A Proposal of Design Method of Obtaining the Construction Items of Mental Models in Product Design

Naoya Okazawa and Toshiki Yamaoka

Faculty of System Engineering, Wakayama University
930 Sakaedani Wakayama-shi Wakayama Japan
s155008@center.wakayama-u.ac.jp, yamaoka@ja2.so-net.ne.jp

Abstract. The purpose of this paper is to propose a method of obtaining a user's mental model and using it for design. It is necessary to consider a mental model in designing user-friendly products. However, little study has been done to use a mental model in the design process. A mental model can be defined as a system image and operation image which people have about the appliances. It indicated that people operate the appliances according to their mental models. In addition, mental models can be classified into two points of view of a functional model and a structural model. The proposed method uses a protocol analysis. In this study, we conducted a test about two products to verify the effectiveness of the method. The target products of the test are a digital camera and an electronic dictionary. As the results, the effectiveness of the proposed method was verified. According to the construction items of mental models in product design, Designers can feedback them the product design. Moreover, the proposed method can be applied to GUI design.

Keywords: Design, Mental Model, Applied Cognitive Psychology, Product Design, Graphical User Interface Design.

1 Introduction

It is necessary to consider a mental model in designing user-friendly products. However, little study has been done to use a mental model in the design process. Therefore, the intuitive designing without a mental model have been widely used. The purpose of this paper is to propose a method of obtaining the construction items of mental models and using it for design. The proposed method can be used not only product design but also graphical user interface (GUI) design.

First of all, a mental model can be defined as a system image and operation image which people have about the appliances. It indicated that people operate the appliances according to user's mental models. In addition, the mental models can be classified into two points of view of functional model and structural model. The functional model can be defined as model to understand "how to use it", and the structural model can also be defined as model to understand "how it works" [1]. In this study, the functional model can be defined as the image about the procedure for

the operation, and the structural model can also be defined as the image about the structure and the relations of the element of the appliances. Figure 1 shows an image of the functional model and structural model.
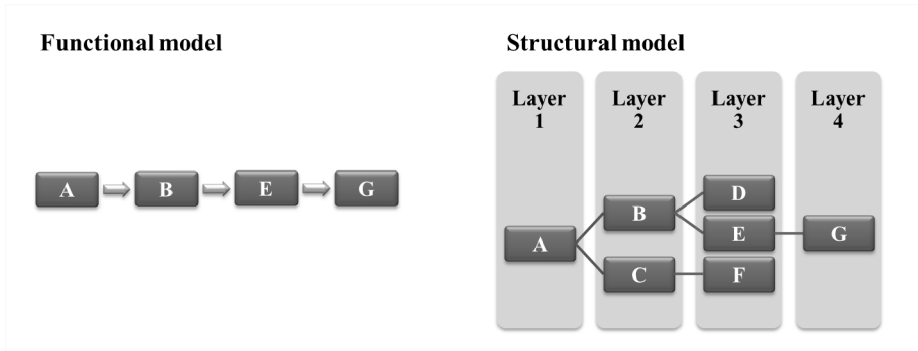

Fig. 1. Image of the functional model and the structural model

2   Proposed Method

2.1   Methods of Collecting Date

The proposed method is as follows
(1) Designers decide a target product and a basic task which participants conduct. Designers should choose the beginners about the product as participants.
(2) Designers divide a task into some subtasks.
(3) Designers conduct a test using protocol analysis. Then, they check the operational problems in the test.
(4) Designers observe the number of subtasks that the participant was able to do in the beginning, middle and the last of the test.
(5) Designers calculate a construction rate of the mental model from the subtask that the participant was able to do by each step (in the beginning, middle and the last of the test). Figure 2 shows the flow of the method from (1) to (5).
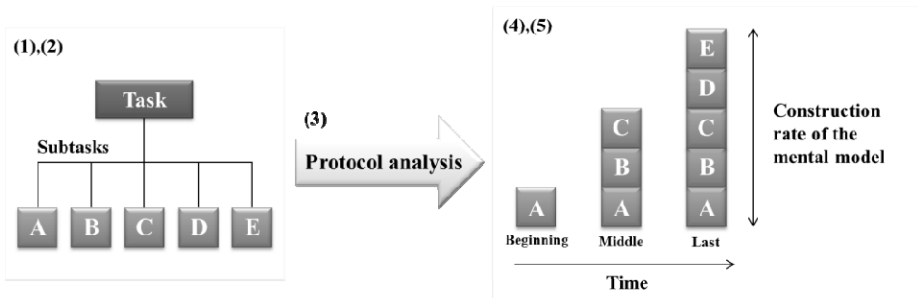

Fig. 2. Flow of the method of collecting data

2.2   Methods of Analyzing Data

The analysis method of the results is as follows.
(1) Designers check the construction rate in the step of the beginning.
a) When the construction rate in the first step is high, the interface design of the product is good, and the participant may be person with advanced skills.
b) When the construction rate in the first step is low, the product needs a clue for mental model construction. Designers go to the next analysis procedure.
(2) Designers check the rate of change of the construction rate between the step of the beginning and the middle step. Similarly, they check the rate of change between the middle step and the last step. Table 1 shows the combination of the rate of change between each step. The number in a Table 1 corresponds to the number of the analysis method to show later.

