INTERNATIONAL DESIGN CONFERENCE - DESIGN 2014
Dubrovnik - Croatia, May 19 - 22, 2014.

A SUPPORT FOR DESIGN OF USE IN CONSIDERATION OF USE PHASE

S. Shimada, T. Ogata, J. Ota , T. Hara and Y. Kurata

Keywords: service engineering, co-design

1. Introduction

As society and the economy develops, people require an increasing variety of products and services and various processes need to be developed for providing the same. Therefore, the entire development process becomes very complex. In particular, the design and the use phases are strongly and inseparably related. Recently, in some forms of design, customers have attended to the development process [Robey 1982], [Barki 1994], [Yang 2003] and simultaneously designed and used products/services. Many approaches have been used for achieving the same, such as user-centered design [Abras 2004], participatory design [Pilemalm 2008], lead-user innovation [Hippel 2005], and reinvention [Carroll 2004]. Methodologies to analyze users' requirements are developed, such as Conjoint Analysis [Green 1990], Quality Function Deployment(QFD) [Chan 2002], Customer Relationship Management(CRM) [Payne 2005]. However, when one user design some products or services on his/ her own desire and situation, these methodologies are difficult to apply to the design. For example, Conjoint Analysis is the methodology for specifying factors of products and services statistically with much amount of data and thus, this methodology is not valid for defining one user's requirement. QFD can give the direction of design based on relationship among users' requirements and function of products and services. However, QFD requires designers to input many information for the relationship and that takes much time and effort. Especially, users hope to consider only attractive factors. Therefore, for design by users, a methodology that can improve design while users reflect their interests in objects to design is necessary.

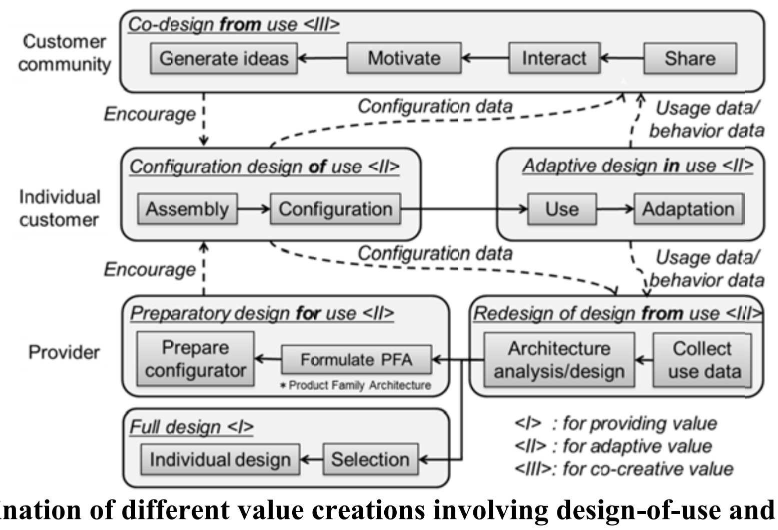

Figure 1. Combination of different value creations involving design-of-use and design-in-use by the customer [Hara 2013]

The authors have introduced a model for combining design activities by the manufacturer, individual customer, and customer community (Figure 1) [Hara 2013]. This paper focuses on the "Configuration design of use" and "Adaptive design in use" by an individual customer. The data gained through these processes is valuable for other processes. Thus, by encouraging value creations on these design, the entire development process is expected to be activated and improved.

In section 2, we explain engineering processes that involve and do not involve customers. The importance of design by customers is explained from the difference between these two processes. In section 3, we propose a support for design in consideration of the use phase. Then, we study a tourism service as an example. In section 4, we describe the characteristics of the tourism service and the problem definition in the field. In section 5, we propose a support based on the actual support system for designing a trip. In section 6, we summarize the conclusions of this study.

2. Design by customers and tasks of providers in an engineering process

2.1 Customers in the general engineering process of a product

Figure 2 shows a general engineering process of a product designed by providers [Hara 2013]. The design process includes concept design and detailed design, and the production process includes production, manufacture, and quality control. In this entire process, customers attend only to the use phase. In other words, customers simply consume the goods designed and produced by providers. In the design process, customers only appear as the Voice of Customer (VoC), and their characteristics and behavior are not considered.

