalet or Lightpools).

Cases	Description
Rich Interaction [13]	Removed buttons manipulating the product, and proposed an interaction method that carries out its functions through higher physical movement rates of product and structures.
Interaction Relabeling [8]	Methods of extracting ideas by relating interactions (mechanism) of two non-related products while designing a product interaction.
Extreme Characters [8]	Extracting ideas by creating an extreme character for users.
Experience Prototyping [4]	Drawing interaction ideas by creating and experiencing use situation.
Product Personification Method [35]	Methods of finding a suitable interaction by giving characters to products. (Characterize interactivity → Set relations between a user and a product → Organizing conversation between a user and a product → Finding actions suitable to the product)
Technology probe [15]	Understanding the opportunity of a technology having interactions by observing how the new technology is being used by users in an actual environment
Design by Tangible Stories [32]	Designing a physical interaction by creating stories with imaginary samples related to the product being designed, and by relating it to a function giving unexpected fun.
Hands-only scenario [16]	Extracting ideas about new interaction methods through properties of product materials used for a tangible interaction design
Designing Behavior in Interaction [39]	Creating a movement (behavior) through a choreographer and applying it to the actual designing product (lamp).
Towards an Articulation of Interaction Aesthetics [21]	Aesthetic interaction qualities defined as pliability, rhythm, dramaturgical structure, and fluency. Among them, the rhythm introduced as a starting point for design
Interactivity Attributes [23]	A new way of conceptualizing and designing interactive artifacts is proposed that emphasizes the importance of articulating sophisticated qualities of interactivity for promoting the design of aesthetic interaction
soft(n) [41]	The concept of somaesthetics as an approach to the design of expressive interaction was explored. This concept is exemplified through the design process of soft(n), an interactive tangible art installation developed
El Ball del Fanalet or Lightpools [34]	El Ball del Fanalet or Lightpools, a Virtual Reality (VR) artwork follows the interaction-driven VR application design strategy.

Table 1. Interactive product design cases and methods

Most of these approaches do not provide a holistic point of view about the product development process. The applications of these approaches are limited to some specific parts of the product development. These approaches are mostly used for gaining interaction ideas suitable to the existing functions of a product. This also makes it hard for designers to consider new category products. It is also hard to design an interface by needs from reenacted contexts. Also, in the cases of finding user needs through current functions, it does not provide any idea of how the new interaction will turn out.

Our point of view has similarities with the fourth category, in the sense that an interaction is given in the beginning by designers. But its difference from those approach, which search for user values with finished design results (e.g. prototypes), is that it has a needs-searching approach based on movement of interaction during the design development process. Our approach is a design process led by interaction, which can connect every process naturally, from finding needs, to the ideation stage.

Also, in the sixth category, Löwgren [21] introduced Bloom, a generative music application designed by Brian Eno and Peter Chilvers for the Apple iPhone that uses rhythm as a starting point for design. Rhythm can be a dominating factor in the musical domain of interaction, however, based on the fact that interaction is the starting point of product development, it implies that the suggested approach of this research has the closest similarity. Parés [34] suggested the interaction-driven virtual reality (VR) application design strategy in El Ball del Fanalet or Lightpools. They emphasized and demonstrated the possibility and the potential of interaction as a driving factor for developing such an application as opposed to the content-drive strategy. Although Parés also used the term interaction-driven, this approach seems to be closer to *interface-driven* instead of interaction-driven.

For the previous research by one of our authors [23] that was in the fifth category, the results from their study of exploring how the concept of interactivity attributes affect the way of thinking and designing in interaction design through the comparison with the conventional interaction design approach further enhanced the potential of the approach we propose in this paper.

The approach we wish to propose in this study is a design approach that can search for user's values, needs and functions through the exploration of movement within the proposed interaction concepts. The approach also considers all the information discovered naturally during the entire design development process. This is not an approach for finding ideas about the movements in interaction after one has already decided on the functions. We have adopted the concept, i.e. *form and function follows interaction*. This differs from the common methods that try to find out what kinds of movements will be best for a product's interaction. Our approach, unlike the traditional interactive product development approaches based on the traditional product development drivers, such as users and technology, starts with the concept of interaction and actualizes its way into the area of users and technology. It can be seen as a design approach based on interaction concepts.

