A Practical Method for Design for Affordances and Its Implementation

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Affordances play critical roles in making interactions, both for products and for services, successful and meaningful. Affordances are perceived by human from affordance features, structure elements of the artifacts. Earlier, the design for affordance method has been proposed where repository of affordance features are used. First affordances are identified through function-task interaction matrices or use activity observations. Using affordance feature repository where many alternative structural elements for a specific affordance are stored together with corresponding design constraints and contexts, affordance features for those identified affordances are retrieved considering similarities between the target design constraints and context and those of the affordance features in the repository. Using the clues given by such affordance features, the new affordance feature is to be designed through an analogical reasoning. In this paper, implementation results of the design for affordance method proposed earlier are described together with analysis of design processes using this method. Practicality of the method in delivering design results with enhanced affordances has been demonstrated as well. A sketch to acquire design process characteristics with big enough participants has been made toward enrichment of the proposed design for affordance framework.

Key words: *Affordances, Design for Affordance, Affordance Features, Analogical Reasoning*

1. Introduction

The characteristics of products and services that induce natural activities of people, namely affordances, play critical roles in making interactions successful and meaningful. That is, affordance is the message that induces human activity, and perception and judgment aspect of human activity is tightly related with affordance. While the importance of affordances have been emphasized (Gibson 1979), (Norman 2002), not many systematic methodologies to design in such affordances have been developed. A systematic method, called Function-Task Interaction (FTI), to identify affordances using the interaction between functions and tasks has been proposed by Galvao and Sato (Galvao & Sato 2006). Maier et al. introduced affordance-structure-matrix for evaluating what affordances are embedded in each component of a product. This matrix can illustrate correlations of affordances and also of components (Maier et al 2007). The notion of affordance features, structural elements of artifacts that provide affordances, has been utilized in (Murakami et al 2006), (Kim et al 2008), (Kim et al 2009), (Lim 2011) and (Kim et al 2011).

Recently, Kim proposed a practical framework of design for affordances (Kim et al 2012). The proposed framework is composed of three major steps. First affordances are identified for the given design problem. This

can be done in a few different ways including FTI method. The output of the first step is the list of affordances. The first step is marked by 1 Fig. 1 illustrating the framework. Then using the repositories of affordance features where multiple affordance features for a given affordance are compiled, affordance features for each affordance identified in step 1 are browsed as marked by 2 and 3 in Fig. 1. Then affordance features of a given affordance are selected considering design constraints and context of those in the repository so that those affordance features with design constraints and contexts similar to the current design constraints and contexts are used in the subsequent process as noted by 4 in Fig. 1. The second step includes the selection of affordance features in the repository. Using the clues given by such affordance features, the new affordance feature is to be designed through an analogical reasoning. The last step in this framework is then the analogical reasoning step that converts the source affordance features in the repository into the target affordance features to support the affordance of the current design problem as noted in Fig. 1 as the transformation from 4 to 5.

