Study on Career Education for the Age of Computerization with Benefit of Inconvenience

Kiyohisa Nishiyama[1(✉)] and Manabu Sawaguchi[2]

[1] Nagoya University, Furo-cho, Chikusa-ku, Nagoya-shi, Aichi 484-8603, Japan
nishiyama.kiyohisa@e.mbox.nagoya-u.ac.jp
[2] Ritsumeikan University, Osaka Ibaraki Campus 2-150 Iwakura-cho, Ibaraki, Osaka 567-8570, Japan

Abstract. This paper aims to introduces a challenge in career education for university students then further argues about the possibility of next generation career development methodology assuming the future Human Computer Interaction. The career education utilizes innovation methodology based on Benefit of Inconvenience (BI), which is called "Fubeneki" in Japanese. In this research, we analyzed the sample ideas of BI systems submitted by participant students in lectures and workshops in which BI concept was introduced and then, recognized typical misunderstandings of BI. In addition, we explored the results of a survey conducted on the students and business persons. The survey results of the participant students were compared with those of the business persons to argue expected connection between the innovation with BI and future methodology for career education.

Keywords: Benefit of inconvenience · Career education · Idea generation

1 Research Back Ground

In the long history of technological evolution, innovations have mainly focused on eliminating time consumption and other physical burdens spent for achieving intended objectives; so, the meaning of innovation may have been equivalent to developing a new convenient system. In fact, human beings, so far, have successfully reduced their physical burden by replacing manual labor operations by automated machines since the Industrial Revolution. Management techniques such as Industrial Engineering and Quality Control also have greatly contributed to improvement of productivity in mass production. In addition, the recent evolution of Information Technology based on computer is reducing even intellectual burdens on human beings. The word, IOT (Internet of Things), has become popular since a few years ago; one may feel that many sorts of things are starting to be interactively connected thorough computer network and our society is rapidly becoming more convenient.

Excessively convenient society, however, may be exposed to various problems, while the technological evolution has realized many conveniences. Carl Benedikt Frey and Michael A. Osborne evaluated occupations that may disappear in near future at

higher possibility being replaced by machines equipped with AI (Artificial Intelligence) and pointed that workers engaged in these occupations may lose their jobs [1]. Operations in the occupations at higher risk of disappearing seems to be composed by tasks that may be easily standardized, and some have already started to be replaced by computerized machines. As other examples, human abilities may be worsened by excessive dependence on the convenient machines and excessively convenient society may be stressful by making our lives more hectic.

The university career education, which is the main agenda of this paper, is an important issue for providing guidelines with the students to proactively design their future life plans. In general, typical contents of university career education includes lecture talks given by successful business persons, introduction to certain industries and occupations, and others. Individuals each, however, may be further required to proactively challenge to create new values that contributes future society for progressive career development. In near future, human beings will be more surrounded by computerized machines equipped with ultimately optimized capabilities in certain designated tasks, where manual routine task generates extremely lower additive values.

The authors are focusing on an innovation methodology that exploits Benefit of Inconvenience (BI) mainly associating with the value creation in excessively convenient society. This methodology intentionally add inconvenience for value creation, while conventional innovation methodologies aims to eliminate time consumption and other physical burdens for value creation. The authors and the other members, so far, have formed BI Research Group, which is organized by Society of Japanese Value Engineering, and developed a methodology for systematic innovation by using BI through analysis on successful innovations based on BI [2].

2   Research Objective

This research aims to apply the innovation methodology that exploits BI to lectures and workshops that can be associated with career development and argue about new university career education contents for next working trend. This paper introduces systematic procedures for generating BI systems implemented in workshops and lectures provided by the first author. The lecture participant students, so far, submitted many sample ideas of BI systems based on the instruction. Then the samples have been analyzed to evaluate the understanding of participant students on the concept of BI system through the lectures and workshops for future challenges. In addition, we explored the results of a survey conducted on the students and business persons who have strong interest on Value Engineering [3], a world-widely popular management technique. The survey results of the lecture participant students were compared with those of the business persons to argue expected connection between the innovation with BI and future methodology for career education.

