A Scheme for Representing Beneficial Inconvenience

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Abstract. This paper proposes a representation scheme of human-machine interaction that provides users with beneficial inconvenience. The scheme consists of three layers. The top layer represents user-dependent subjective matters, and the middle layer describes inconvenience as an objective phenomenon that creates opportunities to get objective benefits. The bottom contains a task-achievement model whose basic structure is a triangle relation among user, object, and system, based on Vygotsky's insight into human activities. This paper demonstrates the performance of our scheme by representing typical situations for obtaining beneficial inconveniences in a uniform construction. This scheme can also be used as a testing ground of *fuben-eki* designs. *Fuben-eki* stands for the benefits of inconvenience, and a *fuben-eki* design means a design that appreciates the concept of *fuben-eki*.

Keywords: Representation scheme · System design · Human machine system · Benefit of inconvenience

1 Introduction

Assuming that convenience means saving time and reducing effort, efficiency and high functionality provide convenience to users, but the disadvantage of solely pursuing it has been an open question for some time [1]. One typical way for pursuing convenience is automatization. But the US federal aviation administration reported that the continual use of autoflight systems could lead to the degradation of a pilot's ability to quickly recover aircraft from undesired states [2]. The recent developments of vehicle automation systems will remove the fun of operating vehicles from drivers and shift their responsibility from active operators to passive observers [3].

This paper focuses on human-machine interactions. Interactive tools require time and effort. In this sense, one aspect of the research on interactions is investigating beneficial inconveniences, some of which are beneficial for interactions, even though not every one provides benefits.

To investigate the conditions for beneficial inconveniences, we collected positive and negative examples. The former include

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– a cell production system instead of a line production system
– barrier-aree (aree is a Japanese word that means existence) instead of barrier-free.

Compared with a line production system, a cell production system is superficially inconvenient because it requires that workers have the skills to assemble such complex productions as automobiles in small groups. But it does allow them to be skilled and encourages them to understand production. Compared with barrier-free, barrier-aree introduces such minor obstacles as differences in floor levels on purpose to maintain physical abilities [4].

The collected examples can be classified into two groups:

G-1 interactions between artifacts and users
G-2 methods, rules, or policies.

A cell production system and barrier-aree belong to G-2. Positive examples provide users opportunities to get the following benefits of inconvenience [5]:

– fostering affirmative feelings
– providing motivation for tasks
– reassurance
– enhanced awareness
– prompting system understanding
– personalization.

2 Representation Scheme

Our proposed scheme is for G-1 and can represent all of its positive examples and eliminate all of its negative examples. The scheme consists of three layers (Fig. 1). The top layer represents user-dependent subjective matters: perceived efforts and benefits. The middle layer states an inconvenience as an objective phenomenon that creates opportunities to get objective benefits. The bottom layer contains

