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# Guidelines of System Design for Embodying Benefits of Inconvenience

Yuichi HASEBE *, Hiroshi KAWAKAMI *, Toshihiro HIRAOKA *, and Keita NOZAKI **

**Abstract**: The benefits obtained from inconvenience, which we call the FUrther BENEfit of a Kind of Inconvenience (fuben-eki), are now being recognized in many research fields. To design systems that embody such benefits, this paper proposes fuben-eki cards. A set of them consists of principle cards and benefit cards. Each principle card shows a tenet to make a system inconvenient that leads to the positive outcomes shown on each benefit card. The results of evaluation experiments show that principle cards increased the number of ideas when they were used for the divergent thinking processes of a fuben-eki system design.

**Key Words:** fuben-eki, human-machine system, creativity support tool.

## 1. Introduction

In general, designers tend to unquestioningly pursue convenient systems. Although convenience may enrich our lives, it may not always be the best for users. On the contrary, convenient systems may encourage such harmful aspects as decreases in human skills and motivation [1],[2]. Contemplating the negative aspects of convenient systems has actually prompted us to focus on the benefits of inconvenience that have been overlooked because only convenience has been pursued. A theory of designing systems that focuses on fuben-eki, which stands for the FUrther BENEfit of a Kind of Inconvenience, has been proposed to appreciate the value of inconvenience [3].

A fuben-eki system incorporates the benefits of inconvenience. There exist many good examples of fuben-eki systems but proper guidelines to design them remain unknown. We discuss here guidelines for the conceptual design of fuben-eki systems and propose a tool that supports their design.

## 2. Outline of Fuben-Eki

Before discussing a fuben-eki system, we must define two terms: convenience and inconvenience. Convenience is ambiguous. It depends on subjective aspects. This paper employs a relatively narrow definition of it: "saving labor to attain a specific task" [4]. In this definition, labor implies time-consuming operations and/or special skills, including mental load. We regard inconvenience as the opposite of convenience. An inconvenient system or method requires more labor of users to complete a specific task than a convenient system or method.

The following are examples of fuben-eki:

- allowing users to understand systems through interaction,
- enhancing awareness, and
- fostering affirmative feelings.

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Of course, not every inconvenience has beneficial aspects. Fuben-eki is different from nostalgia that tends to design retro-style things. Inconvenience must be inevitable to get fuben-eki. In other words, inconvenience is not a compromise with fuben-eki. For example, the time and effort to type in a password are only compromise with security. In this case, security is not fuben-eki. Typing in a password is not obligatory and can be replaced by other security methods. However, if a person feels subjective benefits that are caused by typing, those feelings are fuben-eki.

The design theory of fuben-eki systems is a methodology that exploits fuben-eki even if the level of convenience is lowered [5]. This theory explains the relationship between inconvenience and benefits without clearly stating the practical guidelines to design such systems.

## 3. Design Methods of Fuben-Eki Systems

Fuben-eki systems are designed so that users obtain benefits from inconvenience. The time and effort of using fuben-eki systems provide benefits as the by-products of accomplishing the task.

### 3.1 Fuben-Eki System Design

In this paper, our proposed design processes convert existing systems into new fuben-eki ones. This section presents the guidelines for designing fuben-eki systems. The systems, which will be converted into fuben-eki systems by the present process, are called target systems.

Conventional system design that aims to produce convenient systems is evaluated in terms of one axis, i.e., the amount of labor (Fig. 1 (a)). Fuben-eki system design, on the other hand, adds another axis that evaluates such subjective benefits as self-affirmation and a sense of security (Fig. 1 (b)) [6]. Based on these dimension axes, at least the following two directions, A and B, can be considered for fuben-eki system design.

