# University-Industry Collaboration in Design Fields

## Management to Promote Reflective Practice by Students

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**Abstract**: In recent years, there has been a rise in university-industry collaborations in design fields across Japan. Normally, company designers and students have different background knowledge about design and thus their designs also have diverging characteristics. Although this heterogeneity is important in formulating a creative design, it leads to incompatibility in the collaboration process. Therefore, in order to create good performances, management of the collaboration process is necessary to deal with these problems. Through extensive analysis of successful cases of collaboration in Japan, my research indicates that "reflective practice" preformed by students is an important tool in dealing with incompatibility and that management can encourage reflective practice and thus achieve a more desirable collaboration process.

***Key words: University-Industry collaboration in design fields, Management, Reflective Practice.***

### 1. Introduction

In recent years, design has been increasingly acknowledged as a significant management resource and there has been a rise in the number of Japanese companies working with students of design universities on joint projects. These projects explore the possibilities of increasing the innovation of product designs and promoting creativity within the design organization. Normally, company designers and students have large differences in their background knowledge and thus the characteristics of their designs. While students create designs that emphasize creativity and originality based on imaginative ideas of their youthful sensibilities, company designers create designs to solve the practical problems of society and daily life. From the viewpoint of creating innovative designs and implementing them, such a huge heterogeneity is attractive to companies. However, this heterogeneity also leads to problems between company designers and students in the collaboration process. In order to bring about desirable performances, it is necessary for management to utilize this heterogeneity and to resolve any problems heterogeneity creates. However, existing studies have yet to discuss how the process of university-industry collaborations in the design fields can be managed. Therefore, research for this study was carried out to answer the question: "How can we deal with arising problems caused by heterogeneity in the collaboration process?". Through making a deep analysis of a successful case in Japan, my research aims to clarify some of the requirements of managing a collaborative design program that effectively utilizes and deals with the problems arising from heterogeneity. In this study, "design" mainly refers to the product design. The collaboration between design universities and companies is referred to as "University-Industry Collaboration in Design Fields".

## 2. Examination of existing studies

### 2.1 Features of the design process

The fundamental problems of the design process are to achieve fitness between the form in question and its context, and also to create an ensemble comprised of the form and its context [1]. According to Alexander [1], context defines the problem and presents a request to the form. In other words, the form is the solution to a problem and its design is determined by the designers' definition of the form's context. Therefore, designers need to define the context accurately. In this sense, defining the context is the core task of the design process. However, in modern society, multiple elements that should be satisfied interact complexly and design problems often reach insoluble levels of complexity. Alexander [1] and Simon [18] suggest that disassembling the design problem into semi-independent components is the most effective way of dealing with complex problems. In this way, designers can reach “satisfactory solutions” by frequently repeating a cycle in which they capture the “gap” between goal and reality as the problem, explore acceptable alternatives, evaluate them, and finally express the finished form. This analytical solution is useful in clarifying the structure of complex design problems. On the other hand, we must admit that there are certain limitations in dealing with unique design problems characterized by tacit knowledge features. When the designers perform tasks, they interweave many kinds of knowledge and information complexly and internally [7]. The designer's cognitive processes are dynamic with countless interacting factors occurring tacitly [20]. As mentioned above, the design process is the process of defining context accurately and achieving fitness between the form in question and the requested form's context. The design process is characterized by the complex cognitive process of utilizing various kinds of knowledge, thinking both logically and intuitively, and progressing in an action-oriented way through trial and error.

### 2.2 Management of organizational design process

If designs are created by organizations within companies, the complexity of the design process increases due to the involvement of multiple designers. One of the basic principles in the organizational design process is the achievement of “consumer-centered product designs”. Consumer-centered product designs grasp the needs and basic knowledge of users efficiently, share them among organization members, and reflect them to be designed rapidly [9]. Norman [11] also emphasizes that it's important for designers to share the same image (cognition) as users for the final design (product) while researching the designs of tools used in daily life. The suggestion of Norman [11] implies that, from the viewpoint of creating good designs more efficiently in an organization with several members, designers need to share not only the cognition and needs of users but also the knowledge and cognition of the other members working on the design (product). However, it is not easy for designers to share image (cognition) among the members of a design group because there are unique features reflected in the sensitive aspects of each member's design that go beyond logical explanation.