DESIGN PATTERNS OF THE THREE STARTING POINTS

To figure out the possibilities of the interaction-driven design, and to understand which requirements our approach needs to have, we looked to see how the interaction-driven design approach is different from the other general product development approaches, namely user-driven product development and technology-driven product development.

Definition of Design Pattern

In this study, we examined differences in design activities with different starting points. Design activity can be described by several perspectives. Dorst and Dijkhuis[11] used five frameworks for comparing design activity as follows; designer, design problem, design process, design knowledge, and example model. This study focuses on design process among five frameworks. Analysis of the design processes [3, 26, 36-38, 46, 51] was preceded by seeing how the elements of interactive products, such as form, function, and interaction actualized, and in what ways they linked [18] together. Repeatable sequences and paths [31] in ideation process have been defined as the design pattern.

Research Design

We devised an experiment in which we explored the differences among the ideation processes that are initiated from the three different starting points; namely, movements in interaction which correspond to our interaction-driven design; and the two others, that are, user needs for a user-driven design, and new technology for a technology-driven design.

From the ideation point-of-view, there are two important things to be considered in identifying the differences among them: 1) understanding the characteristics of the ideas from each approach, 2) understanding the thinking processes of these approaches. For this, we carried out an ideation workshop having three starting points (user, technology, interaction) for design ideation, and the thinking processes among the different participants were compared. We did not ask them to use any specific design method (e.g. technology probe etc.) so that the processes they followed could instead be based on pure design thinking rather than being influenced by a particular method's rules.

Figure 2. Workshop settings and ideas extracted from the workshops

Nine paid participants volunteered for the study. One was female. Average age was 29.4 years (*sd* = 3.0). All of the participants' majors were industrial design. Nine graduate-level participants were divided into 3 teams with 3 members in each team. In each team, there was at least one member who had experiences as a professional designer. Participants were given a goal to design a personal mobile device, and to develop a product in a new product category other than currently existing smart phones and smart pads. Also, their ideas had to include the purpose of the product, user's needs, functions, and detailed interaction methods.

In each team, all three participants were given 40 minutes of ideation time at the start of the workshop. Then, they had 30 minutes to share, discuss, and develop their ideas together. Ideas were to be written down in their notes to share the flow of their thinking process from the starting point to the point where the ideas became concrete. After sharing their ideation, for about 20 minutes, a focus group took place to discuss their ideation process. The important questions asked were as follows: 1) What was the hardest/most difficult part of this type of ideation process? 2) What parts of the ideation process do you think need to be improved to help get better ideas? 3) In what situations of design do you think this type of ideation process will be useful? (What parts did you like about this type of ideation process?) 4) What are overall impressions when thinking about the connection and relationship among interactions, technical factors and user's needs during this type of ideation process?

Figure 3. Examples of the starting points: user's context (left) and technological factors (right)

Information about the starting point was shown on the screen in a Microsoft PowerPoint format so that the participants could see them throughout the workshop (Figure 2). When user's needs were set as a starting point to see the ideation pattern for a user-driven design approach, the first information was given in the form of context to the user, and designers were to first extract needs and think of suitable ideas by referring to their similar experiences. User's contexts given were: moving (walk / public transportations / car), learning (class / researches), resting, playing, leisure activities, exercise, and self-development. These contexts were chosen to help designers easily relate to their everyday life experiences (Figure 3). In the case of technology as a starting point, the given technological factors were 3D related, networks related (Wi-Fi etc.), touch, flexible and transparent displays. Finally, in the cases having interaction as the starting point, movements of interaction such as spinning, shaking, bending/unfolding, rolling, throwing and catching were provided (Figure 4).