**A: Utilize existing inconvenience**

This particular direction first identifies the potential fuben-eki features of the target systems without changing the level of convenience; it utilizes existing inconvenience by transform-

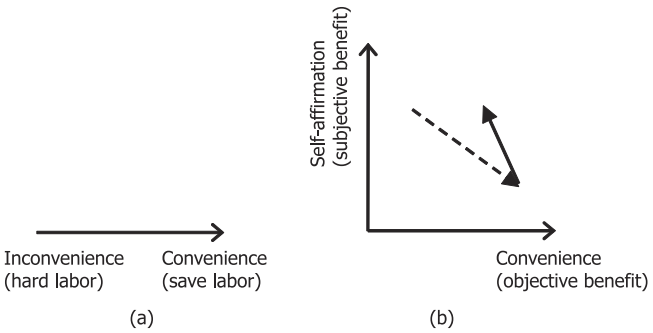


Fig. 1 1- or 2- dimensional axes for evaluation [6].

ing the annoying labor into a process to obtain fuben-eki. For example, we may increase user fulfillment and affirmative feelings by presenting explicit feedback of actions. Based on psychological theories with respect to motivation, Hiraoka et al. proposed an eco-driving support system that presents the evaluation and target scores of fuel saving [7]. Although this system does not change drivers' labor to operate a car, it increases their motivation by describing their achievement in terms of its degree of eco-driving.

Gamification, the use of game design elements in non-game contexts, also effectively delights users and encourages them to obtain fuben-eki [8]. Giving rewards or feedback is one such element that satisfies the "users' need for self-actualization [9]" and increases their motivation. The elements motivate users to enjoy time-consuming tasks.

Not only feedback but also presenting the degree of inconvenience is effective. Users can recognize fuben-eki by learning the degree of such inconvenience as difficulty and rarity. For example, Oomaki-onsen, a hot-spring resort that can only be accessed by boat, becomes popular by exploiting the inconvenience of transportation.

**B: Transforming target systems to be more inconvenient**

In general, an increase in convenience decreases the subjective benefits (shown by the dotted arrow in Fig. 1 (b)) [6]. We can design fuben-eki systems by transforming target systems into inconvenient ones (black arrow in Fig. 1 (b)) and embodying new benefits. The course to transform the target system into an inconvenient one not only retrogresses its actual historical development but also introduces novel inconveniences. For example, Kitagawa converted navigation systems into fuben-eki systems by introducing a novel inconvenience: the degradation of information [10]. In this navigation system, the trails being followed by users disappear. Therefore they need to recall the surroundings of the trails when they use the system again; the system encourages users to remember landmarks more precisely.

Another example is a ruler (Fig. 2) that only has prime number scales. A conventional ruler is only a convenient tool for measuring length, but an inconvenient ruler allows users to devise their own ways to measure length [11].

In contrast to conventional approaches to design that have uniformly pursued convenience, a direction that allows users to appreciate the time and effort for interacting systems leads to a new approach to good relations between users and systems.

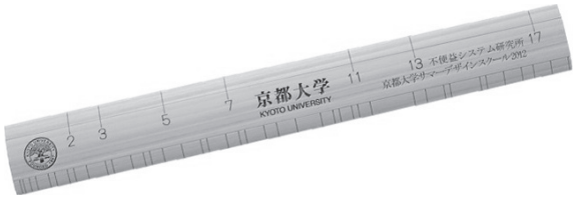


Fig. 2 Prime number ruler.

### 3.2 Supporting Method for Fuben-Eki System Design

In direction B, converging on the lower left corner of Fig. 1 (b) does not make sense; making a system inconvenient does not always lead to a fuben-eki system [6]. To construct a fuben-eki system, we need to embody subjective benefits. Direction B can again be split into two methods.

**B-1:** first specify the fuben-eki to be actualized and appropriately make the target systems inconvenient.

**B-2:** first make the target systems more inconvenient and then judge whether users can obtain fuben-eki.

Knowledge of the relation between inconvenience and subjective benefits facilitates method B-1. Naito et al. proposed a fuben-eki matrix (Table 1) and fuben-eki principles (Table 2) [6]. By choosing the convenience of the target system and the desired benefit of inconvenience from the rows and columns, users can find appropriate fuben-eki principles at the matrix intersections. The IDs of the principles (1, 2, ..., 12) are placed at the intersections of the relevant convenience and benefit. Users can embody the desired benefit by applying the recommended principles to the target system.

While method B-1 determines the desired fuben-eki first, method B-2 first transforms the target systems into inconvenient ones. At this stage, no concrete images of conceptualized systems and their benefits are required. Therefore this method has fewer constraints for generating ideas and effectively encourages divergent thinking processes [12], such as brainstorming [13]. Brainstorming battle [14], which integrates brainstorming with the essence of games, is a framework for designing fuben-eki systems by following method B-2.