Organizational design activity is strongly associated with knowledge creating and sharing among members [4]. If design is realized through knowledge, we can regard design process as a problem-solving process that combines explicit knowledge and tacit knowledge. In the design process, tacit knowledge is particularly important [20]. Dumas [7] pointed out that, in order to create good designs, cross-functional teams involved in the design need to go through the complex process of, for example, interweaving their knowledge with each other. Moreover, in order to generate more creative designs, the interwoven knowledge should be diverse and there should be little relationship between the separate pieces of knowledge [8]. It becomes necessary in organizational design

processes for members of the design team to share the cognition of the users through mutual coordination and to interweave their tacit knowledge into the design. Therefore, in order to carry out complex processes within organizations, it is necessary for interdependent members involved in design development to coordinate and share their work and cognition mutually [3].

Though some basic requirements in the organizational design process have been pointed out in existing studies, these studies have merely discussed the management requirements of the design process for the creation of designs in a single organization. Moreover, these discussions do not fully answer the management issue of creating designs in multiple organizations which have different domains, such as university-industry collaboration in the design fields. It is supposed that a collaboration process involving highly heterogeneous members becomes more complex and difficult to coordinate mutually to meet the above-mentioned requirements of management. Moreover, arising problems are also presumed to have a serious effect on performances. My research focuses on how university teachers and company designers can concretely deal with problems in the collaboration process through making a deep analysis of the successful case of collaboration in Japan discussed below. Finally, my research identifies how university teachers and company designers can develop and manage a collaboration process.

## 3. Case

This case concerns the university-industry collaboration activity of the Power Products R&D Center of Honda R&D Corporation (Honda) and Tohoku University Art and Design (TUAD) which took place from April to December in 2008. Following the flow of joint projects, the research in this chapter carefully examines which kinds of problems arose between members in the collaboration process and how university teachers and Honda designers dealt with these problems. This case was selected specifically for the reason that both Honda and TUAD recognized the need for effective collaboration in the activity and because this case fit this research's question. The description of this case is largely based on survey records from interviews done by the author and on secondary materials. Interviews with 4 individuals involved in the collaboration activity were conducted four times from August 2008 to April 2009.

### 3.1 Background and purpose of the collaboration activity

Honda has been actively working on joint projects with students from design universities in Japan for many years. Their purpose is to develop better designs by utilizing the creative ideas and youthful sensibilities of students, and also to promote creativity and awareness in their own designers through interactions with students. In this case study, Honda and TUAD worked on designing of "power products" such as tillers and mowers that use a small general-purpose Honda engine. Their final aim was to complete the prototype models. Collaborative activity progressed in the way of students proposing designs for power products and their university teacher or Honda designers giving them advice and guidance.

### 3.2 Collaboration activity

As the collaboration activity continued, the problems that the university teacher and Honda designers had to resolve were that firstly, students had no basis for conceptualizing a design because they lacked experience in designing actual products for companies, and secondly, they were not familiar with power products like tillers

and mowers. Therefore, students often failed to generate ideas in the early stage of laying out the design's concept. To deal with this problem, their teacher arranged an opportunity for the students to operate existing Honda power products in a field constructed on the university grounds specifically for this project. He also gave students the chance to actually grow crops in the field from spring to autumn. The students experienced seeding, weeding, and harvesting. By using the existing products in various seasons, situations, and for various purposes, students gained an understanding of the basic premises of design. For example, they gained a sense for the product's operation and structure ("What makes work easier?", "What power products use general-purpose engines?"). Through this understanding, students became capable of pointing out the specific problems of existing tillers and mowers. Some of the problems they encountered were: "The existing products were hard to bring to the field", "The operating display of the existing products was not refined and hard for novice users to understand", "The existing products were too difficult to operate for users who did not have much strength", "The form of the existing products was unfamiliar". Through these experiences, students gained a deep understanding of the user's actions. For example, they learned which function was required in which specific situation, and they were able to set out the design concept and express the form based on the problems they found in their own experiences.

