A Collaboration Support Tool for Multi-cultural Design Team Based on Extended ADT Model

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Abstract. In design field, collaboration is a crucial key method which leads to widen conceptual design idea. Collaboration helps us to share our knowledge together and concert idea in a design process. We also can share diverse viewpoints among collaborations. In this paper, a collaboration support system which based on extended ADT model, TTS method ADT is proposed. ADT model is a representation model for conceptual design. It is used for grasping artifacts as a communication medium between designers and users. The process of observing, sharing and creating design plans are represented through the extended ADT model. During an observation process, three influential factors: physical factor, emotional factor and cultural factor are observed with diverse viewpoints. Each process is visualized and shared by using TTS method by using visual information such as idea sketch, note and photo. By using this tool, designers in a team can visualize their idea, share it with others, and create novel design plan which based on multi-cultural background. An example of design process with TTS method is given in order to show the efficiency of proposed method.

1 Introduction

A questionnaire survey is one of the most commonly used methods conducted by designers when they try to explore users' opinions and needs. However, it is difficult to investigate the users' potential needs which are not conscious clearly by the users with the questionnaire survey method. Observation is a useful method of a design process to understand users' various types of users' needs. Matsunami et al. [1] emphasized the importance of observation of users' requirements in their daily life. Regarding the importance of observation, Kelly of IDEO [2] has noted "Seeing and hearing with your own eyes and ears is a critical first step in improving or creating a breakthrough product." Kang et al. also have indicated that observation is one of the most powerful methods to find out users' potential needs. Consistent with these previous studies, there are many other studies that discussed roles and values of observations in a design process (especially User Centered Design (UCD) field). However, it has not been known the researches in which the ways to observe, share, and apply the information into the design plans are studied. It is difficult to make use of the collaboration if the results of

observation could not share enough in a team. Thus, designers should consider not only relationship between designer side and user side, but also relationship in design team members for creating better design plan. For instance, Kang has produced several international design workshops and has found out that diverse viewpoint in observing process help to discover the users' various needs, which include potential needs [3]. In these workshops, each group consisted of participants who have a different nationality and major. Different nationality could lead to diverse viewpoints from their different experiments. Many new discoveries would be expected on the observation process through diverse viewpoints. Actually, many participants in the design workshops could not conduct an observation and share the observed information effectively. Some groups could obtain rich information from their observation but they could not share and apply the observed information adequately into their design plan. In this paper, a design process supporting method for sharing the observed information with group members and applying the information to create new idea is discussed.

2   Collaboration in Design Process

In designing process, the concept of diverse viewpoints is one of the most important factors which may contribute to create novel idea. Generally, human gains knowledge through experiences. Thus, a team in which each member has diverse experiences should have high possibility to create variable idea. According to James, different viewpoints in an observation are very important in a creative process [4]. Brown and Wyatt [5] have emphasized the importance of observations with multi- disciplinary team in design process. Kiyokawa et al. [6] have reported that personal characteristics influence process of knowledge activation in a creative work. Such diverse viewpoints in an observation process could find out unexpected users' needs. However, the personal viewpoint, which is formed through one's experiences, is hard to change suddenly. In order to expand conceptual idea, collaboration is an approachable key method for facilitating achievement. Collaboration is a process where two or more people work together with sharing their idea. Collaboration leads to widen possibility domain of design solution. Fig. 1 illustrates the basic idea.

In this figure, A, B and C indicate designers who have different backgrounds. Each circle indicates the sets of solutions as an innovation which can be reachable by a person. In this case, A, B, and C have different background, Such as different experiences, different knowledge and different skills respectively. Therefore, the expected outcomes of them are different with individuals, so the sets of reachable solutions are also different. This is a reason that the three circles do not overlap entirely with each other.

Assume the case in which A, B and C cooperate in a design process of C's context. The areas which indicated by white area means normal solution of C while gray color (A and B), mean additional knowledge, we call it prime solution for C. Collaboration helps the designers to share our knowledge together and concert idea in a design process. This situation may lead us to design new idea
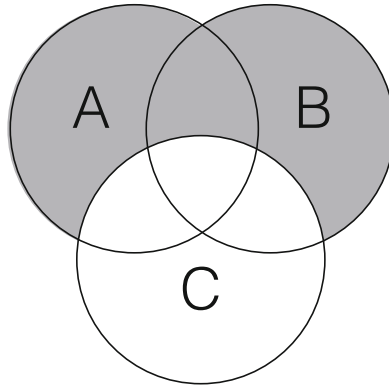
Fig. 1. Reachable solution areas of A, B and C

based on broaden concept domain. The above situation can be described as the following formula:

$$R = (A \cup B \cup C) \tag{1}$$
$$P = (A \cup B) - C \tag{2}$$

R means the set of whole reachable solutions under collaboration of A, B, and C, and P means the set of prime solutions for C. Collaboration manner in which the designers can reach many elements included in P is required for an effective design process.