To obtain good solutions, one must produce as many ideas as possible in divergent thinking processes [15]. To generate many ideas by method B-2, one needs to take into account as many parameters of inconvenience as possible and explore as many benefits as possible that can be obtained from the transformed target systems. However, since it is difficult for designers inexperienced in fuben-eki system design to produce so many ideas, we propose fuben-eki cards to support divergent thinking processes in fuben-eki system design.

### 3.3 Fuben-Eki Cards

Fuben-eki cards, a card-type tool for conceptualizing fuben-eki systems, are based on the fuben-eki matrix and principles. A set of fuben-eki cards consists of principle cards and benefit cards (Fig. 3). Their layout is based on idea pop-up cards [16]. There are 12 yellow principle cards on which the fuben-eki principles are shown. The benefit cards are green and show eight benefits including six in the columns of the fuben-eki matrix. The pictogram shown on each card helps users intuitively understand the meaning of the principles and the benefits.

Table 1 Fuben-eki matrix [6].

| | ◇ Enhancing awareness | ◇ Devising ways | ◇ Improvement | ◇ System comprehension | ◇ Preventing loss of skill | ◇ Encouraging initiative |
|---|---|---|---|---|---|---|
| speed | 5, 7 | | | | | |
| quickness | 1, 2, 6, 7, 9, 10 | 3, 4, 6, 1, 2, 8 | 3, 4, 6, 8 | 3, 4, 6, 1, 10 | 3, 4, 1, 6, 8, 10 | 3, 10, 1, 4, 6, 9 |
| volume/weight | 1, 5, 6 | 5, 6, 1, 3, 4 | 3, 4, 5, 6 | 3, 4, 5, 6 | | 3, 4, 5, 6 |
| un-deterioration | 2, 5, 6 | 2, 5, 6 | | 3, 5, 10 | 3, 5, 10 | 3, 5, 10 |
| few types of operation | 5, 9, 10 | 4, 5, 6, 8, 9 | 4, 5, 6, 8, 9 | 4, 6, 5, 9 | 5, 6, 8 | 4, 5, 6, 9, 10 |
| low amount of operation | 5, 9, 10 | 3, 5, 8 | 3, 5, 8 | 3 | 3, 5, 8 | 3, 5, 9, 10 |
| standardization | 5, 10 | 3, 4, 5, 6, 8 | 3, 4, 5, 6, 8 | 3, 4, 6, 5 | 3, 4, 5, 8 | 3, 4, 5, 6, 10 |

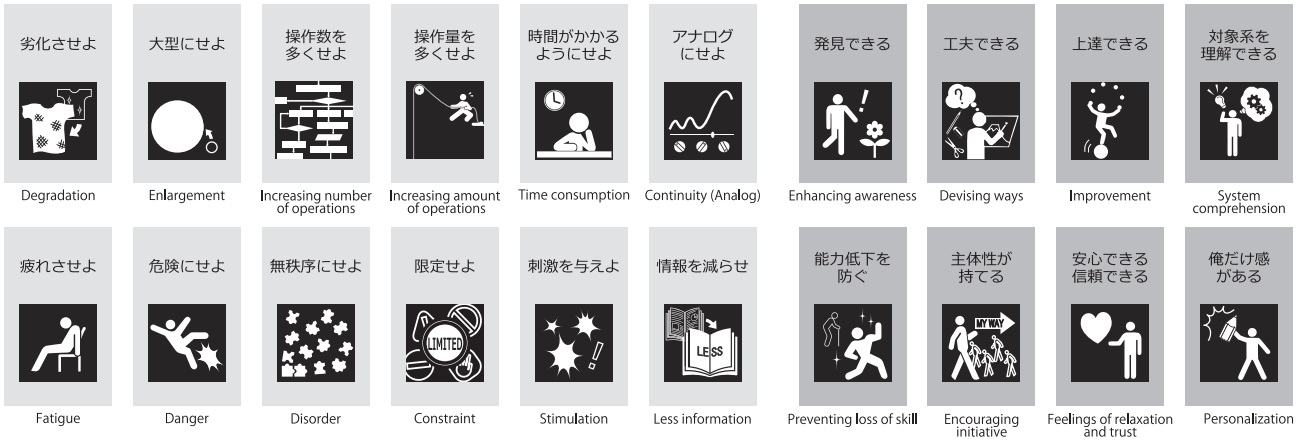


Fig. 3 Principle cards (yellow) and benefit cards (green).