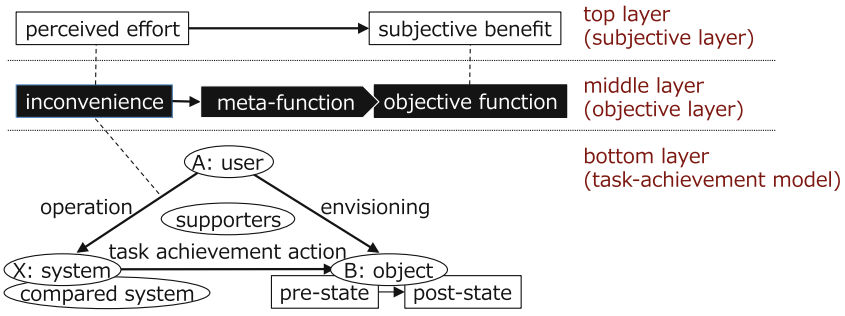

Fig. 1. Basic structure of proposed scheme

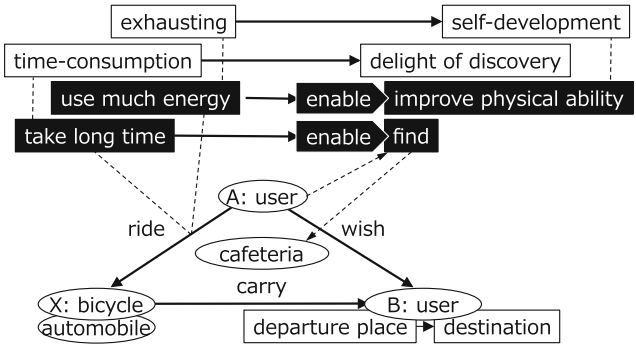

Fig. 2. Example that represents benefits of inconvenience

a task-achievement model (TAM), whose basic structure is a triangle relation among A (user), B (object), and X (system). TAM is based on Vygotsky's insight into human activities [6] and the abstracted action model [7].

Figure 2 shows an example of G-1. Compared with an automobile, a bicycle is superficially inconvenient in the sense of time-consumption when the task is moving over long distances. But it enhances the awareness of several things along the way. It may enable bicycle users to find a cafeteria, which is overlooked when traveling by car. If the user perceives time-consumption as a matter of inconvenience and feels that it is beneficial to find her favorite place to eat, this situation is a positive example of *fuben-eki*, which denotes a viewpoint that embraces the benefits of inconvenience.

2.1 Top and Middle Layers

Since the benefits of inconvenience are emotional, e.g., reassurance, affirmative feelings, and motivation, they cannot be scaled in a quantitative manner. So this paper measures them by an ordinal scale. Humans can directory perceive the quasi-order of emotions without physical scales [8].

The positive aspects of inconvenience are classified into two groups:

- Objective functions
- Subjective benefits

Subjective benefits are represented in the top layer, but they cannot be directory related to inconveniences. As an explanatory mediator between them, the middle layer introduces objective functions and represents objectively observable inconveniences and functions. The top layer consists of subjectively perceived efforts and benefits.

In the top and middle layers of Fig. 1, arrows denote causal relations and their directions are from causes and effects. By inconveniences (the left part of the middle layer), users perceive their own consumption efforts (the left part of the top layer), and objective functions (the right part of the middle layer) are

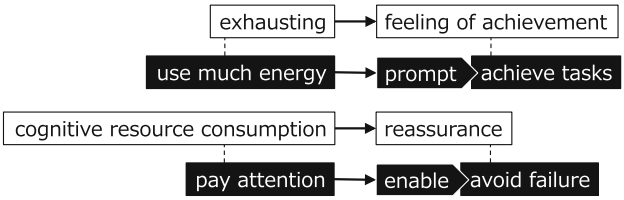

Fig. 3. Examples of top and middle layers

also derived by inconveniences. When users recognize subjective benefits with the help of perceived efforts and objective functions, such subjective benefits are called *fuben-eki*.

Even though taking a long time is generally inconvenient, it allows users to make long-term commitments to systems that might provide opportunities for discovery. Figure 2 shows this situation. In this case, the delight of discovery is enhanced by time-consumption.

The upper part of Fig. 3 shows a situation where inconveniences impose a great energy expenditure on users to achieve a task, and she perceives it as exhausting. However she might be filled with a sense of achievement, which is not only derived by the fact that the task is achieved but by recognizing her contribution to it. The feeling cannot be obtained without the subjective perception of an effort.

The lower part of Fig. 3 shows another example. Focusing on avoiding failure is inconvenient when users feel that their cognitive resources are being consumed, but the situation where failures are avoided not by a black box but by themselves reassures users.

Meta Functions in the Middle Layer: Objective functions are classified as follows:

- enabling (allowing) investments of time and effort
- enabling (allowing) collateral functions
- prompting action
- prompting task-achievement

Each objective function is composed of a noun phrase and such a meta-function [9] as enable or prompt.