3   Research Methodology

In the workshops and lectures, the author firstly provided systematic procedures for generating systems that exploits BI, which is the concept of BI system, with participant students. Then, the students tried to generate original BI systems with respect to the procedure. The students were asked to record and submit detailed idea generation process. As analysis on the samples, we observed the submitted BI systems and their generation processes to define their ideation and misunderstanding patterns. In addition, we asked the participant students, who has experienced the explanation about the BI system above, to voluntarily join questionnaire survey and investigated the students' awareness on value creation. The following part of this paper will illustrate the systematic procedures for generating BI system provided in the workshops and lectures followed by the details of the questionnaire analysis.

3.1   Systematic Procedure for Generating BI System

The systematic procedures for generating BI system developed by the BI Research Group has assumed that its users are familiar with function analysis, a fundamental method of VE. One may predict that the participant students without enough knowledge about function analysis take time to generate BI system following the procedure. Then, the authors have simplified the instruction to the procedure by exploiting the concept of the technology evolution proposed by Theory of Inventive Problem Solving (TRIZ) [4] as well as a problem model developed by the first author [5]. The instruction focuses on visually clarifying the difference between conventional value creations and those exploiting the concept of BI by using schematics.

3.1.1   Conventional Value Creations

The procedure proposed by the BI Research Group firstly requires its users to define detailed functions of a system, which is an artificial object or service designed to achieve certain purpose, by using function analysis to BI potential essence for effectively develop BI system. On the contrast, the instruction in the author's lectures and workshop, requires the participant students to grab the definition of a system with a problem; A system generates "Positive State", in which the purpose of the system is achieved, at the same time "Negative State" is generated as shown in Fig. 1. Here, the "Negative State" is a state in which costs such as time, labor, resource, energy, environmental burden, and others are generated. This concept is based on the definition of a conflict introduced in TRIZ [4].
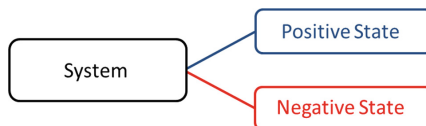

Fig. 1. System and its conflict

Figure 2 shows the major trend of innovations in the 20th century. The main interest of the innovations was mass production of systems that realizes the "Positive State", which is commonly desired by the public, and reduction of its "Negative State". One may notice that many systems are still evolving following the trend.

Automobile may be a typical example of this evolution. Humans used horse and carriage as a mean for traveling before automobile was put into practical use. The system of "horse and carriage" may have required a lot of labor to take care of the horse, and the horse itself would have been so expensive that anyone could not purchase. This is "Negative State" generated from the horse and carriage system. Then, automobile powered by engine were invented, and then, the "Negative States" have been greatly reduced. The system of automobile continues to evolve for reducing other "Negative States" such as lowering prices, reducing failures, increasing fuel efficiency and others.
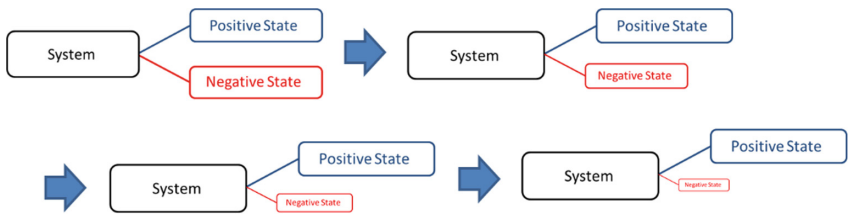

Fig. 2. System evolution in 20th century

Harmful Effects of an Excessively Convenient System
However, the situation may be eventually recognized as too convenient and, therefore, harmful, when this evolution reaches excessive. An example is that many workers are under the risk of unemployment because they may be replaced by machines equipped with Artificial Intelligence in near future. So, people may be concerned by such situation and start arguments on the relationship between human beings and highly evolved computers (Fig. 3).

Fig. 3. System with excessive convenience

Automobile may also be an example of harmfulness due to excessively convenient system. Old fashioned automobiles have been fixed by owners familiar with its simple mechanism. Present automobiles, however, uses electronic control units, which operates with unknown complex mechanism, for various functions. So, it is almost

impossible for the user to fully understand the operation mechanism of an automobile. Automobile technology is still remarkably evolving; some owners, who know old fashioned automobiles, may feel anxious about this situation. In addition, practical application of automatic driving system may cause further trend shifts of mobility deteriorating human physical functions.