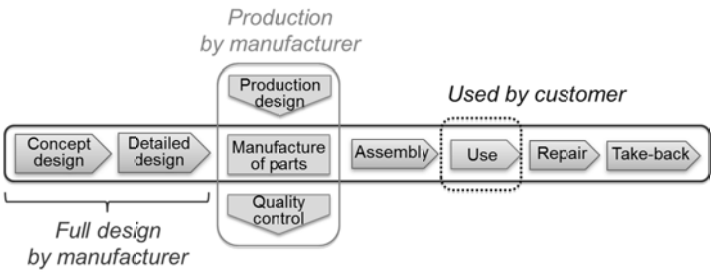

Figure 2. General engineering processes of a product [Hara 2013]

2.2 Involvement of high customer participation

As mentioned above, this study focuses on adaptive design in use by customers. Figure 3 shows an engineering process involving high customer participation [Hara 2013]. The main feature of this process is the processes of configuration and adaptation by the customer. The process of full design by the manufacturer is changed to that of preparatory design.

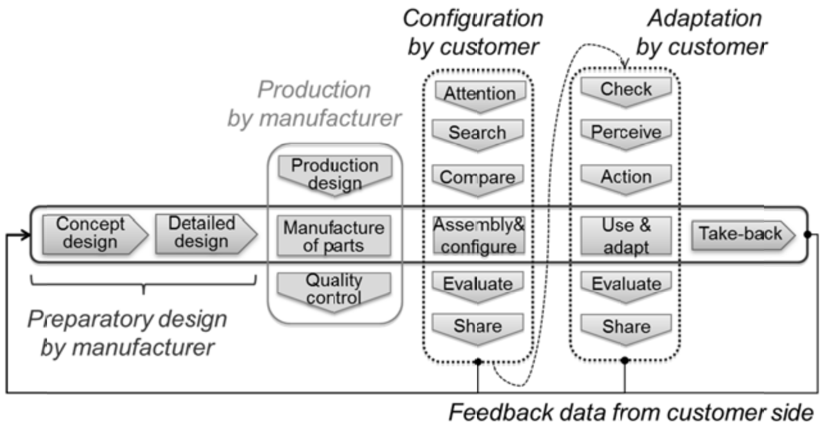

Figure 3. Engineering processes of a product involving high customer participation [Hara 2013]

In this process, manufacturers design the basis of products/services and prepare for configuration by a customer. In this situation, customers not only use products/services but configure and adapt the parts prepared by the manufacturer. Thus, they become co-designers of products/services. By providing customers with more freedom for developing products/services, they can make these products/services more fit to their requirements and the conditions in the use phase.

2.3 Design of use

2.3.1 A role of provider and customer

Explaining Figure 3 with regard to the activities shown in Figure 1, preparatory design by the manufacturer includes formulating the PFA (Product Family Architecture) and preparing the configurator. Next, the process of configuration by the customer is carried out as assembly and configuration in the configuration design of use. In the use phase, customers use and adapt products/services to the environment in the use phase.

In particular, in the use phase, many customers use and adapt products/services individually (without the providers' help). However, it is difficult for non-experts to design the same even with the assistance of experts [Barki 1994]. Therefore, providers need to develop products/services, of which they are experts, such that they are easy to use and adaptable to various environments in the use phase. Customers using these products/services in the use phase need to actually adapt them. By a combination of these processes by providers and customers, products/services gain more value in particular needs and environments.

2.3.2 Early studies and present situation of support

Customer involvement is used as an approach to respond to each customer [Robey 1982]. At a theoretical level for involvement, [Yang 2003] defined some types of involvement according to the degree of steps that the customer attends to and proposed postponement management. Postponement management is a management approach for handling supply chains. In this approach, by involving customers in the phase in which products/services are differentiated, the quality can be improved and cost, such as inventory cost, can be reduced.