3   Developing an Education Material

In this section, collaborative design based on the extended ADT model is conceptualized. Furthermore, a collaboration support tool based on the extended ADT model, TTS method, is proposed.

3.1   ADT Model

The Alethic/Deontic/Temporal (ADT) model is a represented model for a conceptual design [7]. It is used for representing an artifact which can be regarded as a communication medium between designers and users. Fig. 2 illustrates the framework of ADT model. This model consists of three layers; base layer, main layer, and top layer. The base layer represents causal relations which are caused from physical laws, mechanisms, and structures. This layer reflects the target user's environments. The top layer represents operational restrictions from designer's intentions. Instructions or warnings from the designers are described on this layer by using modal logic expressions. The main layer represents state transitions caused from operations. The possible operations for the users are
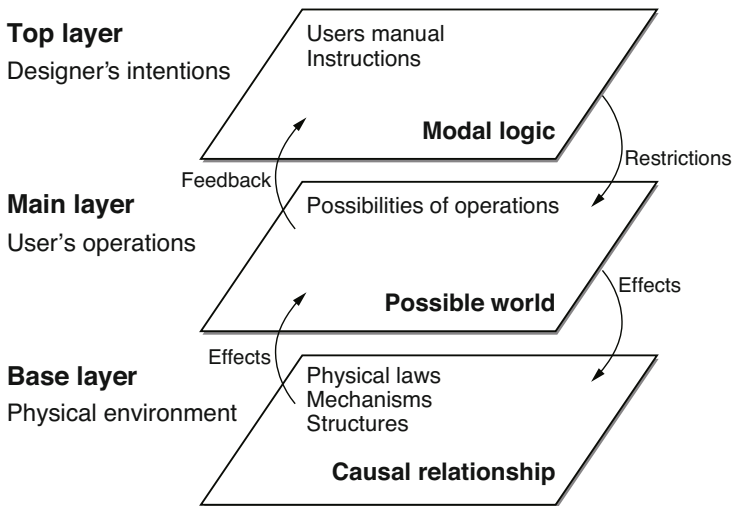
Fig. 2. Structure of ADT model

expressed on this layer. The interaction among the three layers illustrates interaction among designer, operator and environment. This model can be easily expanded to represent other kinds of systems by replacing the physical laws on the base layer with other ones [8].

3.2 Extended ADT Model

Generally, designers have own their own idea. The viewpoint of designers which have different background could be diversified. Therefore, the collaborative design which designers from various nationalities work together may expand possibility domain of design solution. This process let the designers cause awareness for prime solutions which are described in the previous section. To explain such situation, ADT model is extended for represents a concept of collaborative design as shows in Fig. 3.

On the base layer, restriction from environment is described. These restrictions are based on three factors: physical factor, emotional factor and cultural factor. The top layer represents designers' intentions which might be different depend on individual. The outcomes of their work are shown on the main layer. The circles on the main layer indicate the set of possible solution of each designer. As described in section 2, each circle does not overlap completely. With advantage of collaboration, the possibility of design domain is become broaden. Design works should convey designers' intention under restriction from environment. With the extended ADT model, we can understand the effects of collaboration in design process.
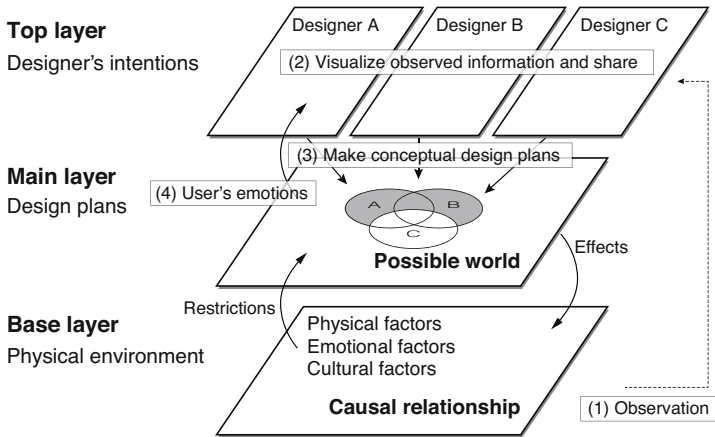
Fig. 3. Structure of extend ADT model