Benefit of Inconvenience

Benefit of Inconvenience (BI), which is called "Fubeneki" in Japanese, is the concept of creating new benefits by intentionally adding inconvenience to a system. Harmfulness in an excessively convenient system may be observed in many fields, when technological evolutions for convenience exceeds their limits. The examples may include not only replacement of working operations by AI but also other cases in various fields. This recognition is our motivation to focus on the BI system as a concept of new value creation and to apply the concept to university career education.

Hiroshi Kawakami has introduced the essences included in BI systems shown in Table 1, "12 inconvenience types that generate benefit" and "8 benefit types generated from inconvenience" [6]. One may generate ideas associated with BI with respect to the ideation cards of Fig. 4 enhancing one's creativity with the inspiring illustrations [7]. The author introduced the examples of each essence in the lectures and workshops, and shared the example ideas proposed by the students.

Table 1. Essence of Benefit of Inconvenience

(a) 12 types of inconvenience for BI	(b) 8 types of BI
Enlargement	Prevent downskilling
Increase of number of operations	Improve
Time consumption	Devise ways
Constraint	Feel at ease, feel reliability
Continuity (Analog)	Enhance awareness
Fatigue	Understand system
Increase of amount of operations	Make original
Less information	Personalization
Stimulation	
Danger	
Disorder	
Degradation	

BI System Generation Based on 4 System Categories

As shown in Fig. 5, BI Research Group categorizes all systems, such as product and services, into four categories, "A: Harmful and Inconvenient (HI system)", "B: Beneficial and Convenient system (BC system)", "C: Harmful and Convenient system (HC system)", and "D: Beneficial and Inconvenient System (BI system)". The "convenient" and "inconvenient" depend on the amount of time, labor, resources, energy and others consumed to achieve the system purpose, while the "beneficial" and "harmful"
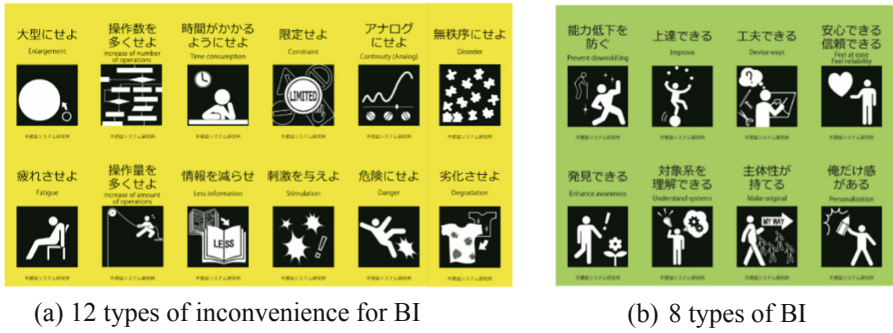
(a) 12 types of inconvenience for BI   (b) 8 types of BI

Fig. 4. Inspiration card for idea generation with BI

Fig. 5. Four system categories

somehow depend on individual subjective perception. Following the idea, one may recognize that innovations in the 20th century mentioned in Sect. 3.1.1 have modified Harmful and Inconvenient systems to be Beneficial and Convenient systems, which is equivalent to shifting systems from "A: HI system to B: BC system".

BI Research Group proposes BI system generation procedure from the viewpoint, how to evolve a system in each of the 4 system categories into a BI system as shown in Fig. 6. So, the BI system generation procedure can be classified into the 4 types of category shift: "A: HI system to D: BI system", "B: BC system to D: BI system", "C: HC system to D: BI system" and "D: BI system to D: BI system". The BI system may be developed by intentionally adding the essence of inconvenience by using the ideation cards following the procedure. This concept is also applied in the author's simplified explanation in the lectures and workshops. The following sections illustrates the detailed explanation about the procedure to shift systems into the category of D: BI system.
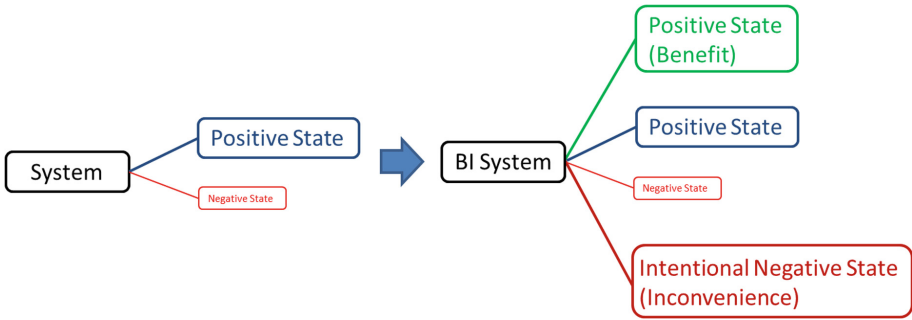
Fig. 6. Schematic of BI system development