2.2 Bottom Layer

In the bottom layer, a task-achievement model (TAM) or a combination of TAMs is represented. The basic structure of TAM is a triangle relation among A (user), B (object), and X (system), based on Vygotsky's insight into human activities [6]. By introducing the notions of the abstracted action model [7], arrows from A to X, from A to B, and from X to B denote an operation, its envisioning, and a task-achievement action, respectively. The task-achievement is

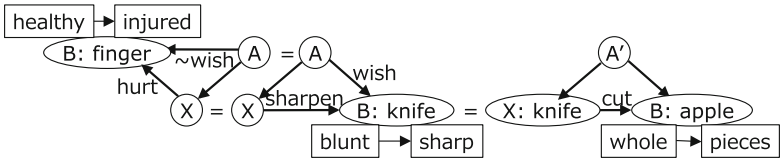

Fig. 4. Combinations of TAMs

represented by the state transition of B. Additionally, for representing inconvenience, another system belongs to B. Inconvenience can only be defined by comparing an inconvenient system with a convenient one.

3 Representation of Beneficial Inconveniences

Inconvenience requires users to invest time and effort for the following reasons:

- operating systems
- envisioning task-achievement
- just waiting for task-achievement by systems
- preparation for achieving tasks
- conscious attention to possible mistakes.

The differences of such types of investigation are represented by the differences of the destination of the links from the objective layer (dashed lines in middle part of Fig. 2) to the arrows in TAM (solid arrows at bottom part of Fig. 2):

Arrow from A to X denotes time and effort for operations,
Arrow from A to B denotes time and effort for envisioning,
Arrow from X to B denotes time and effort for just waiting.

Other types are drawn by combinations of TAMs (Fig. 4). The center triangle is the preparation of the main task, which is represented by the right triangle. By unifying the B of the center triangle with the X of the right triangle, two triangles are joined and the scheme sketches for sharpening a knife take the position of preparing the main task: cutting an apple. By unifying A and X of the center triangle with A and X of the left triangle, conscious attention to possible mistakes is represented, where user A does not wish to cut himself while sharpening a knife.

3.1 Inconvenience of Operation (Between *A* and *X*)

Typical inconveniences when interacting with a system arise while operating it. In this case, the inconvenience described in the middle layer is linked with the operation arrow between A and X (user and system) in the bottom layer

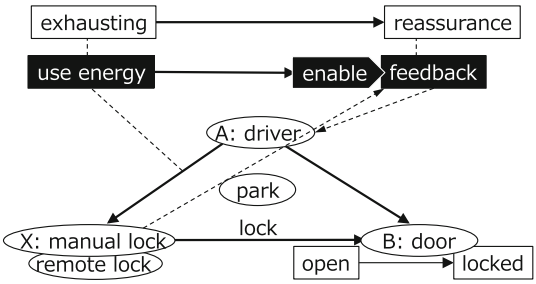

Fig. 5. Locking a door: example of A-X driven inconvenience that leads to reassurance

(Figs. 1 and 2). Figure 2 shows an example where riding (operating) a bicycle is more inconvenient than driving an automobile.

Figure 5 shows another example of inconvenience for operating systems. Compared with remote locking, manual locking is inconvenient because it requires relatively difficult operations. However, it concretely informs users that the lock worked by the reaction force of the twisting hand and by the noise as each door is locked. Such feedback is represented by dashed arrows between the middle and bottom layers in Fig. 5

3.2 Inconvenience of Envisioning (Between *A* and *B*)

Other than operations, envisioning task-achievement also consumes time and effort. Consider sharpening a pencil by a knife; users need to think about the desired shapes of the pencil. Convenient electric sharpeners do not require such thought. In other words, the convenience does not allow users into sharpen pencils in their favorite shapes.

In this case, the inconvenience described in the middle layer is linked with the envisioning arrow between A and B (user and object) in the bottom layer.

3.3 Inconvenience of Waiting (Between *X* and *B*)

Consider the task of sending a message over a long distance. Compared with e-mail, postal mail is inconvenient because it takes much longer. This inconvenience is different from that shown in Fig. 4, where an operation takes time. In this case, what takes time is not the operation but the task achieved by an action by X (system). The inconvenience described in the middle layer is linked with the arrow of the task-achievement action between X and B (system and object) in the bottom layer (Fig. 6).