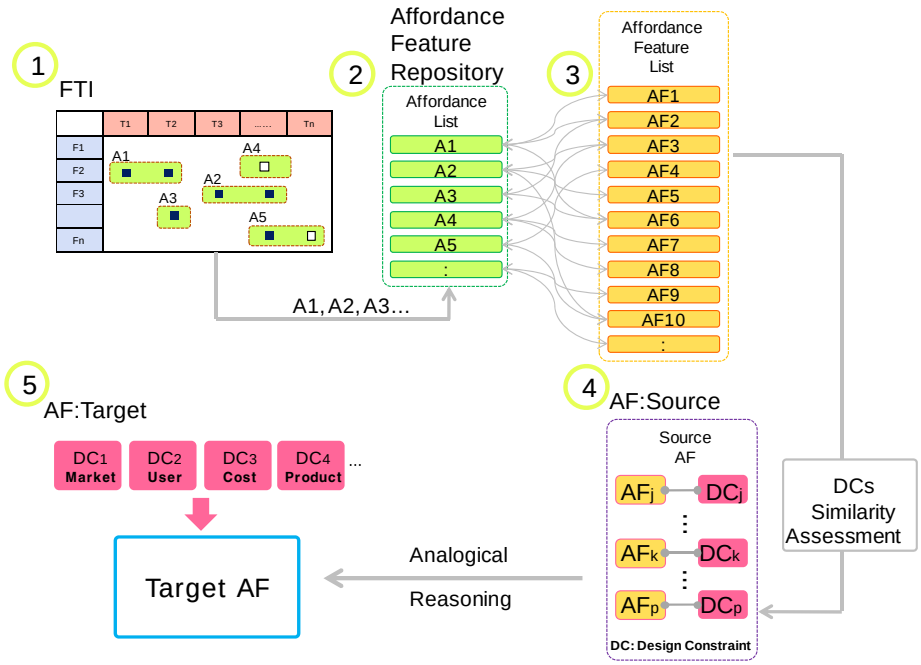

Figure 1. Design for affordance framework (Kim et al 2012)

The facilitation of the proposed design for affordance method is made by well-prepared affordance feature repository where affordance features and the corresponding design constraints and contexts are properly described. Before using the repository, the step of affordance identification should be done by the designers with thorough function and task analysis. The creative process of analogical reasoning from the source affordance features into the target affordance features would be done in many different ways reflecting the corresponding designer's design approaches. Some comparison of design processes in this framework has been reported in (Kim et al 2012) where design steps of several designers have been recorded and analyzed through interviews with designers. An experimental implementation of the proposed design for affordance framework has been reported where 36 participants redesigned a luggage carrier (Kim et al 2013). In this paper we briefly describe the design process and the implementation experiment together and discuss about the potential approach to obtain the process

information effectively on implementation cases so that information for design process and design knowledge can be acquired.

2. Design Process Using the Design for Affordance Framework

2.1 Design for Affordance Experiment

To illustrate the design for affordance framework, a simple product design experiment has been conducted. Affordance identification using FTI has been done and presented to the designers and the affordance feature repository in the form of software has been provided with guidance to use them to make their final design. The design process of each designer has been recorded using tablet sketch pad synchronized with think-aloud narratives. Once each designer finished her design, a retrospective interview has been done to capture designer's intent and reflections. By observing the design processes, the process characteristics in this method could be understood.

In the experiment, the task was to re-design a tumbler, a portable coffee cup. Four designers designed their new tumbler by using affordance feature repository. Design process could be divided into four stages. These stages included activity review, concept ideation, detail development, and final sketch. Each designer's process is depicted in two different ways: Sketches made in the design for affordance process are shown in a time sequence. Then, source affordance features used are shown together with corresponding sketches in the second depiction. In this way, the design process flow can be easily observed in the first depiction, while specific reasoning clues are identified where source affordance features are shown together with target sketches (Kim et al 2012).

2.2 Protocol Analysis of Design Process

After the four designers' experiment in designing a new tumbler, a protocol analysis was conducted to understand details in their design behavior. The coding scheme for the analysis is composed of eight design activities as needed in the process of design for affordance using affordance feature repositories: Understanding Task (UT), Analyzing Affordance (AA), Activity Review (AR), Browsing Repository (BR), Referencing Source affordance feature in the repository (RS), Conceptualizing Idea (CI), Sketching (SK), and Not Applicable (NA) as shown in Figure 2.

Design for affordance process diagram can be obtained from the analysis using the coding scheme. Note that the designer conducted the function-task interaction matrix method to identified affordances and was so familiar with the affordances that she did not need to return to analyze the affordances more than in the begging. While the designer's activities of BR, RS, CI, SK and AR appeared repeatedly, NA activity appeared sometimes with somewhat lengthy SK activities. These are due to the operation of Sketch program required saving and re-sketching, and should be treated extrinsic to the design for affordance process. The long SK at the end corresponds to final touches to make sketch clear.