In this collaboration process, the university teacher and Honda designers did not set a goal for specific output, but rather, they let students design freely in order to make use of their superior sensitivity and perception. Therefore, students had to carry out the process in highly ambiguous situations because the image of the design output was unknown in the earliest phase, and the idea of students sometimes grew too impractical to be of any use to Honda. From the viewpoint of the designers at Honda, the unrestricted designs created by students seemed physically unachievable and so designers needed to modify the design to be effective and practical, yet keep with the good sensibilities of the students. Moreover, students seemed unskilled at shaping their ideas and intent into concrete concepts and putting them into words effectively. Therefore, it was difficult for them to share the basic concepts and backgrounds of their designs. To deal with these situations, when it was necessary for designs created by students to be modified, or when students could not design as expected, the teacher assisted students in identifying their own mistakes and new value standards by using prototypes and sketches to ask their students questions, rather than giving concrete or direct instruction about how to improve the content. The teacher also encouraged students to reflect on their own premise of design by showing examples of reference designs and requiring students to retry the operation of current products in the field. Students were thus able to reflect on their own designs, create ideas, and set concepts that concerned real problems. Honda designers also urged students to use words to describe concepts and forms based on practical experience as much as possible. Students became able to explain the basis for the concepts and forms of their designs more clearly and objectively because they were designed to fulfill the needs of the real problems they had experienced.

After students constructed a basis for their designs, designers carefully analyzed the students' sketches and prototypes to identify the designs' key elements. However, they encountered the problem that students were unaware of the important points or elements in their own designs. Therefore, designers carefully analyzed the sketches and prototypes proposed by students and created movable objects as prototypes to empirically verify the potentials of the design. Using the prototypes, they then verified that the designs were the designs that students had wished to express by explicitly communicating the key elements of the design to students. Through these interactions, students became aware of the substantial elements they had wished to express in their original

designs, and also came to understand, empirically, the important elements of the company designer's thought-process. By confronting the thought-processes of the Honda designers, students gradually learned how they could use their own perspectives in the design process.

In the final stage, Honda designers visited the university every week to assist the students in completing actual models based on the concepts they had created. In this stage, designers and students gradually revised the models to their complete state through discussion of the objects in front of them. In this way, designers and students were able to directly observe the differences in their thought-processes and focuses and thus, they were able to gradually fill the gap between the differences in their concepts of the design.

### 3.3 Results

Students made presentations about the final design output at a final presentation. In the end, the concept and form of the designs originally proposed by students were based on the problems they identified through their practical work experiences. Since the basis of the designs were clear, they were easy for Honda designers to understand and the unique perceptive of the students was combined with the product's functionality and form to create designs that had never been seen at Honda. For example, one student proposed a design for a tiller which combined both the functions of a large tiller used to till soil and a small tiller used to cut the weeds between ridges in a field. This design made work easier by keeping the functionality of the small tiller, yet enabling users to do their work with only one machine by simple changes in the function and weight of the machine according to each situation. In this way, Honda was laying the foundations for future product development, rather than developing products for short-sighted commercialization. The idea and form of this design was praised highly by all sections in Honda. Honda also recognized and commended the improved creativity within the organization. Honda designers have the tendency to design within realistic and severe constraints. However, they were able to re-capture their own creativity when faced with the rich and pure ideas of the students working with them in the collaboration activity. This made it possible for designers to create designs from a flexible point of view unbiased by the usual concepts of tillers and mowers. Honda designers had to think about the deep and fundamental problems of design in order to share their ideas with the students during the collaboration process. Therefore, the collaboration activity served as a good opportunity for Honda designers to reflect on and reaffirm the methodologies of their routine work, and then come to a greater understanding of the purpose of design. As mentioned above, the collaboration activity stimulated the Honda designers and prompted them to make changes in their way of thinking and in their awareness of design. Therefore, it worked as an opportunity for them to not only explore new possibilities in design, to but also promote the organization's creativity.

