Creative Systems Analysis of Design Thinking Process

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Abstract Nowadays, the importance of innovation has increased as a means to solve problems in a complex human society, and design thinking is used in various fields as one of the effective approaches for it. However, since the understanding of the functions of each process is superficial, there is a tendency that the utilization as a framework is limited, and that the sufficient effect is unable to obtain. In this research, we clarify phenomena that should be occurring in each process of design thinking, aiming at understanding and practicing intrinsic function of design thinking. Therefore, it is necessary to interpret the method of design thinking and the work of each process that constitutes it through the creative system and psychic system in creative system theory to promote understanding for using design thinking. In this research, we divided design thinking into five steps taking over the methodology advocated by Stanford University d.school: Empathize, Define, Ideate, prototype, test. We clarified each functionalities in these stages using creative system theory and extracted the essence. By redefining its meaning and deepening the understanding, we expect to grasp the meaning of the process in practical scenes and to demonstrate better effect. This research may contribute to the realization of truly sustainable innovation by supporting the maximization of the existing framework of design thinking.

1. Introduction

In recent years, the importance of innovation is increasing as a means to solve problems in the complex human society, and design thinking is used in various fields as one of the approaches. Design thinking is a method for realizing innovation in technology and business domain using human-centered approach with designer 's sensibility and way of thinking.

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However, the idea of design thinking is only perceived as one of the approaches to solving problems and idea conception methods, and it could be said that the value as a medium of communication supporting practitioners' creativity has not permeated. Therefore, there is a hypothesis that deeper recognition of the functions each process of design thinking can make for more effective application.

The creative system theory defined by Iba recognizes creative process as autopoietic reproduction networks that include discovery as an element, discussing from the system theory of autopoiesis (Iba, 2010). Therefore, if the process of design thinking is to be a "creative process", it may also be possible to capture the mechanism and essential function of each process by grasping it as one autopoietic creative system reproducing networks of discoveries. Therefore, in this research, we clarify the phenomena that should occur in each process of design thinking from the viewpoint of creative system theory, aiming to understand and utilize the essential function of design thinking.

2. The Creative Systems Theory

Creative system theory captures the process in which the element “discovery” is continuously generated in the creative system (Iba, 2010), from theory for creativity based on the autopoietic systems theory (Maturana & Varela 1980; Luhmann 1984). Autopoietic systems, promoted by Humberto Maturana and Francisco Varela in biology (Maturana and Varela, 1972) is a unity that the organization is defined by process of a reproduction network of elements. Since creation is autonomous and closed as a system, input and output with the outside is impossible in terms of operation. “Psychic system” is a autopoietic system with elements of consciousness which is disappear instantaneously, which is sustained by system reproduction of consciousness by consciousness. According to Iba, “Elements of a creative system are discoveries, where each discovery is produced based on previous discovery, associating the on-going creation (Iba, 2010)”, and the chain of discovery cannot happen without contingency (Iba, 2016). Luhmann, promoted social systems theory, mentioned “Social systems arise through the initiation of communication, and develop autopoietically from within themselves” (Luhmann, 2013). He defined society not as existence of substance but as what is generated continuously, and communication is included as elements of the system that is a phenomenon that is maintained by repeating the process of information being conveyed and understood over and over. In the creative system, the process itself is defined as an autopoietic system by discovery as elements.

3. The Creative System in Design Thinking Process

In the following, we will explain each ideal aspect with creative system in the process of Stanford-styled design thinking. Design thinking is a methodology of design to apply and nurture creativity, originally described as a method for architects and city planner in “Design thinking” (Rowe, 1987). And it was introduced into the business domain by David Kelly, a founder of IDEO which is a design firm in the USA. Nowadays, methodology and values that have been regarded as general knowledge can no longer be applied to the development of new businesses and services due to the rapid changes in the social environment resulting from the progress of technology. Richard Buchanan defined these problems as “wicked problem”, and design thinking is an approach to solve them through design (Buchanan, 1992).

Human-centered design is one of the concepts necessary for solving complicated problems, and design thinking can be carried out in compliance with the approach of human-centered design. Tim Brown depicts design thinking as follows: “Design thinking can be described as a discipline that uses the designer’s sensibility and methods to match people’s needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity. (Brown, 2009)”

Currently, application of design thinking is done in various forms, but this time we will analyze the 5 step process proposed by Stanford d.school which David Kelly, one of IDEO founder, founded as an educational institution. In the 5 steps process, there are the following: Empathize, Define, Ideate, Prototype, Test. By repeating these processes over and over while working in teams, people can find a new way to solve problems.