Table 2 Fuben-eki principles [6].

| | |
|---|---|
| 1. Degradation | 7. Fatigue |
| 2. Enlargement | 8. Danger |
| 3. Increasing the number of operations | 9. Disorder |
| 4. Increasing the amount of operations | 10. Constraint |
| 5. Time consumption | 11. Stimulation |
| 6. Continuity (Analog) | 12. Less information |

Table 3 Experimental conditions.

| Group | | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Number of participants | | 9 | 6 | 9 | 7 | 8 | 7 |
| First | target system | *P* | *Q* | *P* | *Q* | *P* | *Q* |
| | cards | no | | no | | no | |
| Second | target system | *Q* | *P* | *Q* | *P* | *Q* | *P* |
| | cards | principle | | benefit | | no | |
| | | with PC | | with BC | | w/o C | |

**Examples of design using fuben-eki cards**

As an example of using fuben-eki cards, the authors transformed TV into a new fuben-eki system. First, was made TV more inconvenient by referring to principle cards. For example, by referring to a card "disorder," we can conceptualize a new TV where the channels and their numbers change haphazardly. Next, the authors explored the benefits embodied by the transformed TV. By referring to the benefit cards, the authors found such benefits as "stumbled on unexpected TV programs" from "enhancing awareness."

## 4. Evaluation Experiments of Fuben-Eki Cards

To evaluate the utility of our cards, we conducted the following experiments and verified these two hypotheses:

$\alpha$**:** the cards will increase the number of ideas;
$\beta$**:** the cards will increase the number of benefits associated with each idea.

### 4.1 Experimental Procedure

Forty five participants included both men and women in their teens or twenties who gave informed consent. They did not have any knowledge of fuben-eki. The participants were requested to create ideas for new fuben-eki systems by following method B-2. This task is called idea generation, which was conducted twice. The target systems were a microwave oven (*P* in Table 3) and a wall clock (*Q*). The authors divided the participants into three groups:
(i) with principle cards (PC),
(ii) with benefit cards (BC), and
(iii) without the cards (w/o C).
Each group was split further into two groups based on the order of the target system (Table 3).

**First idea generation task (explanation + 20 minutes)**

The participants were given a brief outline of fuben-eki and the following four principles of brainstorming [13]:

1. Criticism is ruled out.
2. "Free-wheeling" is encouraged.
3. Quantity is wanted.
4. Combinations and improvements are sought.

After the introduction, the participants generated ideas to transform the target system into an inconvenient one and to find benefits for their ideas by solo-brainstorming. They had to create as many ideas and obtain as many benefits as possible. They wrote down their ideas and benefits on paper and could find more than just one benefit in each idea. The time limit was 20 minutes.

**Second idea generation task (explanation + 20 minutes)**

The participants were requested to create ideas to change the other target system into a fuben-eki system in the same way as in the first task. As shown in Table 3, the PC group was allowed to use and refer to their principle cards. The BC participants were allowed to use and refer to their benefit cards. The card users were instructed how to use them. The w/o C group did not use any cards.

**Questionnaires**

At the end of the experiment, the participants answered questionnaires regarding the experiment and how they felt about the utility of the cards.

### 4.2 Instructions to Use Fuben-Eki Cards

The instructions for using the cards are described below:

**For principle cards**

- refer to one card to produce an idea,
- explore the benefits without cards,
- if no idea is produced, change the card quickly,
- the contents of the cards can be interpreted creatively.

**For benefit cards**

- produce ideas without cards,
- refer to each card to explore benefits,
- if all the cards have been referred to, move to the next idea,
- the contents of the cards can be interpreted creatively.

Participants were encouraged to refer to each card quickly from various viewpoints.

### 4.3 Results

The authors obtained the following datasets by conducting the above procedures:

- number of ideas created by each participant in the first idea generation task (number),
- number of benefits found by each participant in the first idea generation task (number),
- number of ideas created by each participant in the second idea generation task (number),
- number of benefits found by each participant in the second idea generation task (number),
- answers to questionnaires by each participant (score and free comments).