## 4. Analysis

### 4.1 Incompatibility in the collaboration process and "Reflective Practice" as the problem-solving concept

As discussed in the case above, the significant problems in the collaboration process were that, first, designs created by students were physically impossible to develop into prototype models because the designs put too much emphasis on originality and novelty, and second, students were not able to express their desired concepts and forms accurately because their basic ideas were vague. They were therefore, unable to share a specific image and understanding of the output with the Honda designers.

These problems are assumed to arise due to the incompatibility between the context as defined by a real company and the context as defined by students. The diverging definitions of context are assumed to arise because the framework for student's actions is very different from the framework of company designers. Designers' cognitive features combine their own beliefs and aesthetic feelings toward their experiences with the methodological framework they depend on for generating design concepts [13]. Designers define the context and convert their ideas into forms within the framework of their own personal experience and internal knowledge [16]. Tacit knowledge is deeply rooted in an individual's actions, experiences, ideals, values or emotions, and it is personal [10]. Moreover, interpretation, understanding and deduction of the perceptions and sensitivities of users are derived from self-reflection and are susceptible to individual differences such as culture, experience, education [12]. Therefore, the design framework of designers is supposed to vary greatly depending on the environment and organization in which they are involved. Thus, the defined context differs depending on the individual. Company designers who worked in the joint-collaboration activity have a framework for their actions that is very different from the framework of students because they base their designs on different values and logic in their everyday work. Students are supposed to be limited in accurately defining the context for designs used in real companies with existing frameworks because their own experience is limited. As mentioned above, incompatibility arose between the context as defined by company designers from a real company and the context as defined by students in the collaboration process because there was a huge difference in the framework for their actions. In order to achieve a desirable result, it was important to deal with such incompatibilities. It was especially important that the university teacher and company designers did not directly modify the designs the students created and contexts they defined, but rather, they allowed students to re-define the context and modify the form into a desirable state by themselves. If teachers and designers had modified the students' designs directly, they would have risked losing the pure elements of the students' design and thus become unable to achieve their original purpose: making use of the unique features of the students designs. Therefore, in order to indirectly modify the design into a desirable state, it was necessary for students to learn how to define the context by making changes to the existing framework of their actions. Students also needed to re-define the context based on the new framework for their actions and to create a form to fit its context.

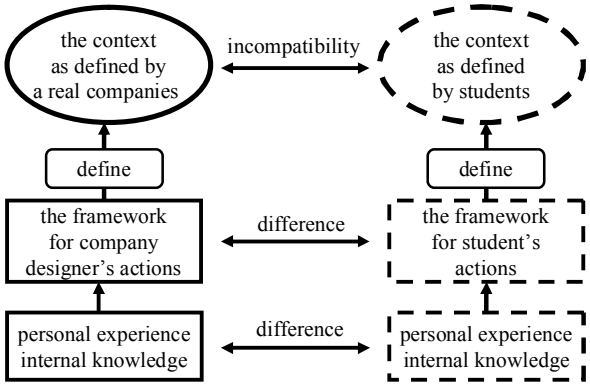


Figure.1: Incompatibility between the context for designs of real companies and the context as defined by students
Source: Illustrated by the author

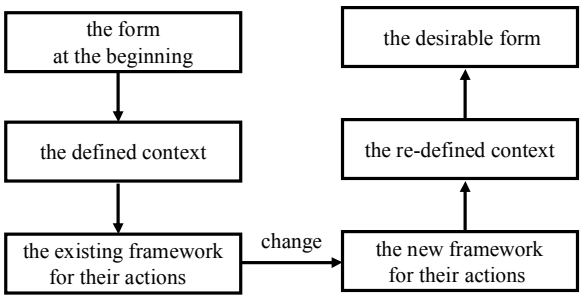


Figure.2: Dealing with incompatibility through making some changes in the framework for their actions
Source: Illustrated by the author

My research suggests taking "reflective practice" into consideration as a means of achieving higher learning in students. Schön [16] proposed that the "reflective practitioner" is one who reflects on unexpected experiences in the field and faces the hard task of going beyond his or her field in order to find the theory of practice.