3.4 Other Inconveniences

Preparation: For relaxation at a hot spring, we need to travel to a hot spring inn. For cutting ingredients with a knife, we need to sharpen it. Moving to an

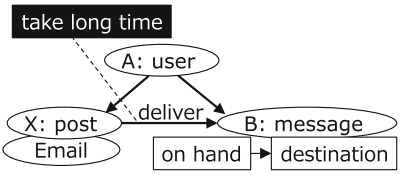

Fig. 6. Postal mail: example of X-B driven inconvenience

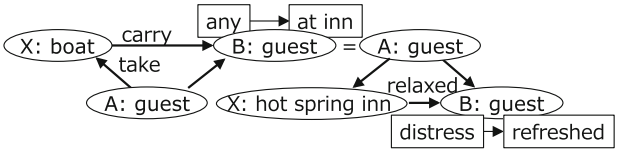

Fig. 7. Example of preparation-tasks driven inconvenience

inn and sharpening a knife are preparations for the main tasks. Generally, they are said to be inconvenient, but the difficulty of reaching inns is beneficial for attracting guests to secluded hot springs.

Inconvenient preparations are represented by combining TAMs. Figure 4 shows an example of knife sharpening, and Fig. 7 shows a secluded inn. The inn is surrounded by a channel, and guests need to take a boat to get to it. In the figure, by unifying the A of the main task with the B of preparation, two TAMs are combined.

Conscious Attention of Possible Mistakes: Conscious attention of possible mistakes is also represented by combining TAMs. Figure 4 shows an example how knife sharpening might cut fingers. The state transition of B of the left most triangle is imagined and A (user) wants to avoid it.

Figure 8 shows another example. Compared with digital cameras, traditional cameras are inconvenient because film must be loaded into them and the number of pictures is also limited. Therefore, user need to concentrate on camera-

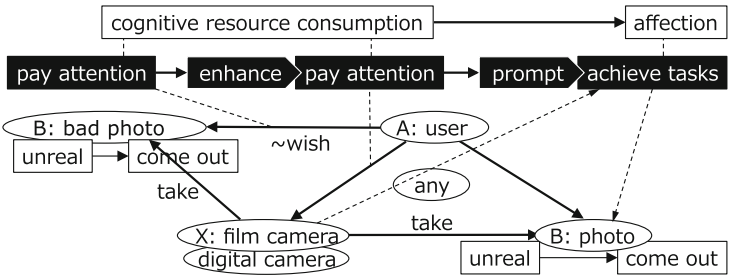

Fig. 8. Camera: example of conscious-attention driven inconvenience that leads to affection to photos

operation to avoid mistakes. In the middle layer of the figure, attention to avoid mistakes enhances the attention to operate the camera.

4 Discussion and Conclusions

This paper proposed a model for representing human-machine interactions that provides the benefits of inconvenience and demonstrated its ability by representing typical cases. The main purpose of the present paper is to provide a uniform grammar to describe each case, but the ability of our proposed scheme is not confined to representation. It can be applicable to a *fuben-eki* design.

Design Support by Analogical Reasoning: Since the structure of our proposed scheme is simple, the scheme enables comparisons among completely different systems. Such comparison leads to analogical reasoning of the latent benefits of normal systems based on known *fuben-eki* systems. For example, sharpening pencils by a knife takes longer than by an electric sharpener, and moving by bicycle also takes longer than by automobile. Considering travel by bicycle provides the delight of discovery, and sharpening by knife has the potential of designing a tool that enables users to discover the latent features of pencils.

Negative Example Elimination: Our proposed scheme can be used as a format to check whether an inconvenience provides subjective benefits. It explains how the activity, which is described in the bottom layer, leads to subjective feelings of inconveniences and benefits described in the top layer.

If an interaction between systems and users cannot be represented by the proposed scheme, the interaction cannot provide the benefits of inconvenience. For example, single-lens reflex cameras are more inconvenient than compact cameras because they require difficult operations, but they also provide high-quality images. When the delight of getting high-quality pictures is placed in the slot of the subjective benefits in the top layer and the slot of the perceived effort is filled with the difficulty of operations, there are no causal relations between them. Such a situation is unacceptable. On the other hand, when intense cerebrations lead to understanding the mechanism of cameras, and cerebration efforts lead to emotional attachment to photos, this situation can be represented by the scheme and is acceptable.

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