A: HI System to D: BI System

This idea generation procedure is extracting potential BI elements from an existing HI system and, then, recognizing it as a BI system as shown in Fig. 7. For example, majority of current automobiles are equipped with automatic transmission, while previously manual transmission was more common. Automatic transmission is obviously a convenient system because it reduces burden on drivers, but one may also feel the fear of uncontrollable situation caused by unpredictable system failures in which drivers cannot do anything. On the contrast, automobiles equipped with manual transmission, drivers may notice a secure feeling that is originated from actual engagement with mechanics. One may notice that this is a BI system, which exploits the inconvenience of manual transmission to obtain the feeling of security, and it should be clearly distinguished from nostalgic feeling on old fashioned system.
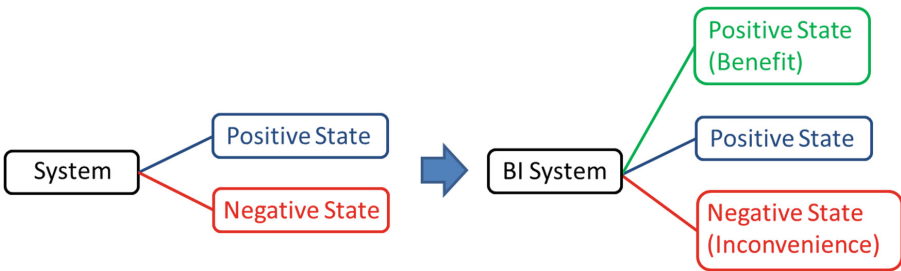

Fig. 7. A: HI system to D: BI system

No product and service that exists in the world is perfect; this thinking procedure is equivalent to defining BI that has not been recognized so far associating with inconvenience in arbitrary systems. In this category shift, one may firstly select a product or service and confirm recognizable inconveniences, then, generate BI ideas exploiting them with respect the ideation cards.

B: BC System to D: BI System

As shown in Fig. 8, this idea generation procedure is creating a BI system by adding inconveniences to an existing BC system. An application example of this procedure is an automobile equipped with special automatic transmission that has a special control mode similar to manual transmission style. BBQ restaurant, as another example, allows customers partially engaged in the cooking process, room for devising, providing opportunity for cooking skill improvement and accomplishment feeling.
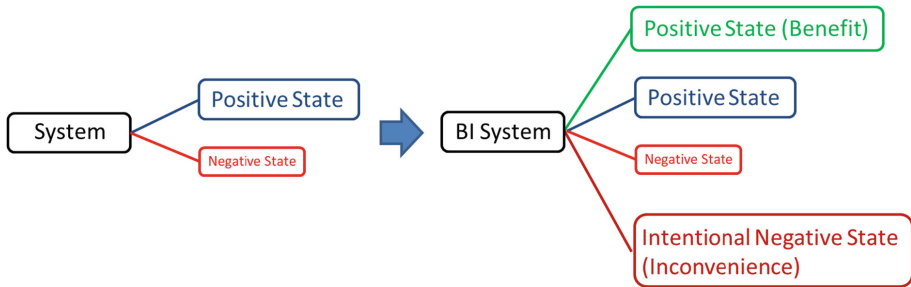

Fig. 8. B: BC system to D: BI system

Our predecessors have invented products and services that exist in the world pursuing certain conveniences. So, in this category shift, one may again firstly select a product or service, and select potential inconveniences with respect to the ideation cards, then, generate BI ideas exploiting the added inconveniences.