Reflective practices are based on the model of "theory-in-use", also called "Model II" [2]. Theory-in-use is the "theory of action" that determines individual actions, apart from the individual's "espoused theory". Argyris and Schön [2] emphasize that, in order to deal with the difficult situation of problem-solving in practice, it is necessary to change from the theory-in-use base of Model I, which involves single-loop learning that is self-closing and one-way, to the theory-in-use base of Model II, which involves double-loop learning that is open and denies individual theories and actions.

In university-industry collaboration in design fields, students placed in the difficult situation of designing for companies without any prior experience, who reflect and make changes in the existing framework for their actions, are the learners who put into practice the action world of Model II. Practical inquiry is achieved through "mind-body" activity and therefore inquiries need to be achieved through interactions with others and with encouragement from other people [6]. In fact, the action world of Model II is characterized by a mutual relationship based on interactivity, openness and cooperation [2]. Argyris and Schön [2] suggest that "personal experience" and "examination of dilemmas" are basic requirements for moving in to the action world of Model II. Therefore, it is supposed that, in order to promote higher learning in students in the collaboration process, the following requirements must be made; a) Students must be able to freely experience work with the absence of expected outcomes; b) Students must directly confront the gap between actions they supposed would be effective and their actual achievements; c) Students must learn through interaction with others. University teachers and company designers who encourage reflective practice in students need to be able to grasp the cognitive states of the students within the designs they created, and to suggest improvements at the appropriate time and by the appropriate methods. In this situation, university teachers and company designers need to carefully observe the cognition of students and the progress of their designs in order to give better encouragement.

## 4.2 Management requirements for promoting reflective practice by students

### 4.2.1 Acquiring knowledge about users through direct experiences

Normally, students do not have a basis for designing actual products in companies. Therefore, before setting out a concept, it is important that university teachers and company designers encourage students to acquire knowledge about users through direct experience. Acquiring a rich knowledge about users is the central element to recognize the context and apply it to the requested form. Acquiring rich knowledge brings about constructive opportunities for students to reflect on their espoused methods and premises. In the design process, it is necessary to quickly manifest a user's knowledge in the design [9], and tacit knowledge is also particularly important for designers to create a better design [20]. However, students have a limited understanding of users because it is impossible for university teachers and company designers to communicate enough tacit knowledge about users to students through words alone. Tacit knowledge can be acquired by generating experience actively [14]. Therefore, direct experience is supposed to be the best way of promoting students to acquire knowledge about users. To students, directly experiencing the way products are designed means placing themselves in the context of the design and experiencing it first-hand. In the case study of Honda and TUAD, students acquired knowledge and understanding of user's cognition by operating existing products in an actual field, and they became able to express the objective concept and form of design based on the knowledge they acquired. Students also became able to reflect on the premise and basis for their designs after experiencing various problems in growing their own crops. Thus, students are should be able to reconstruct a new framework for their actions

based on their existing framework and the rich tacit knowledge about users that they acquire.

### 4.2.2 Do not instruct and guide students to modify directly

In order to create a situation for students to reflect on the existing framework of their actions by themselves, it is important for students to develop ideas freely and to confront the dilemmas that occur when the actions that they supposed would bring about effective results turn out to be ineffective. The occurrence of these unexpected or unintended results and the emotions of surprise or confusion that accompany them are essential for reflective practice [17]. However, learners need appropriate encouragement from others in order to achieve inquiry by themselves [6]. In order to encourage students facing severe problems to reflect and make changes to the existing framework for their actions using reflective practice, it is necessary for university teachers who are familiar with the characteristics and personalities of designs of students to accurately grasp the students' cognitive processes by carefully observing the design outputs they create. It is also necessary for university teachers to act as learning supporters by providing useful feedback that the students can reflect upon. The important point of this situation is that learning is supported based on Model II. In this case, the most effective teachers used the following strategies to support students who faced problems: The teachers did not give specific instruction to students on how to create designs. They used prototypes and sketches to ask questions to their students, showed examples of reference designs, and had students retest the functionality of current products in the field. University teachers also encouraged students to think about why their designs were ineffective and to reflect on their own premises about the designs. As mentioned above, students grow when teachers make them face dilemmas, so it is necessary for teachers to create unexpected obstacles in the design process. Argyris and Schön [2] emphasize that it is the role of “instructors” to support the reflective practice of learners. They pointed out that instructors who forced intervention by giving instruction to learners in a one-way direction risked creating a situation in which learners could not reflect effectively. This kind of instruction is based on Model I and it prevents students from learning openly. When students are facing obstacles, it is very important for teachers to give students psychological support. When students feel disappointed with their own incompetencies, university teachers need to regard it as a positive sign and need to avoid adding guilt to the students' feelings of sadness. The essence of reflective practice based on Model II is learning from the non-effective actions themselves [2].