A more concrete process pattern can be observed as in the early part of the segment A-3 in the figure. A pattern of design activities composed of BR, RS, CI, and SK in sequence can be identified as shown in Figure 2. This pattern repetitively appears in the other segments of every Designer's design process. By associating the design for affordance activities with specific design sketches and used affordance features in the repository as shown in Figure 3. Here the pattern of BR, RS, CI, and SK has been identified in many segments of all four designers.

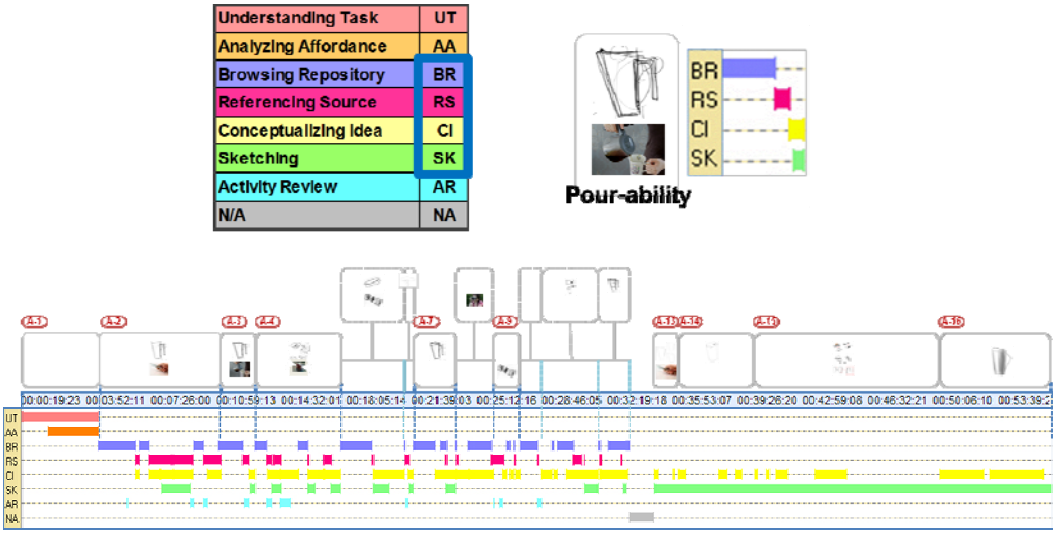

Figure.2 Protocol Analysis of Design for Affordance Process

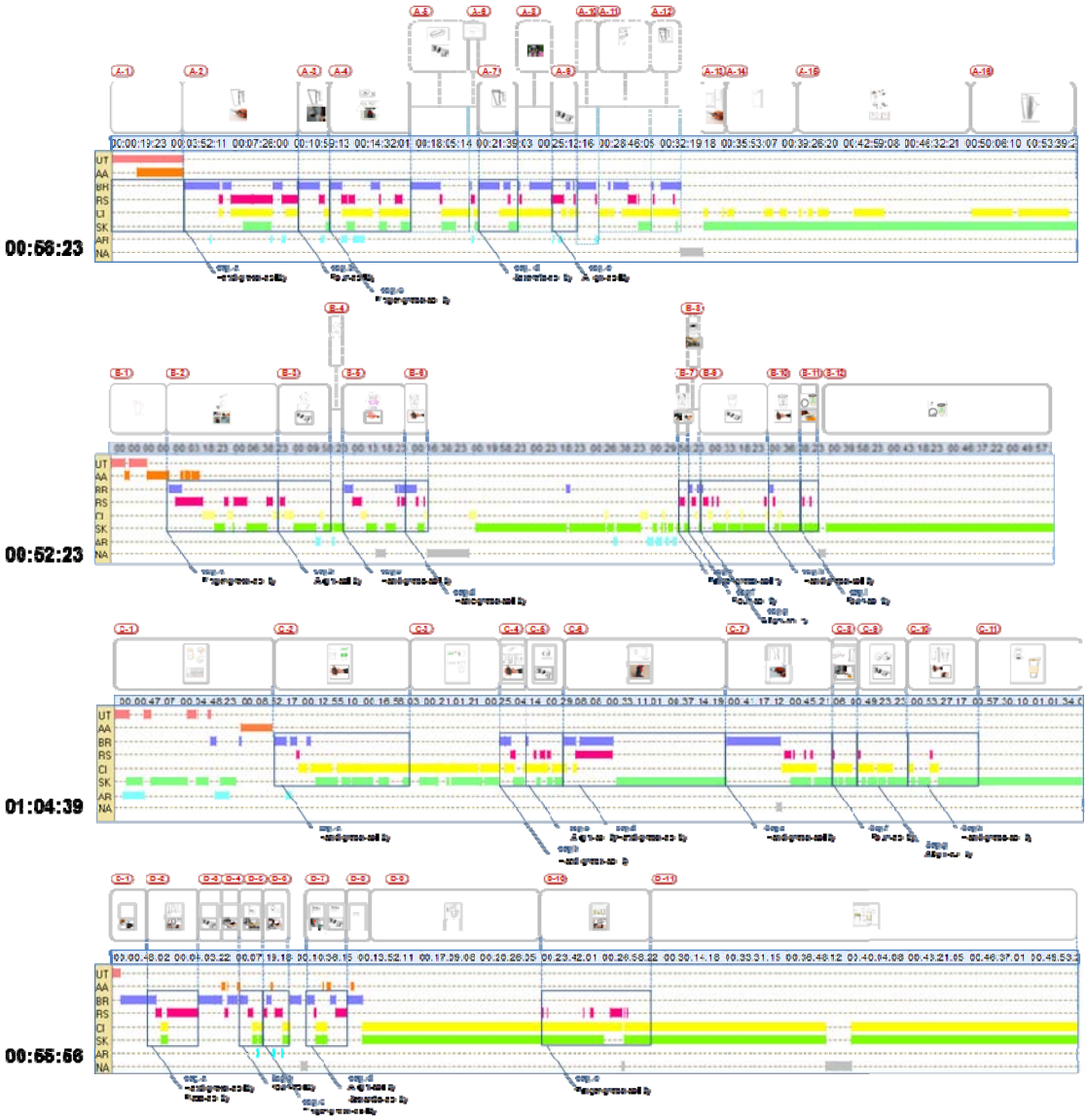

Figure.3 Protocol Analysis of Design for Affordance Process of Four Designers

3. Implementation Experiment of the Design for Affordance Method

To illustrate how the design for affordance framework proposed is to be used by typical designers, a product design implementation experiment has been conducted (Kim et al 2013). In the experiment, the task was to re-design a hand carrier cart. Nine affordances have been identified using FTI and the affordance feature repository in the form of sticker photos with a limited number of affordance features per affordance has been provided for the simplicity in an experiment implementation, with guidance to use them to make their final design. Once each designer finished their design, a brief retrospective interview was done to capture designer's intent and reflections. Twenty eight students with different major fields such as mechanical engineering, system engineering, consumer science, design and architecture and six designers with experiences participated. The design time duration of experiment was limited to 60 minutes. After the thirty four participants' experiment in designing a new hand carrier, the level of analogy of the affordance feature sources of the repository and targets in their final sketch have been evaluated for those 9 affordances.

An example of final sketches is shown with explanations of source affordance features and analogical reasoning. This sketch received the best score out of 34 sketches. Four affordance features of new hand carrier such as for hand grasp-ability from the handle of the chin-up bar, place-ability from the bottom surface of the computer mouse, move-ability from the wheel of the bicycle and steering-ability from the handle of the hand cart were evaluated as direct analogy as shown in the Figure. In case of the affordance feature of contain-ability, the bottom of new hand carrier was designed as flat shape which could contain without the limitation of size of objects derived from the cart for the grocery market. Referencing the structure of the grill support in the repository of support-ability, the supporting part of hand carrier was developed to the foldable support net which could support diverse sizes of objects. The participant got an idea from the scale in the repository of stabilize-ability and the handle design which could make stable balance during moving was devised by extending the part of handle to access from the sides as well as from the middle-top. These 3 analogical reasoning cases received 3 points and make much improved carrier cart design (Kim et al 2013).