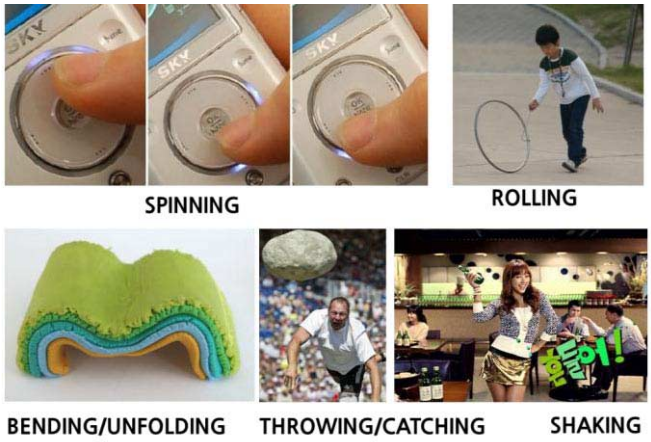

Figure 4. Examples of the starting point: Interaction

For the analysis on the ideation workshop, verbal protocol analysis was used [1, 10, 46]. Opinions gathered throughout the focus group were used to define characteristics, and pros and cons of each design pattern.

User-driven Design Patterns

Figure 5 indicates the patterns of ideation based on user's needs. Most of the UCD (User-centered design) methods are focused on how to find user's needs. After that, function requirements of a product are listed up from discovered needs. User-driven design patterns may also be seen as general design patterns of UCD.

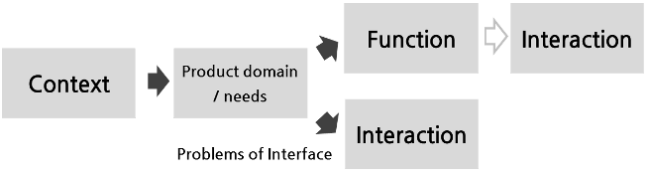

Figure 5. Ideation pattern based on user needs

Problem solving of existing interface

The level of user's needs can be classified as function-related or interaction-related levels. It was possible to see that user's needs related to the interaction aspect of a product were mostly related to the needs that can be discovered from usability tests. There were patterns of extracting interaction ideas to help improve the interface problems that were carried by currently used devices. For example, the left image of figure 6 indicates solutions to a problem that one remote controller cannot control many products. In order to do so, pointing function has been added in the remote control to point devices and pointed devices have been arranged to work manually. The right image of figure 6 is a layered interface of E-book readers. Due to the possibility where physically written memo may cause interference, in order to avoid this matter while interacting, memo layered has been added to manually turn on and off.

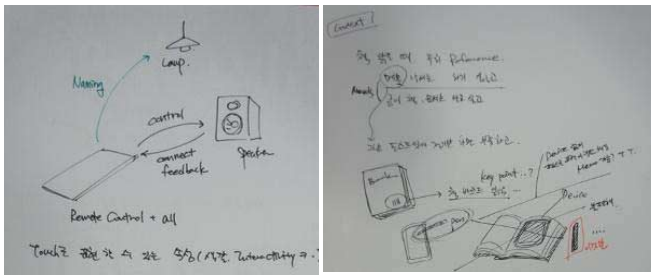

Figure 6. Sample Solutions to the problems of current interface.

Performing new functions with existing interaction styles

All of the ideas proposed by the participants were product designs with applications of currently existing interaction styles (Figure 7). When looking at the detailed patterns of ideations, it was possible to see non-existing functions came from needs in the user context. However it was hard to extract ideas regarding a new interaction style for these functions. This was a phenomenon created because the new functions were controllable with existing interaction styles. This was discussed in the focus group and the participants mentioned that this was the result, because there wasn't any data that could be used to get an inspiring idea regarding new interactions.

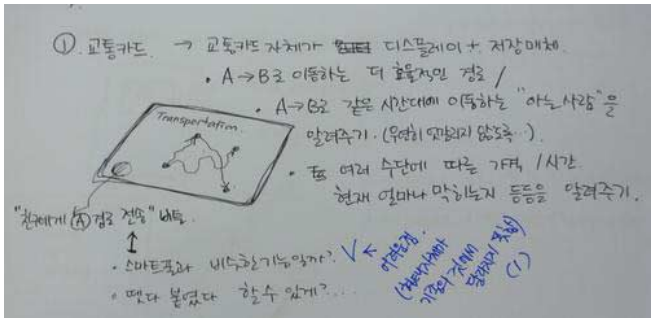

Figure 7. Performing new functions with existing interaction styles: a participant created car-full function for transportation. This function was based upon currently existing touch interaction.