Table 1. The combination of the rate of change between each step

		The rate of change from **the middle step** to **the last step**	
The rate of change		High	Low
from **the first step**	High	a)	b)
to **the middle step**	Low	c)	d)

a) The interface design of the product is good in that the participant constructed a mental model steadily.
b) Designers check attentively the operational problems from the utterance data of the participant between the middle step and the last step.
c) Designers consider why the rate of change is low between the first step and the middle step.
d) The interface design of the product is not good in that the participant was not able to construct a mental model. Therefore, designers recheck the interface design of the product from the viewpoint of a functional model and a structural model and make improvement plans of the interface design.

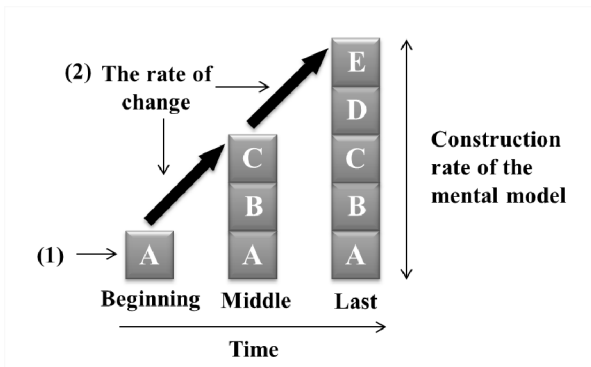Figure 3 shows the flow of method of (1) and (2).

Fig. 3. Flow of the method of analyzing data

3 Test Using the Proposed Method

In this study, a test about two products was conducted to verify the effectiveness of the method. Target products of the test are a digital camera and an electronic dictionary.

3.1 Methods

Participants are two university students (age 21 years old, man). They are beginners about target products. Table 2 (Digital camera) and Table 3 (Electronic dictionary) show the tasks and subtasks that they performed.

Table 2. Task and Subtasks of the digital camera

Task	Delete of a taken photograph
Subtask A	Understand the operation
Subtask B	Press the Power button
Subtask C	Press the Display button
Subtask D	Press the Delete button
Subtask E	Press the Decision button

Table 3. Task and Subtasks of the electronic dictionary

Task	Delete of a history of past searches
Subtask A	Press the History button
Subtask B	Understand the operation
Subtask C	Press the Delete button
Subtask D	Select One Delete
Subtask E	Press the Decision button

3.2 Results

Figure 4 (Digital camera) and Figure 5 (Electronic dictionary) show the results of this test. Moreover, Figure 4 and Figure 5 show the subtasks that the participant was able to do in each step.
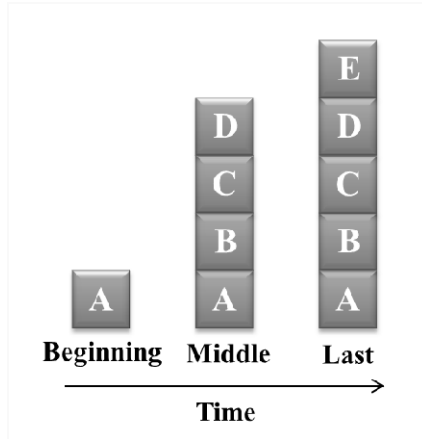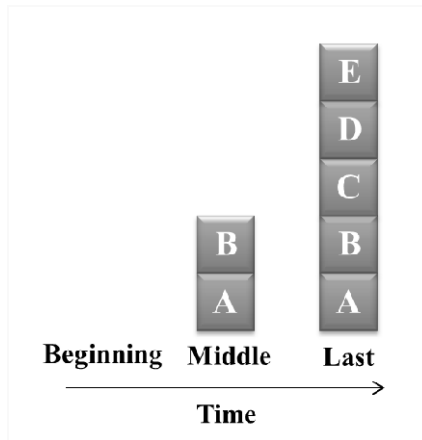
Fig. 4. A result of the Digital camera

Fig. 5. A result of the Electronic dictionary

3.3   Discussion

About the Digital Camera. As the construction rate in the first step is not so high, the digital camera should be checked from a viewpoint of the mental model.

According to Figure 4, the combination of the rate of change of the construction rate falls under b) of Table 1. The operational problems were checked from the utterance data of the participant between the middle step and the last step, but the operational problems were not picked up.   Therefore, it can be presumed that the interface design of the digital camera is relatively good.

About the Electronic Dictionary. As the construction rate in the first step is low, the electronic dictionary should be checked from a viewpoint of the mental model.

According to Figure 5, the combination of the rate of change of the construction rate falls under c) of Table 1. The operational problems were checked from the utterance data of the participant between the first step and the middle step, picked up the operational problems regarding the term. It can be presumed that the interface design of the electronic dictionary becomes better by finding a solution about the problems.

4   Conclusion

As the results of the test, the effectiveness of the proposed method was verified. The proposed method surpasses other method because it is simple and useful. The present study focused on the concept of the mental model that plays a vital role in designing user-friendly products. According to the construction items of mental models in product design, Designers can feedback them product design. Moreover, the proposed method can be applied to GUI design.

Reference

1. Preece, J., et al.: human-Computer Interaction, pp. 123–139. Addsion-Wesley Publishing Company (1994)