### 4.2.3 Interaction through visualized objects

The last requirement of management is to encourage students to use reflective practice more effectively by interacting with other members of the design group and together analyzing the visualized objects. Visualized objects refer to the idea sketches and the prototypes such as rough models and mock-ups created in each phase of the design process. “Visualizing” in design is the process of converting ideas and concepts into explicit and concrete objects and externalizing tacit knowledge into a concrete forms [5]. Therefore, visualized objects work as a common language, a cognitive mediation and a communication tool, and help in sharing images and cognitions among members [19]. In addition, visualized objects stimulate the members to be more creative because they concentrate on the essential parts of the design and help generate various experiments [15]. Moreover, visualized objects improve the efficiency of the design process by summarizing ideas quickly into forms [20].

These functions of the visualized objects are supposed to be useful in promoting reflective practice and encouraging students to make some changes to the existing framework for their defined contexts. Visualized

objects are the externalized objects of designers' cognitive processes and ideas [5] and they allow the cognitive process to be observed. Thus, by being involved in students' cognitive processes by using visualized objects in time to grasp their cognitive situations, university teachers and company designers are able to examine the designs in an appropriate way. Direct feedback through the object in this way can be "validating information" or "directly observable data" needed for reflective practice. Students become able to critically reflect on their own framework for actions and premises. University teachers and company designers also become able to unconsciously and implicitly find the important points in the designs made by students and to extract the essential elements of the designs through careful observation of the intermediary and incomplete objects. In this way, students gain familiarity with the company designers' ways of thinking and perceiving by clearly figuring out the important elements of their designs through visualized objects. Students are supposed to able to reflect on their own actions and ways of thinking by comparing themselves to the company designers and recognizing their differences.

In this case, when the university teacher and company designers grasped the content of the students' defined context and their cognitive situations, they thoroughly analyzed idea sketches and prototypes created by the students and tried to communicate with the students through them. The teacher also promoted students to reflect deeply on their own premise of design by providing some valid questions through objects created by the students. Moreover, the designers created prototypes and examined them empirically with students. Those interactions functioned as opportunities for the students to recognize the essential elements of their own designs and to acquire a new value standard through facing the thought processes of company designers. As mentioned above, interactions based on objects should be utilized effectively to promote students reflective practice.

## 5. Conclusion

Through deep analysis of the process of university-industry collaboration in design field, which has not been clarified in any existing studies, my research of the successful case of collaboration between Honda and TUAD in Japan points out that in the collaboration process there is incompatibility between the context for design in real companies and the context as defined by students. The collaboration process generated a way to deal with this incompatibility through interactions. My research also stressed that, in order to create good designs without losing the characteristics created by students, it is necessary to encourage students to make some changes in the existing framework for their actions rather than modifying the design output created by students. Furthermore, management which aims to promote reflective practice, an important concept in helping students achieve higher learning, must face some requirements. In order to grasp the cognitive situation of students and the context they define, and also to encourage students to use reflective practice, it is necessary for university teachers and company designers to use reflective practice as well. It is important for all members to do reflective practice until they reach a desirable design.

Incompatibility arising in the collaboration process is a serious obstacle in the way of achievement. However, from the viewpoint of reflective practice, incompatibility also provides important opportunities for students to learn. Therefore, in the collaboration process, how to deal with the situational problems arising from incompatibility is more important than how to prevent the problems from arising. It is necessary that all members try not to eliminate or modify problems with the attitude expressed by Model I, but rather, try to have a Model II attitude by being open and regarding dilemmas or problems as crucial opportunities.

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