C: HC System to D: BI System

As shown in Fig. 9, this idea generation procedure aims to cancel the "Negative State" caused by convenience in a HC system by intentionally adding inconveniences to the system. As mentioned above, excessive pursuit of convenience may cause harmfulness resulting in an HC system. For example, the development of IT has enabled us to easily send messages through e-mail or SNS. However, this development has accompanied "Negative State" caused by excessive convenience such as overlooking important mails, lack of organic communication and others. As another example, too much dependence on electronic calculator may increase the number of people who do not understand the fundamental calculation theory. One may develop a BI system by adding small inconvenience to the HC system to cancel the harmfulness caused by excessive convenience.

In Japan, like other advanced countries, the population of elderly people is increasing and the future importance of elder care services is often stressed. Some elder care services may focus on eliminating the burden in the life of elderly people, which is equivalent to pursuit of convenience. However, it may result in deteriorating the physical function of the elderly people. So, in aging society, one may have potential opportunities for new value creation exploiting the category shift of "C: HC system to D: BI system". Therefore, it may be advantageous for university students to take the new category of value creation, BI concept, for their effective career development.
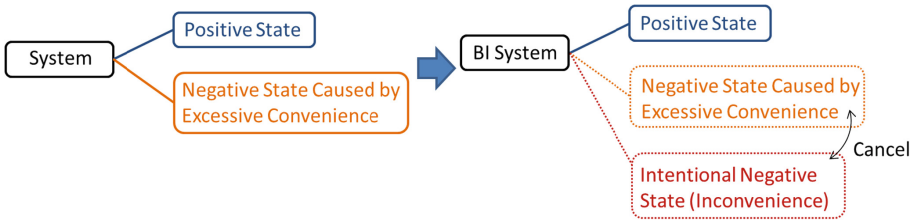
Fig. 9. C: HC system to D: BI system

In this category shift, one may firstly select a system that can be recognized as a HC system or a system that has potential to be a future HC system and select candidate inconveniences that may be intentionally added to the system for BI generation to cancel the "Negative State" caused by the excessive convenience.

D: BI System to D: BI System

As shown in Fig. 10, this idea generation procedure aims to develop a new BI system by transferring the essence of already recognized BI to another system. For example, BBQ restaurant provides the guests with the opportunity to devise and sense of accomplishment through the self-service of cooking. This concept can also be applied to other restaurants dealing serving other cuisines.
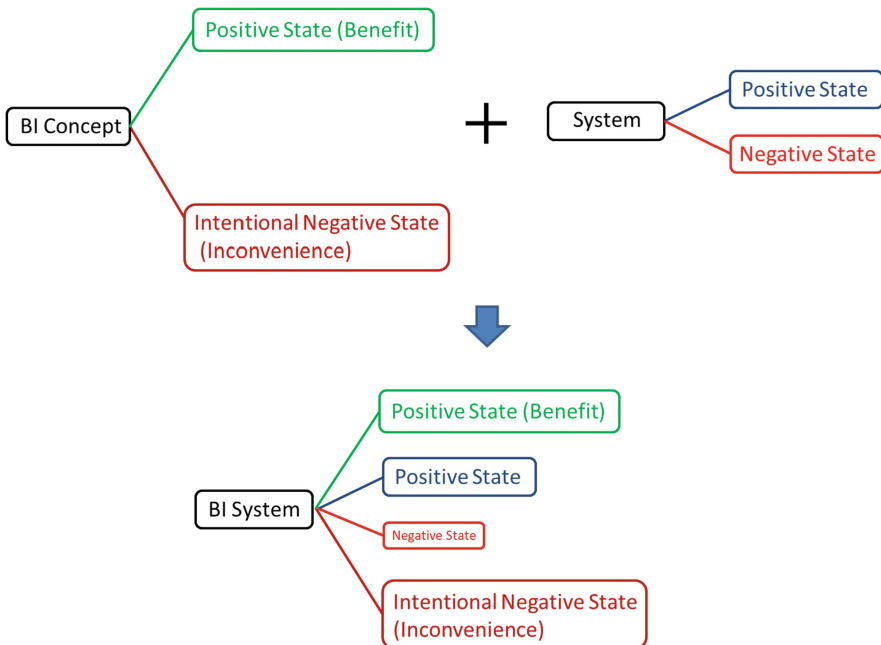

Fig. 10. D: BI system to D: BI system

In this category shift, one may start with recognizing a BI essence in a BI system that has been already invented, and by transferring it to another system for generating new BI system concept.