3.3   Collaboration Support Method Based on Extended ADT Model

Generally, conversation (language exchange) is a normal way to share own opinion and idea with others. Sharing with conversation is the handiest way because it does not need any tools. However, the conversation is likely be influenced by time series and is hard to conduct as a simultaneous work. Moreover, for multicultural design team, due to each member uses their own language, it is difficult to communicate and share information in the group immediately. Meanwhile, visualization is another promised way to share their opinions and ideas with others. By using the visualized information such as photo, sketch, and note are not affected by time series, is able to be conducted as a simultaneous work in the same time without a common language.

In addition, visualization as meta-recognition is very important in perceiving an idea in a design process [9]. Visualization as meta-recognition is a way to express own notion through the visualization such as idea sketch, note and photo. Beyond just expression tool, these idea-visualization tools are cognition tools as well. In addition, Takano et al. [10] proposed a tool for supporting conception by using the visualized languages of adjective, noun, and mimetic word in a group.

Thus, the authors have proposed a novel information sharing method for design process based on the extended ADT model to achieve information sharing in multi-cultural design team. This method is called TTS (Turning Thinking Sheet) method. The procedure of TTS method proceeds following schemata of the extended ADT model with drawing information on worksheets. Image of worksheet which is used in the method, turning thinking sheet (TTS), is shown in Fig. 4.

The TTS is used in process of observation, idea sharing and creating new design plans. Team members exhibit their own idea on TTS pages as visual information such as idea sketch, note and photo. TTS method is composed
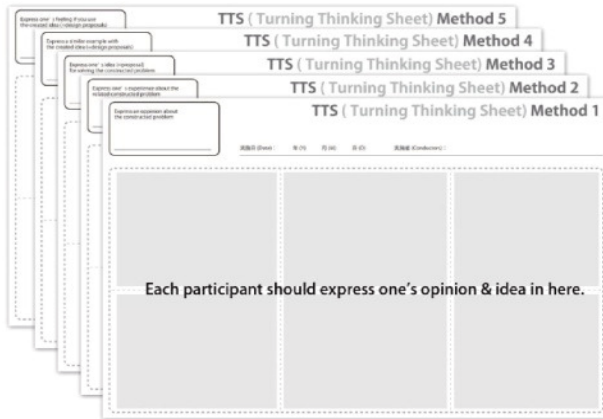
Fig. 4. Image of turning thinking sheet (TTS)

of the following four steps to make effective collaborative design with multi-cultural members:

Step 1 In the observation process, each member records the results of observation by using idea sketch, memo or photo on the first page of TTS.

Step 2 Members categorize observed data according to three factors (physical factor, emotional factor, and cultural factor) and record on the second page of TTS. Then, each member share own observed information via visualized information as meta-recognition approach.

Step 3 All members act in concert to sketch out conceptual design which fulfill the users' needs on the third page of TTS.

Step 4 On the forth page of TTS, members explain in which how users feel when users used their designed work. Every member has to show own opinion, experience, and idea on each TTS page and deliberate own TTS pages to all member in their team.

This process is corresponded to the scheme shown in Fig. 3.

4   Case Study

In this section, a design process with TTS method in a multi-cultural design workshop is shown as an example case. This workshop was held in Seoul, South Korea. Team members were students from Japan, China and Korea. The assignment given to the teams was "Eating in Korea." The TTS method was used in observation process, idea sharing process and designing process. Scenes of using TTSs in the workshop are shown in Fig. 5.

Fig. 5. Scenes of using TTSs in a multi-cultural design workshop

4.1   Observation

During the workshop, members instructed to observe cultures of South Korea. They found the following facts: (A) A tourist tries to taste different foods on one's journey; (B) Party with friends or family is always pleasant; (C) Koreans usually share a dish with others and they use chopsticks as utensil in their eating; (D) There are many side dishes in Korean food which, leads to a lot of space on a table are required and chopsticks set across plate of side dish are easy to fall into the table; (E) Sticking chopsticks into the food is considered as rude behavior in Korea.

4.2   Visualization for Sharing

The data from observation process were divided into three parts which are physical factor part, emotional factor part and cultural factor part. Consequently, each member shared own observed information with group member.

For the fact of (C) described in above section, a Japanese member pointed out that Japanese usually do not prefer to use their own chopsticks for share dishes. If the team consisted only Korean members, this idea should not come across because sharing foods with their own chopsticks is quit usual act for Korean. This fact was added on the TTS.