As a concrete example of customer involvement available in the market, Figure 4 shows NIKEiD [Nike Inc. 2013], an online service provided by Nike. By using NIKEiD, customers can customize their shoes and order them easily.

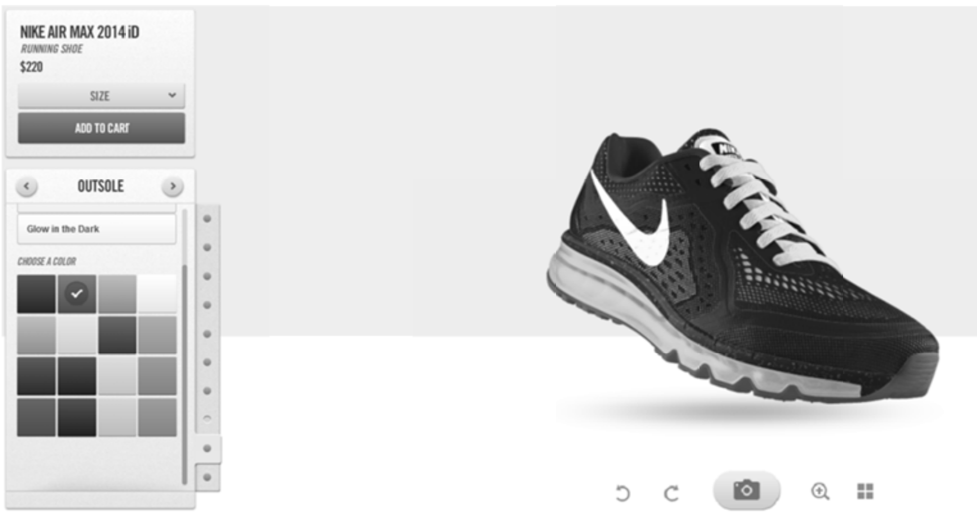

Figure 4. User interface of NIKEiD [Nike Inc. 2013]

Early studies and systems focused on supports to gain solutions for design. However, to encourage more customers to design by themselves, especially in the use phase, the support of design in consideration of use is needed.

3. Proposal of this study

3.1 Objective of this study

As mentioned in section 2.3.1, the combination of processes by providers and customers is important for products/services to gain more value for particular needs and environments. In this light, this study focuses on configuration design of use in consideration of adaptive design in use. It is difficult for providers to attend to the use phase in many cases. Furthermore, supporting customers through trained personnel will incur a large burden and cost. Thus, we aim to encourage adaptation by customers by providing support in configuration design through a computer system. In other words, we propose providing support for preparing and using the configurator. In the next section, we explain our proposal from two viewpoints.

3.2 Proposing support

3.2.1 Support for customers to understand their requirement more clearly

As described above, early studies and systems focused on support to gain design solutions. However many of these supports estimate the requirement of customers who use the system to calculate the score of design solutions. From this viewpoint, these supports can be categorized based on the relationship between the requirement and the components/solutions. Figure 5 shows four types of supports based on customers' activities in design. (a) The first is support for visualizing requirements. It cannot contribute toward developing a solution separately. It works as a support to the input requirement. (b) The second is direct support for developing a solution based on customers' requirements. A computer system evaluates the components of products/services based on input data for requirements and recommends a solution fit to these requirements. (c) The third is support based on actual components. One example of this support is the recommendations that appear in Amazon [Amazon.com 2013]. When customers buy some products, the system recommends other products based on the similarity of features. Another example of (c) is customization, such as that in personal computers. In this case, providers divide products/services into some components and prepare a configuration based on the divisions.