3.2 Questionnaire Survey

The authors have performed questionnaire survey, which aims to confirm the perception on BI, with voluntary cooperation of participant students in the lectures and workshops. The questionnaire survey has already been performed on business persons who has interest on VE by Society of Japanese Value Engineering [8]. The questions focused in this research were, *Q1: "Do you think that there are some benefits (value) that come from an inconvenient situation"*, *Q2: "If your answer to the previous question is "Yes", do you think that there is a function which may intentionally realize some benefits from an inconvenient situation?"*. The answers to these questions are "Yes", "No" and "Yes or No". The results from the business person and the students were compared to argue about the application of BI to university career education.

4 Results

This section shows the results of the lectures and workshops about BI focusing on the submitted BI systems as well as the questionnaire survey performed on the business persons and the participant students.

4.1 BI Systems Generated Through Idea Generation Procedure

So far, 81 ideas of BI system have been submitted through the workshops and lectures. These BI systems were generated based on the idea generation procedure introduced above, but some ideas seemed to be generated with misunderstanding about the BI concept. Here, Table 2 shows the number of BI systems based on each idea generation procedure with the number of ideas that seemed to include misunderstanding.

Table 2. Sample ideas of BI

	Number of submitted BI systems	Number of BI systems with misunderstanding
A: HI system to D: BI system	25	5
B: BC system to D: BI system	25	8
C: HC system to D: BI system	12	3
D: BI system to D: BI system	16	3

4.2   Questionnaire Survey

In total, 83 business persons and 22 students have answered to the questionnaire survey. "Yes" was selected by 59 business persons and 20 students selected in *Q1: "Do you think that there are some benefits (value) that come from an inconvenient situation?"*. Then, 67 business persons and 22 students joined *Q2: "If your answer to the previous question is "Yes", do you think that there is a function which may intentionally realize some benefits from an inconvenient situation?"*. "Yes" was selected by 52 business persons and 15 students in Q2. Figure 11(a) and (b) illustrates the breakdown of the answers made by the business persons and the students respectively. The sample numbers for Q2 is smaller than those for Q1, because only those who answer "Yes" to Q1 join Q2.
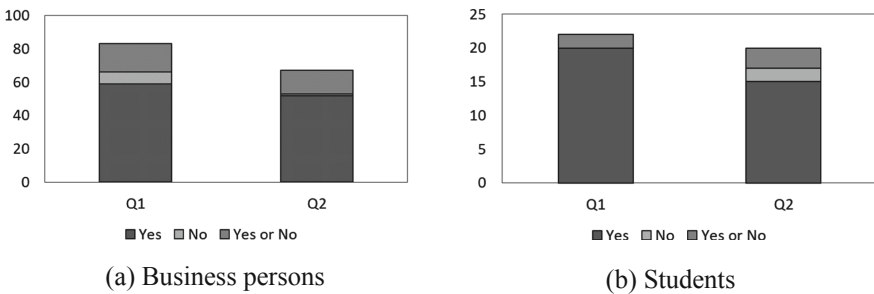

(a) Business persons   (b) Students

Fig. 11.   Survey results

5   Discussions

This section firstly performs discussions about the BI systems submitted by the participant students in the lectures and workshops. The discussions focus on each of the four idea generation procedures, "A: HI system to D: BI system", "B: BC system to D: BI system", "C: HC system to D: BI system" and "D: BI system to D: BI system". In addition, the results of the questionnaire survey conducted on the business persons and the students are compared to consider the meanings of learning the concept of BI for the students' career development.