The shared information was generalized and reaaranged. The results of the sharing process are shown in Table 1.

Table 1. Observed information and the factor

Causal factors	Results of observation
Physical factors	(1) Many plates of side dishes need a lot of space on a table.
	(2) Chopsticks set across plate of side dish are easy to fall into the table.
Emotional factors	(3) A tourist tries to taste different foods on one's journey.
	(4) Party with friends or family is always pleasant.
	(5) Some people do not prefer to use own chopsticks for share dishes.
Cultual factors	(6) Koreans share the food with others.
	(7) Koreans use chopsticks in their eating.
	(8) There are many side dishes in Korean food.
	(9) Sticking chopsticks into the food is considered rude behavior in Korea.

4.3 Conceptual Design

After members shared their observed information within a design team, members considered all information together and drawn up design works which fulfills users' need. In this workshop, a team decided to develop an adjustable chopsticks for Korean food party. The rough drawing of the new chopsticks is shown in Fig 6.

The top of the chopsticks are made with magnets. The front parts of the magnets are attached to the right side of each plate. When users take some foods in the side dishes, users just change the top of chopsticks with the front part attached with the dishes. Then, take some side dishes to one's plate. After that, return the front part to the original position.
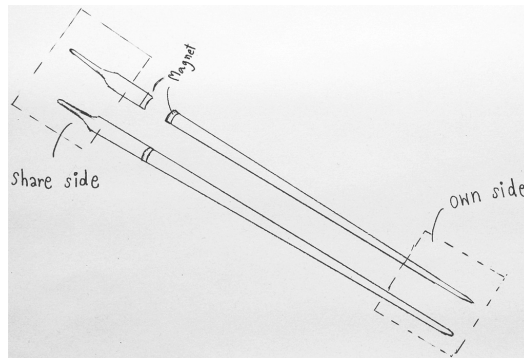
Fig. 6. Sketch of chopsticks for Korean food party

4.4 Considering Users' Emotion

The new chopsticks has been designed in order to help users to share side dishes on the table more convenient. The users can feel sanitary to share the food with others when using these new chopsticks. The new chopsticks are easy to used,
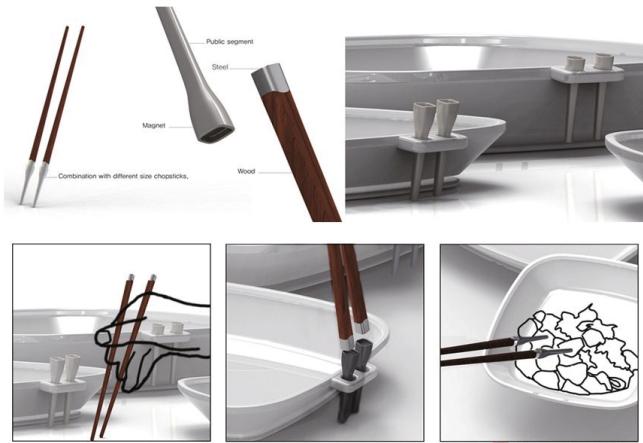
Fig. 7. Conceptual design of adjustable chopsticks

require just small space and do not obstruct the spoon of food. Moreover, with using these chopsticks, the table is become nice and tidy because we do not need to cross chopsticks on the plate of side dishes anymore. The conceptual design of adjustable chopsticks is shown in Fig. 7.

5 Conclusion

In this paper, the authors have extended ADT model for representing process of collaborative design. The model consists of three layers, base layer, top layer, main layer. The base layer represents restriction from environment which was divided into three factors: physical factor, emotional factor, and cultural factor. Designers' intention which may be different depend on individual is represented on the top layer. The main layer represents the outcome of design. The collaborative design can expand the possibility of design plans. In addition, a collaboration support method for design process, TTS method has developed based on extend ADT model. TTS method helps designers to understand users' situations and needs through observing three factors which are physical factor, emotional factor and cultural factor. With these factors, designer can find out users' needs including a potential needs which is difficult to be found out with the approach based on the questionnaire survey. An example in which the TTS method is used for collaboration among design team has been shown. The designers could find a unique design solution, in which multi cultural sense of values are reflected, with the proposed method.

Despite we can see the efficiency of the method, there are additional changes. The first, the format of sheets used in TTS method should be reconsidered. In the current study, a sheet used in each step has same format. Better format for collaboration should be developed. The second, designers have spent too times in first and second steps of TTS method. In order to easy to use, some procedures

which took long times should be modified by using electronic technologies, such as digital camera and smart phone.

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