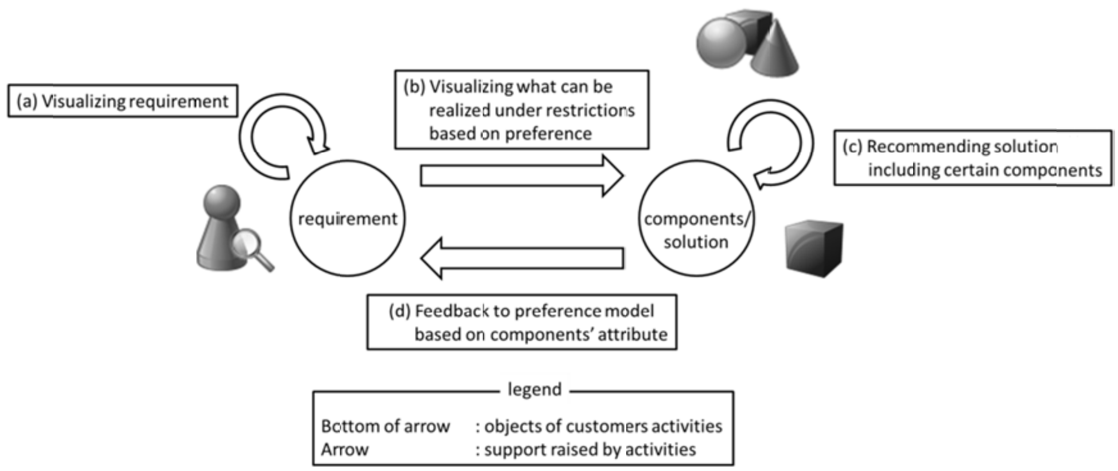

Figure 5. Customer's activities and support by a methodology

(d) is hardly supported because if a concrete solution is obtained, it means the end of design on most support systems. One example of this estimation is the system of interactive design. For example, [Yanagisawa 2003] proposed a system to design Eye Glass Flame. In this system, customers evaluate a presented solution repeatedly, and "knowledge" about the design eye glass flame is updated in the system. This estimation does not appear in the user's view, and the estimation itself is not a support for the user.

This study aims to prepare a configurator that supports all four arrows.

3.2.2 Support to exploit a proper design solution in the use phase

Another proposal is to show a design solution to customers that can be easily adapted in the use phase. Providing some similar solutions is one approach for this purpose. Case-based design [Hinrichs 1991] is a methodology for this design. However, it is cumbersome for customers to prepare many solutions for various use cases, and therefore, a simpler support should be made. We propose an approach to provide one basic solution with some options that can be chosen by customers.

For this support, support system let users to fix input data of requirements and restrictions temporarily. Based on the fixed input, support system proposes changes of a part of restrictions, for instance, the maximum limitation of height of a component 5cm lower. Then, the system shows both solution on original restrictions and that on changed restrictions. With these solutions, users can see difference in what can be realized with same requirements on some restrictions. Changes of restrictions depend on the cases. The changes of factors which is incident in situation of actual use and which users cannot influence, are effective as support.

4. Case Study: Tourism Service

4.1 Features of tourism service

In this study, the proposed approach is demonstrated for the case of a tourism service. Tourism mainly involves the experiences of visiting spots for sightseeing. However, visiting alone is not enough to fully enjoy a spot. Knowledge about spots, such as historical background, will enable tourists to enjoy them better. In other words, the quality of tourism depends on whether tourists can travel properly and enjoy a complete experience. Thus, this service is a typical example of services in which the value in use [Vargo 2008] has much importance.

Another important characteristic of a tourism service is the tourists themselves planning and adapting a trip. A packaged tour is a product that is fully designed by the tourism providers. Customers of such tours cannot change any of its aspects. On the other hand, many tourists plan their trip and travel themselves. This can be regarded as a product involving high customer participation. Some tourists travel alone even though it is their first trip to a foreign country. In short, configuration and adaptive design are general, and support for them is also an important issue in the field of tourism.

As design object, tourism service has complexity of components and of relationship among components. This study constructs trip plan as combinations of sightseeing spots. Sightseeing spots, as components of trip plan, are combined through fixing routes for a transfer. The complexity is that even though the same spots compose trip plans, those plans differ in time for sightseeing and transfer. With this feature, supposing some cases is not enough and we propose design in consideration of adaptive design in use. For physical products, the size of each ingredient don’t change in regular usage. However, when a component is replaced by bigger one, other components need to adapt the change or also replaced by another.