Interactions with difficulty in satisfying various functions

Difficulties in interaction designs were shown. It is difficult to find an interaction idea that can perform or carry out more than one function. The user-driven approach has limitations, which cannot overcome the problem solving for current needs. By looking at the patterns extracted from these approaches, it was possible to see that ideation based on needs was more suitable in generating the ideas for new functions rather than in innovations of interactions.

Technology-driven Design Patterns

Figure 8 indicates the pattern of ideation process when the starting point of design is new technology. Starting out from technology shows two different sub-patterns depending on the characteristics of the technology, namely, function-related or interface-related.

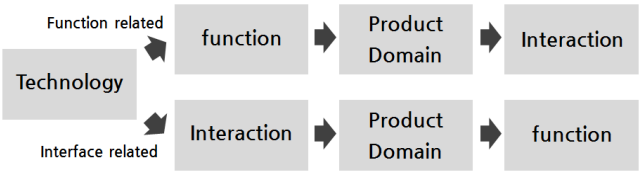

Figure 8. Ideation pattern based on technology

Totally different approaches depending on the characteristics of technology

The biggest characteristic of an ideation process based on technology was that the patterns clearly changed depending on the characteristics of the technology. There was a first link with the function of a product when the technology seemed to have a deeper connection with the functions of the product, such as networks. On the other hand, when the technology seemed to be forming an interface, such as with touch technology, and flexible displays, the first link was product domain and needs, which led to discovering where these interfaces were actually going to be used. (Figure 9)

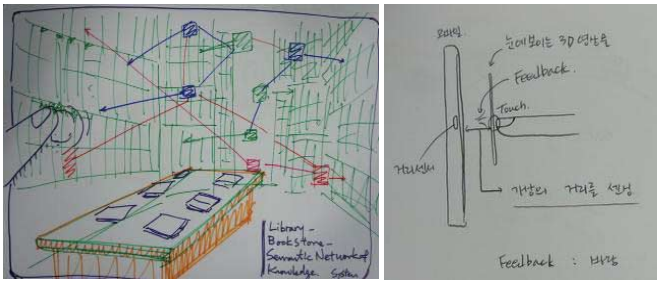

Figure 9. The left picture is an information system for a library. The ideas from function-related technology show service or product level thinking. On the other hand, the picture on the right is from interface-related technology. This idea shows an interface level thinking.

Complications in extracting detailed ideas

When approaching with an interface related technology, it was not easy to think of a detailed interaction using only technical factors. It was hard to find a connection between a specific function and interface technical factors such as "bendable display," or "touch is allowed." It was hard to predict which detailed interactions and functions could be drawn. Figure 10 indicates ideas from technology can draw existing interaction method. It has difficulties of creating detailed ideas. The left image of figure 10 explains the possibility to imply GPS and transparent display in the cockpit of an aircraft which merely indicates the necessity of integrating technical character to the domain. Image on the right of figure 10 shows the idea which expresses the status of individual by applying display to the t-shirt. This also was limited to the technological character where it is linked to the product domain.

The result seems to be caused by the difficulty of thinking towards detailed functions based on the interface-related technology. Thus, without identifying detailed movements

of interactions, merely considering the broad domain of interface technology implication will mostly like to limit the potential ideas of functions.

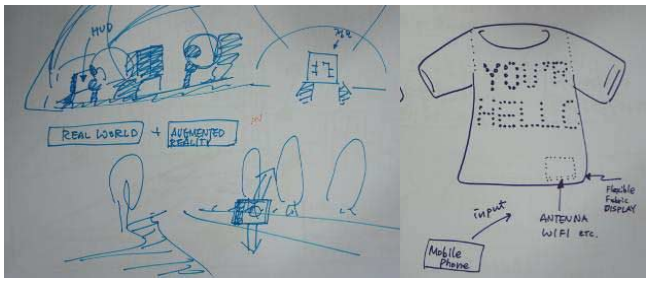

Figure 10. Ideas from technology can draw existing interaction method.

Interaction-driven Design Patterns

Lastly, this study examined the patterns of the ideation process based on the movements of interaction as the starting point for designing an interactive product (Figure 11). Comparing it with the other two approaches, movements created the greatest amount of possible links, such as definitions of movements, contexts related to actions, interactions of different products, possible form factors (physical structure) and etc.