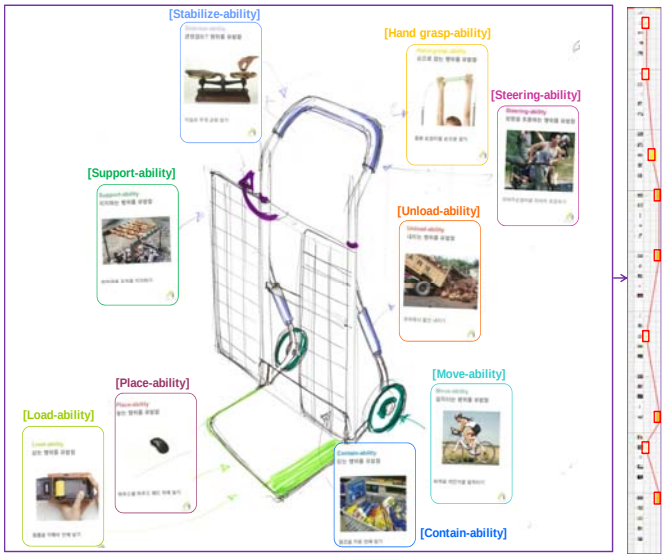

Figure 4. Example of Final sketch and score result

An important observation that those affordance features in the repository that are similar to the given design task of hand carrier in their context and constraints were used more than those with very different contexts and constraints. This confirms that similarities between the contexts of source and target have been evaluated in choosing source affordance feature from repository. Also a lot of new good design proposals for hand carrier carts have been made. This was because good affordance feature designing was enabled by the proposed design for affordance method using repository. While the utility of the method has been confirmed, information on design process has not been obtained as no process information was captured in the sketch with just source affordance features in the sticker-based repository.

4. New Approach to Understand the Design Characteristics of the New Design for Affordance Framework in Realistic Design Situations

It is desirable to understand the process characteristics such as (1) how designers address affordances, for example, sequentially or holistically, (2) browsing behaviors when using affordance feature repository, (3) selection decision in choosing a potential source affordance feature to be transformed to a new affordance feature, for example, how concrete they compare similarities of source and target constraints and contexts, and (4) analogical reasoning behavior in converting source affordance feature to the target. In the previous experiment of protocol analysis, the designer participant size was maintained small enough to conduct thorough protocol analysis. On the other hand, in the previous implementation experiment with 34 participants, not much of process information was captured and analyzed with only the overall design results and simple association of the final design with affordance features in the repository. Design environment where some design process aspects can be captured without relying on think-aloud method would be needed. If some meta data of the use of the affordance feature repository are to be captured as well as those in target affordance features, some process characteristics in the design for affordance framework could be obtained. Sketch results captures before and after affordance feature repository usage would be useful as well. Use of affordance feature repository with such meta data capture would accommodate a big enough number of designer participants. Also a hierarchical and systematic context-based activity modeling (Kim & Lee 2011) would help understand the similarity comparison process when choosing source affordance features.

5. Conclusion

A new design for affordance framework has been proposed where repository of affordance features are used. First affordances are identified through function-task interaction matrices or use activity observations. Using affordance feature repository where many alternative structural elements for a specific affordance are stored together with corresponding design constraints and contexts, affordance features for those identified affordances are retrieved considering similarities between the target design constraints and context and those of the affordance features in the repository. Using the clues given by such affordance features, the new affordance feature is to be designed through an analogical reasoning. Two experiment studies with different goals, that is to understand design process and to validate the utility, have been briefly summarized. Further implementation efforts to enrich

the proposed design for affordance framework so that it can be practically used are needed. One approach toward this would require a design environment where meta data of the use of the affordance feature repository can be captured together with design results change before and after the use of the repository. Also tutorial style workshops on the new design for affordance method would be meaningful to further validate and disseminate the method.

6. References

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