4.2 Problem definition in tourism

In this section, the problem setting of the tourism service is described. For tourists to travel properly, they need to understand their requirements well and exploit their plan in the use phase, and providers should support tourists in the same.

Some support systems for trip planning are developed for a particular sightseeing destination. For example, [Kishimoto 1997] recommended a trip plan for Kanazawa (a Japanese city) based on input data provided by tourists. A user of this system fixes some parameters of attributes such as age and sex and of tourism preferences such as nature. The system calculates the score based on the database and recommends the best plan based on the input data. However, as with the early studies and systems introduced in section 2.3.2, these systems also focus on obtaining a design solution (plan).

This study proposes supporting customers (tourists) to understand their requirements more clearly and to exploit a plan applied by the support system in the use phase. In the next section, we introduce a support system for trip planning developed by Kurata, one of the authors. Based on this system, we propose a support for the tourism service.

4.3 Position of tourism service in other cases

Tourism service has features expressed in 4.1. We choose this service because design by users are general in this field. Co-design between a user and an expert is active at travel agencies. On that point, for applying this study to other field, how to integrate the support and the system into the field is another issue.
The feature of complexity as design object sometimes make support for design dependent on cases. However, supports proposed in this study are common to the cases with the complexity, such as support by feedback to requirement based on activities on components and support to exploit a proper solution by showing the changes of factors which is incident in situation of actual use and which users cannot influence.

5. A system for trip planning and the support proposed for it

We propose an approach to support trip planning using CT-Planner [Kurata 2011]. CT-Planner is a support system for trip planning through interactions between users and the computer system.
Section 5.1 describes the specifications of CT-Planner as well as its functions that have been implemented before this study. Section 5.2 introduces the support proposed in this study and explains the process of trip planning using the new version of CT-Planner. Finally, the expected effects of the support for tourism are described, and the support is discussed from the viewpoint of customer requirements and design solutions.

5.1 Specifications of a system as basis of support

5.1.1 Components of support system and user activities in system

Figure 6 shows the main interface of CT-Planner. In left part of the window, a user can set some parameters regarding preferences and restrictions, such as duration of trip, start time of trip, and sightseeing preferences. The middle part of the window shows a recommended trip plan on the map. The right part of the window shows spots included in the plan under the itinerary.