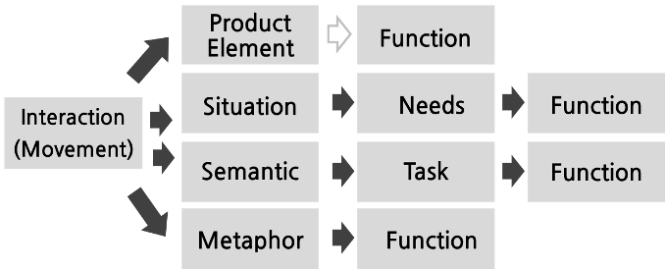

Figure 11. Ideation pattern based on interactions

Finding the product element to apply movement

The first pattern the participants showed involved recalling an existing product and suggesting ideas about where in the product the given movements will be applied. And then, they attempted to find out which functions would be suitable for these movements. For Example, participants tried to apply rolling or spinning movements into product form factors such as hinge, and explored the potential usages such as rolling hinge for recharging batteries (Figure 12).

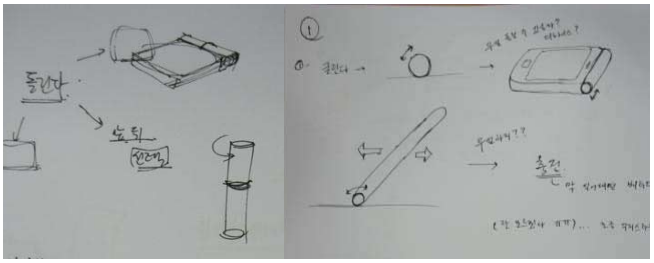

Figure 12. This is the process of applying rolling or spinning movements into the hinge and exploring the potential use.

We were able to see new functions being extracted based on this. This finding also resonates the design patterns realized by the methods of interaction relabeling [8].

Interaction as a tool to bring up memories of experiences

Movements of an interaction brought back memories of related situations. For example, in the case of something being thrown, participants recalled memories of throwing their mobile phones in the past, and it was possible to connect them to user needs (Figure 13). It showed that it was possible to use movements as tools to bring back memories of experiences in the past.

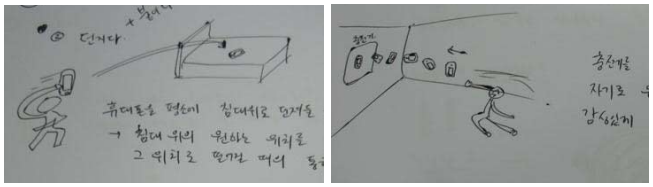

Figure 13. Needs were inspired by certain situation such as past experience of throwing mobile phone to bed which is relevant to interaction of throwing and catching

Semantics of movements

Participants had an understanding about the semantics of movements. For example, we were able to see a participant mapping these movements with tasks carrying out the functions of a product (Figure 14). This participant recognized shaking movements as canceling or resetting something. (Through the focus group, we were able to find out that this participant did not know about these interactions being used on iPhones.) These patterns were similar to those studies on applying studied definitions of gestures to interaction [20].

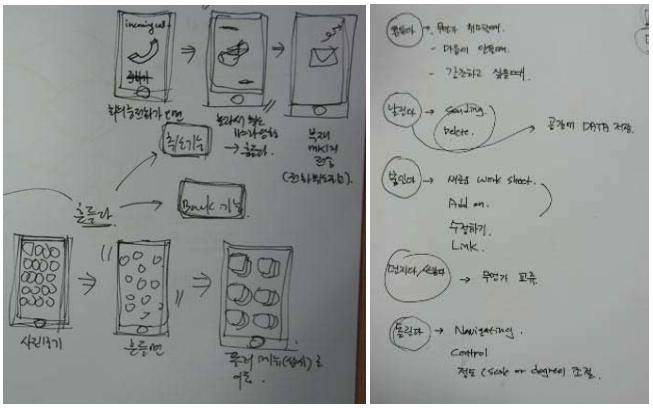

Figure 14. It was found that participants were listing the meaning of interaction where given ideation was starting.

Thinking about products with similar movements of functions

The last pattern was that the designers find a product with similar movements, and apply the function of that product to the product being designed. For example, a participant who saw the movement "going in" associated a key entering a vault and applied these functions in the locking system of the product (Figure 15).