5.1   BI Systems Submitted by the Participant Students

A: HI System to D: BI System
Typical BI systems proposed by the category shift of "A: HI system to D: BI system" included flea market services such as auction, street stalls and others. The inconvenience here is time consumption required for negotiating directly with the product sellers or producers, while one may be possible to confirm the personality of them as the BI of "Feel at ease", "Reliability" and "Understand System". Other opinions of BI essences were "Make original" and "Devise ways" because one may customize own

services through the negotiation. Another typical BI system proposal was festivals and ceremonies. Festivals and ceremonies require the inconvenience of time and effort for preparation, while they promote the understanding one's own society culture as the BI of "Enhance awareness" and further tighten family ties as "Feel at ease". Festivals and ceremonies may also include "Make original" and "Devise way" because various creativities are required in their planning phase. Other BI systems, which may have been inspired by the examples shown in the instruction, were products and services related to DIY (Do it yourself), such as hot pot restaurant, BBQ, self-made furniture. Instead of the inconvenience of time and effort spent on DIY, these systems improve skills for each task as the BI of "Improve", provide rooms for creativity as "Devise ways" and provide opportunity to understand their production processes as "Understand system".

Some BI systems proposed by international students included traditional foods and cultures in their country. In addition, their proposals also included BI essences originated from everyday lives in their home country, which has been firstly recognized through convenient life and relatively temperate climate in Japan. So, career education with BI concept may also be applicable for fostering international perspective.

Meanwhile, some ideas indicated that some students generated BI system with misunderstandings because the fundamental BI concept may not have been properly transmitted through the instruction. For example, some were trying to increase self-satisfaction instead of inconveniencing others. Others generated ideas of BI systems that seemed to be intending to "improve" situation. The BI essence of "Improve", however, should contribute to improvement of certain skills.

B: BC System to D: BI System

Some BI systems generated through the category shift of "B: BC system to D: BI system" was added with randomness to gamify ordinary products or services as the inconvenience of "Disorder" to generate the BI of "Improve" and "Enhance awareness". Other systems realized the BI of "Prevent downskilling" by introducing restriction to a human action that should be unconsciously done, posture for example, as an inconvenience. Other interesting examples include providing an opportunity to
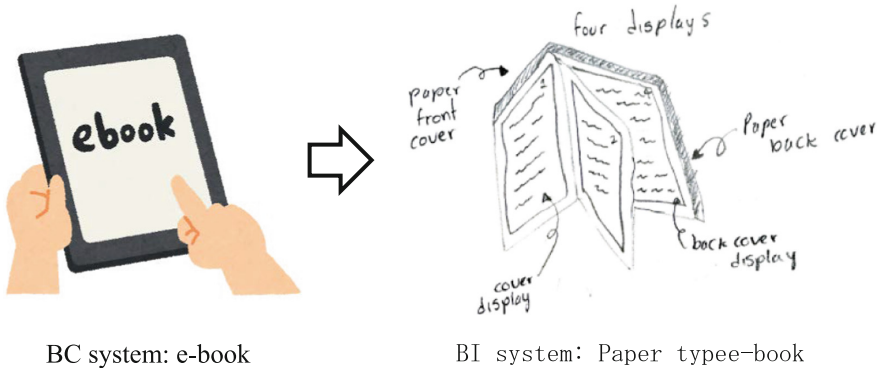

BC system: e-book   BI system: Paper typee-book

Fig. 12. Paper type e-book

appreciate beautiful scenery by riding on slow-speed vehicles, providing special experiences at travel destinations by limiting certain services, and providing a new type of e-book which has multiple displays that simulates to be a paper book as shown in Fig. 12.

Especially in this process, the participant students were required to generate a new system that does not currently exist, but some of them exploited the sample examples of BI systems, such as DIY, without thorough consideration. So, as a future challenge, we may limit the topic of idea generation in order to promote more creative and practical ideas.

Some examples presented here indicated that some participant students misunderstood about BI. Some proposed systems that transfer inconveniences on a certain products and services to others just for their own convenience. Others presented systems that require inconveniences in order to achieve certain purposes. These systems, however, should be considered as either HI system or HC system. Although these system evolutions may include ethical problems, the instruction should have more clearly stressed that these system evolutions are not about BI systems but only transition from HI system to BC system.

C: HC System to D: BI System

In this category shift, the participant students mentioned the following systems as the examples of HC system. It is convenient to have convenience stores that open 24 h anywhere in Japan, but sometimes people waste time by popping into there without clear items to buy. E-mail and SNS are convenient to send messages anywhere at any time, but one may not reply to all messages in a hectic situation and, in addition, organic interactions among people have been lost. Search engines are convenient tool to obtain necessary information anywhere at any time, but too much dependence may deteriorate memory ability.