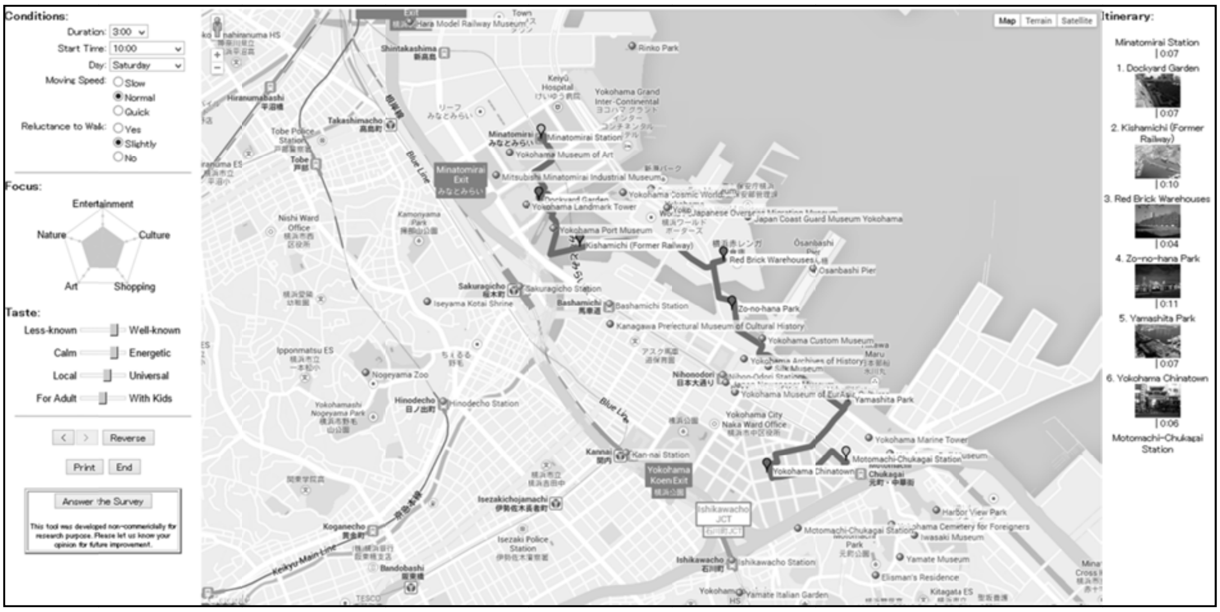

Figure 6. Main Interface of CT-Planner [Kurata 2013]

User activities in the system can be divided into two actions: fixing parameters and choosing components. Figure 7 shows a magnified view of the left side of the main window. By changing various settings using the mouse, the parameters of sightseeing preferences can be changed.

Figure 7. Parameters of sightseeing preferences

When a user clicks on an attractive sightseeing spot on the map, a window such as that in Figure 8 appears. This window shows information about the spot. The lower part of this window has buttons labeled "Visit," "Avoid," and "Depend." If the user clicks "visit," the support system will recommend a plan including this spot. In other words, visiting this spot works as a restriction. Avoiding the spot also works as a restriction in that the system excludes it.

Figure 8. Information and condition of sightseeing spot

5.1.2 Process for planning through interactions

The basic process for planning is similar to that of [Kishimoto 1997]. Based on the input parameters regarding preferences, CT-Planner recommends a plan. The particular feature of planning using CT-Planner is interactions. The user interaction does not end with setting input parameters; while seeing the recommended plan on the map, the user can change the input parameters. When some parameters—either preferences or restrictions—change, the system recalculates and recommends a new plan to fit the new input data. By repeating these steps, a user can fine-tune the plan. [Kurata 2011] said that CT-Planner "models the interaction between a tourist and a tour advisor" and "with this interface, the user no longer has to specify his tour interests explicitly before seeing actual plans."

5.2 Proposing support for tourism service

The concept of support is described in section 3.2. These concepts are now applied to a tourism service using CT-Planner. Figure 9 shows Figure 5 redrawn for a tourism service.