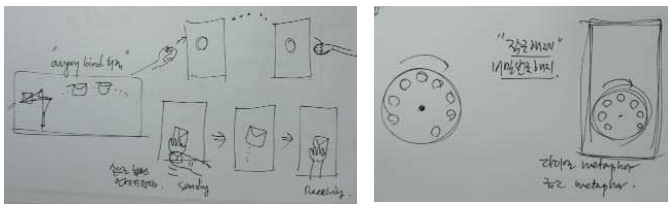

Figure 15. Thinking about products with similar movements of functions

DISCUSSION

Design patterns vary based on its starting point

Through these analyzed data, we were able to see that results differed depending on the linking patterns, or on the order of the factors being combined together. Also, it was possible to see that the aspects of ideas differed depending on what the driving factor was, even when the combining sequences were partly identical. For instance, in both user-driven and technology-driven approaches, the ideation of interactions is usually followed by the product domain and needs identification. However, in the user-driven approach, solutions were derived by problem solving in the interface, whereas in technology-driven approach, interaction idea was linked by designers' intuition without particular rationale. Most of the interaction styles shown in these approaches already existed. This pattern resonates the results from [23]—i.e. the new interaction style ideas tend to be more generated for the cases where the interactivity attributes were the starting point of interaction design.

Interface- related technology

A significant finding in the technology-driven design pattern is that this pattern can be divided into the function-related and the interface-related technology. The interface-related technology means the technology that is used for an input or an output in the interactive product [30].

In the field of engineering design, the term of technology-driven product development is close to functionality and its performance [19]. In other words, the pattern of function-related technology shows the conventional meaning of technology-driven design. Unlike this conventional one, interface-related technology may need to be considered as non-functional one because interface-related technologies such as flexible displays can lead to the ideation of movements of interaction rather than specific functions. In this regard, this interface-related technology can also be applied for the interaction-driven design approach.

Possibility of interaction-driven design for innovation

Our findings showed that innovation on an interaction level may not easily be achieved by working out with user needs and technology. This seemed to be because product development with driving factors such as user's needs and function-related technology, gave limited information for product function and interaction ideation. In particular, interaction seemed to be rather the subordinate factors of functions.

However, when interaction is used as a driving factor, it is possible to actualize factors of a product with all of its possibilities opened. In this case, product development based on interaction opens up a wider range of linking possibilities compared to the user's needs or technology-based product developments, and it creates discovery in an unexpected area instead of only in a problem solving area. This may mean that it is better suitable for an innovative interactive product development approach.

CONCLUSION

In this study, a product development approach based on interaction movements, rather than on technology, and users, was proposed. Throughout our experiments, we analyzed the results with the thought of form, function, and interaction as a combination. In terms of ideation, multiple existing links can be a positive aspect of ideation based on movements, because it opens up more possibilities.

By looking at the opinions from the focus group participants, the advantage of product development based on the interaction concept is that the interaction concept inspires specific functions in design thinking process, not the other way around. It seems more suitable for the product design with strong interaction concepts. However, participants also mentioned that in the case of products with complicated functions, it is not easy to actualize a product directly based on one interaction concept.

Based on interaction-driven design patterns, our approach seems to have possibility to be applied to design practices as follows. First, the suggested interaction concept can be applied to a universal navigation task of interface by the semantics of its movement (instead of the application to the task of each specific function). The wheel navigation task of iPod can be an example of this case. Secondly, it can be used in designing some specific functions of a product, which may likely to go along with an interaction metaphor such as Bloom (thinking about similar movements or functions). Thirdly, it can be used in simple and tangible product development. The product's physical element applied to the movement of interaction can be linked to the product's unique function. At this point, the functions found by the same interaction can guide towards the opportunity to explore new category of a product. Lastly, it can be used as stimuli or tools for user research process [28] or for designers inspiring ideas in ideation because the movement of interaction could recall user needs of certain situations.

ACKNOWLEDGMENTS

We first like to thank all the participants of our study. We would like to thank Minjung Sohn, Boram Lee, and our colleagues in the HCIDL (Human-Centered Interaction Design Lab.) who gave us many useful comments. We also wish to thank the DIS reviewers for their helpful comments and suggestions. This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2010-0023206).

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