The participant students have suggested BI system against the harmfulness by adding the inconvenience of restriction on the usage of convenience store, search engine, e-mail and SNS. Some proposed, which is based on misunderstanding about BI, to use previous system with inconvenience to avoid harmfulness in HC system.

D: BI System to D: BI System

For effective idea generation by exploiting this category shift may be just recognizing unknown potential BI essences sooner than others. So, the BI system in this category shift may have been easier process for innovating new systems. Many proposals, however, were only pointing the essence of existing BI systems. Especially, some BI systems, which are similar to existing systems, were generated by transferring the DIY factors to another system. Some proposed previous systems with inconvenience based on misunderstanding about BI.

5.2   Discussion on Questionnaire Survey Result

In order to confirm the statistical significance of the questionnaire survey result, Z-test was performed on the ratio of the respondents who chose "Yes" to the total respondents. The null hypothesis for the Z-test was "The probability that a questionnaire respondent chooses "Yes" is 1/2.". The calculated Z-value were 3.8, on business person

who answered "Yes" to Q1, 4.5, on business person who answered "Yes" to Q2, 3.8, on students who answered "Yes" to Q1 and 2.2, on students who answered "Yes" to Q2. Hence, the null hypothesis is rejected for all the respondent types at the significance level of 5%. The results of the Z-test indicate that larger number of both the business persons and the students who have been exposed to BI concept recognized potential value in BI and intentional addition of inconveniences works as a strategic BI generation.

Especially recognizing the category shift of "C: HC system to D: BI system" probably contributes the career development of the participant students, in which various tasks are replaced by machines equipped with computers and the students may be required to create values exploiting BI system rather than pursuing convenience. Future works on this research should develop more practical contents such as discussions engaging companies that deal with products and services engaged in this category shift seeking the possibility of application of BI.

6   Conclusion

Innovations have mainly focused on eliminating time consumption and other physical burdens spent for achieving intended purposes; so, the meaning of innovation may have been equivalent to developing a new convenient system. Excessively convenient society, however, may be exposed to various problems, while the technological evolution has realized many conveniences. The authors, then, focus on applying an innovation methodology that exploits BI associating with the value creation in excessively convenient society to university career education as an important guideline for university students to proactively design their future life plans. This research has introduced our challenges on lectures and workshops, where innovation methodology with BI was introduced and associated with career development. The BI systems submitted by the lecture participant students were analyzed to recognize the students' understandings on the BI concept. In addition, we explored the results of a survey conducted on the students and business persons who have strong interest on Value Engineering to indicate possible connection between the innovation with BI and future methodology for career education.

References

1. Frey, C.B., Osborne, M.A.: The Future of Employment: How Susceptible are Jobs to Computerization? Oxford University (2013)
2. Sawaguchi, M., Kawakami, H., Matsuzawa, I., Nishiyama, K., Miyata, N.: Study of VE/VM method sustainable for social growth period-introduction of the third-function named "Fubeneki". In: 2018 Value Summit Conference Proceeding (2018)
3. Tsuchiya, H.: Shin VE no Kihon (New Basic VE in English). The SANNO Institute of Management Press (1998). (in Japanese)
4. Fey, V., Rivin, E.: Innovation on Demand: New Product Development Using TRIZ. Cambridge University Press, Cambridge (2005)

5. Nishiyama, K., Emanuel, L.: Development of checklist for systematic research communi-
   cation in multidisciplinary fields. In: 2018 IEEE Global Engineering Education Conference
   (EDUCON), pp. 427–436. IEEE, Spain (2018)
6. Kawakami, H., Sawaguchi, M., Matsuzawa, I., He, X.: Value engineering introducing value
   of Fubeneki. Value Eng. (294), 10–15 (2016). (in Japanese)
7. Further Benefit of a Kind of Inconvenience System Laboratory. http://fuben-eki.jp/. Accessed
   31 Jan 2019
8. Society of Japanese Value Engineering. https://www.sjve.org/eng/eng-home. Accessed 31 Jan
   2019