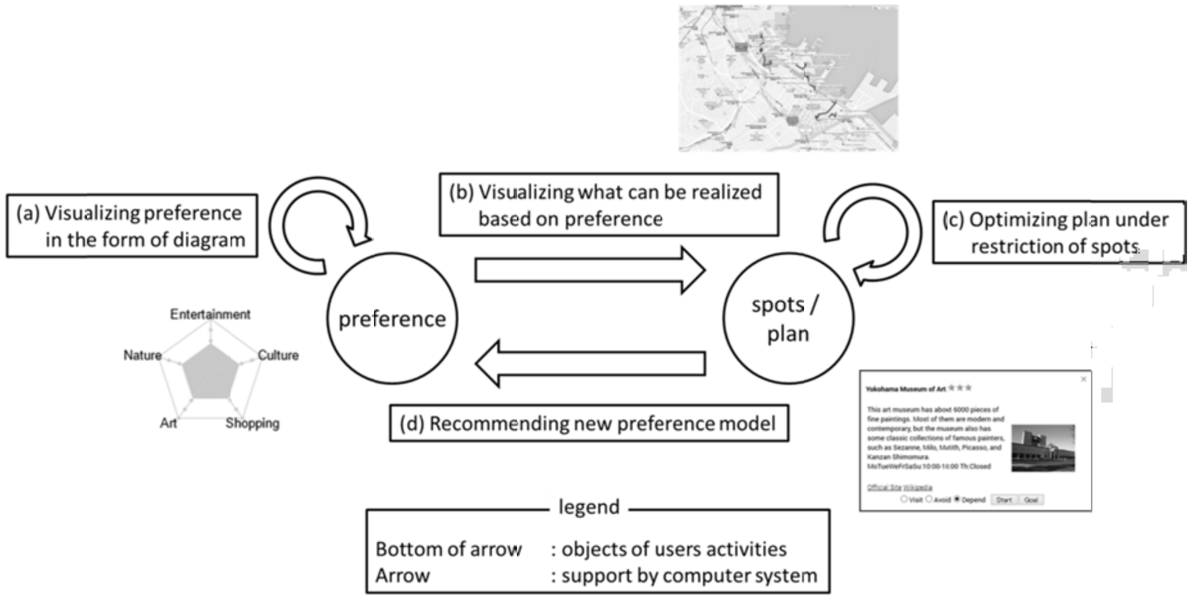

Figure 9. User's activities and proposing support

(a) The left part of the interface shows the visualizing requirement. (b) When a user changes the preferences, the recommended plan is recalculated. (c) shows that if some spots are set as "visit" or "avoid," the plan is calculated under new restrictions. These are supported in CT-Planner [Kurata 2011]. What is original in this paper is arrow (d) and some added support in (b). The proposed support in (d) is feedback to the preference model based on the user's activity at spots. As shown in Figure 10, after setting "visit" as shown in Figure 8, a new preference model is estimated based on the spot. A user can choose whether to update the preference model.

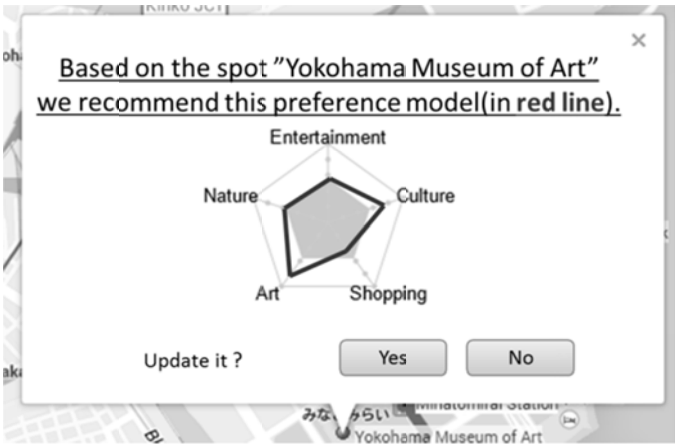

Figure 10. Recommendation of preference model

The support added in (b) shows information about plans with the same indexes of preference(Figure 11). The concept of support is the same as that in (b), but what is visualized is different. CT-Planner shows spots and the root between spots on the map, and the new support shows an interpretation of the plan from the viewpoint of preferences. This can support understanding both the preferences and the solution.

These supports help users understand their requirement more clearly. A support for providing a trip plan that tourists can apply in the use phase is the future focus of our studies.

Figure 11. Visualization of a plan on indexes for preference

5.3 Discussion: Expected effects of proposed support

This study aims to encourage adaptation by customers by providing a support for configuration design of use. Thus, the most expected effect is encouraging adaptive design by the customer in the use phase. Our approach supports customers in understanding their requirements through the design process. This can contribute not only improve customer satisfaction but also motivate customers. Moreover, the adaptation is sometimes connected to reinvention and improves products/services greatly.

The design process focused on in this study is only one part of the development process for products/services, as shown in Figure 1. By encouraging configuration and adaptive design by customers, our proposal can enrich the data used by customers. Then, these data can be applied to other designs, for example, a full design by the provider. In the tourism service, by using data from individual travelers, the quality of packaged tours can be improved.

6. Summary

Adaptive design in the use phase can contribute to great improvements in products/services. Thus, this study aims to encourage adaptation by customers through support for configuring the design of use. We propose a support to make customers understand their requirements and provide solutions so that customers can exploit them in their adaptation. For the tourism service, a concrete methodology of the proposal is explained for understanding the requirements of tourists. These supports are expected to improve other value creation activities.

Future works include implementing the proposed support, including how to provide the solution in a tourism service, and verifying the support through experiments. Furthermore, expertise and a methodology should be generalized and integrate into the development process of products/services.