Here are two examples of ideas hatched by these experiments:

- a microwave oven whose turntable must be turned by hand; users can experience the feelings of being a craftsman,
- a wall clock whose hands deface the clockface with scratches; users will feel the passage of time more viscerally and appreciate it.

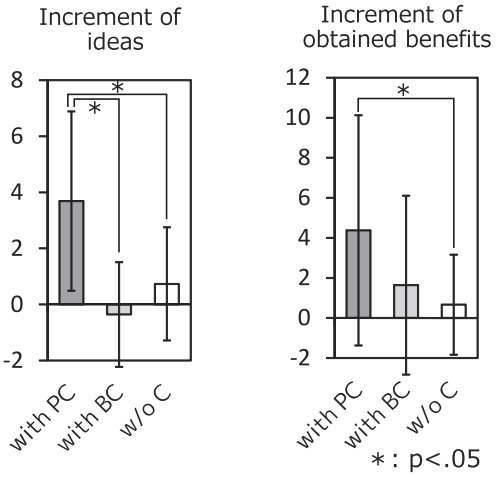


Fig. 4 Increment of ideas and obtained benefits.

The authors focused on the differences in the numbers of ideas and obtained benefits between the first and second idea generation tasks. Figure 4 compares them among the three groups. The analysis of variance (ANOVA) performed on the increment of ideas showed that the main effect among the groups was significant ($F(2, 42) = 10.97, p < .001$). Shaffer's multiple comparison test revealed that the value of the PC group was higher than the other groups at a 5% significant level. In the increment of the obtained benefits, the main effect of the different groups is marginally significant ($F(2, 42) = 2.87, p < .10$). A multiple comparison test showed that the value of the PC group was higher than the w/o C group at a 5% significant level.

### 4.4 Discussion

Based on the above results, hypotheses $\alpha$ and $\beta$ were modified as follows:

**$\alpha$':** principle cards will increase the number of ideas;

**$\beta$':** principle cards will increase the number of benefits associated with each idea.

Modified hypotheses $\alpha$' and $\beta$' are supported by the experimental results. In the questionnaires, some participants who used the principle cards commented that they helped them create ideas of inconvenience and they enjoyed the idea generation task because it resembled a game. These two reasons probably explain why the principle cards increase the quantity of ideas:

- The fuben-eki principles inspire users to conceptualize various aspects of fuben-eki systems.
- The cards and the instructions described in Section 4.2 facilitate free divergent thinking.

However, some participants argued that they could only create ways to transform the target system that were already contained in the cards. Such comments suggest that the principle cards might shackle the thoughts of users. In a future study, we need to compare the cards with other tools or methods.

The benefit cards did not seem to make our target system inconvenient. Some participants argued that the cards did not help them stumble upon ideas to transform the target system. In fact, the cards did not increase the number of ideas; the number of obtained benefits was also small. The effect of each benefit card to explore benefits varied depending on the contents of

the idea; i.e., some of the cards cannot be applied to the idea. Therefore, it is ineffective to only show examples of benefits randomly. We need another way to utilize the cards.

## 5. Conclusions

In the present paper, we discussed two directions as guidelines for designing systems that embody the benefits of inconvenience. The design, especially, in which we transformed the target system into an inconvenient one, can embody novel fuben-eki. However, inexperienced designers had difficulty transforming the target systems to find benefits. We solved this problem by proposing fuben-eki cards as support tools for the divergent thinking process of a fuben-eki system design. Experimental results showed that principle cards, which are parts of fuben-eki cards, increased the number of ideas and the obtained benefits. Therefore, they are valuable for the divergent thinking of the fuben-eki system design.

The divergent thinking process focuses more on quantity than on quality, and qualitative assessments are left to subsequent processes. To refine the ideas generated by the proposed process into practical ones, qualitative assessments on feasibility and effectiveness may be required. Another point of our assessment is the balance between the benefits of convenience and inconvenience. Note that the design theory of fuben-eki systems does not deny the benefits of convenience.

Although principle cards increase the quantity of ideas, they show only the simple principles of inconvenience and it is left to designers to utilize them. Conceptualizing fuben-eki systems with the help of the cards depends on designers, who can exploit their subjective experiences, values, tastes, and humor for generating their own unique systems. In other words, the fuben-eki cards themselves are a kind of fuben-eki system.

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