Acknowledgement

This research is supported by the Service Science, Solutions and Foundation Integrated Research Program, Research Institute of Science and Technology for Society (RISTEX), Japan Science and Technology Agency (JST).

References

Abras, C., Maloney-Krichmar, D., Preece, J., "User-Centered Design", In Bainbridge, W., Encyclopedia of Human-Computer Interaction, Thousand Oaks: Sage Publications, 2004.

Amazon.com, Amazon Inc., (http://www.amazon.com), accessed on 12-01, 2013.

Barki, H., Hartwick, J., "User Participation, Conflict, and Conflict Resolution: The Mediating Roles of Influence", Information System Research, Vol. 5, No. 4, 1994, pp. 422-438.

Carroll, J. "Completing Design in Use: Closing the Appropriation Cycle", Proceedings of the European Conference on Information Systems (ECIS 2004), Finland, CD-ROM, 2004.

Chan L.-K., Wu M.-L., "Quality Function Deployment: A Literature Review", European Journal of Operational Research, Vol. 143, 2002, pp. 463-497.
Green, P. E., Srinivasan, V., "Conjoint Analysis in Marketing: New Developments With Implications for Research and Practice", Journal of Marketing, Vol. 54, October, 1990.
Hinrichs, T. R., Kolodner, J. L., "The roles of adaptation on case-based design", In Proceedings of the Ninth National Conference on Artificial Intelligence, AAAI Press/The MIT Press, 1991, pp. 28-33.
Hippel, V. E., "Democratizing Innovation", London: MIT Press, 2005.
Kishimoto, H., Mizuno S., "Development of tour planning support system using MDL and Genetic Algorithm", Proceedings from the AI symposium '97, SIG-KBS(in Japanese), Tokyo, Japan, 1997, pp. 71-76.
Kurata, Y., "CT-Planner2: More Flexible and Interactive Assistance for Day Tour Planning", Law, R., Fuchs, M., Ricci, F. (eds.) ENTER 2011, Information and Communication Technologies in Tourism 2011, Innsbruck, Austria, 2011, pp. 25-37.
Kurata, Y., CT-Planner4.3 (http://ctplanner.jp/ctp4/index-e.html), accessed on 12-02, 2013.
Nike Inc., Nike.com (http://www.nike.com/us/en_us/c/nikeid), accessed on 12-07, 2013.
Payne, A., Frow, P., "A Strategic Framework for Customer Relationship Management", Journal of Marketing, Vol. 69, October, 2005, pp. 167–176.
Pilemalm, S., Timpka, T., "Third generation participatory design in health informatics--making user participation applicable to large-scale information system projects", Journal of Biomedical Informatics, doi:10.1016/j.jbi.2007.09.004, April, 2008.
Robey, D., Farrow, D., "User Involvement in Information System Development: A Conflict Model and Empirical Test", Management Science, Vol. 28, No. 1, 1982, pp. 73-85.
Vargo, S. L., Maglio, P. P., Akaka, M. A., "On value and value co-creation: A service systems and service logic perspective", European Management Journal, Vol. 26, No. 3, 2008, pp. 145-152.
Yanagisawa, H., Fukuda, S., "Interactive Design Support System by Customer Evaluation and Genetic Evolution: Application to Eye Glass Frame", KES'2003 7th International Conference on Knowledge-Based Intelligent Information & Engineering Systems, University of Oxford, United Kingdom, 2003.
Yang, B., Burns, N., "Implications of Postponement for the Supply Chain", International Journal of Production Research, Vol. 41, No. 9, 2003, pp. 2075-2090.

Satoshi Shimada MA, Graduate student
The University of Tokyo, Research into Artifacts, Center for Engineering (RACE)
Rm535B, RACE, Kashiwa Research Complex, 5-1-5 Kashiwanoha, Kashiwa-shi, Chiba, 277-8568, Japan
Telephone: +81 4 7136 4273
Telefax: +81 4 7136 4242
Email: shimada@race.u-tokyo.ac.jp