3.1 Emphasize

Empathy is the step of finding empathic understanding by observing pain points in the living context around the user's problem. In order to use the process of Human Centered Design, it is necessary to set up certain users and sympathize. There are three major modes: Observe, involve, immerse. In observation, they observe the behavior in the user's living environment. In involvement, they interview with users interactively. In immerse, they experience what you are experiencing. In this phase, observer can get discovery about user’s living context around their problem that lead to find user’s insight.

In order to occur the reproduction of discovery in this phase, observer need to focus not only use’s action but observe their living environment, and speculative potential needs they may have. They conduct an in-depth interview to access the feelings accompanying the facts and the values hidden behind it through the empa-

thy with the target user, not aiming to gain the surface needs but to find the desire in depth psychology, what is called the insight. In the interview, it is necessary to conduct open question, not closed question. In order to deepen the "personality" is promoted by accumulating question-related questions about that person.

Through this phase, information concerning their ideas and values that are not noticed by themselves will be clarified, leading to unexpected discovery of insight. (Insight = remarkable fact that the person himself has not noticed, potential movement of the mind that could not be understood superficially.) And they decompose and integrate the needs and insight found through empathy step, and define the user image and his or her characteristics that they eager to help and the essential problem to solve. Insights obtained in this phase are reflected in the form of "<User's name> needs a way to <Needs (verb)> because due <Surprising Insight>" using Point of View (POV) syntax, Visualize the ideal in the form of a persona.

Soup Stock Tokyo is a Japanese food chain, and the business concepts created from user needs derived through interviews call for a lot of empathy, which made the sales of 4.2 billion yen, 52 stores (as of 2016) in 10 years. What they did was to create a persona with a specific need called "Tsuyu Akino" while proceeding with the interview. It is said that the major factor of success was that they constructed a marketing strategy by thoroughly "sympathizing" her.

What kind of person is "Tsuyu Akino"? They described her persona like as following: Tsuyu Akino is a 37 years old female who lives and works in Tokyo. She is sociable and hard worker who has money to spare with single or double income. She is sociable, and cherishes her time with pursuing what is simple and has good sense. She is distinctive and has strong preferences, and prefers features to decoration. She is a person who orders a chicken liver than a foie gras, and suddenly starts crawling when going to the pool.

Setting the detailed taste and personality makes it easier for people to empathize with the persona, and enables the developers think of menus, shop locations, concepts and so on. Then, Soup Stock Tokyo which is familiar with the everyday life of "Tsuyu Akino" was made.

This step enables to find interesting contexts and themes by observing and interacting with users while sympathizing with curiosity. Through the communication with the users, they can create their context together while interacting with each other, which leads the system to be constructed by continuous discovery.

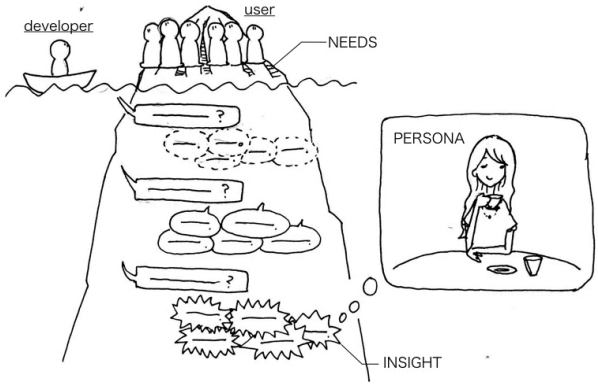

Fig. 1. The process of making a persona through emphasize

3.2 Define

Next, in this phase, it aims to define the problem along the extracted insight and the unique approach and design goal with originality to the solution. Establishing an approach is to set the scope for doing ideation, and in order to create a challenge, each team members needs to be aware of themselves and their characteristics and strengths and quality in communication within the team is required in the communication.

From the viewpoint of creative systems theory, it is thought that this step is an act of forming an autopoietic system with elements of discovery about problem awareness. The idea for solving the problem requires the chain of "discovery", which depends on individual creative system (Iba, 2010). This step seems to have an important role to determine what problem they eager to solve, in the system formation that is made of the discoveries continuous.

Wii, released by Nintendo, a Japanese game company in 2008, is one of the examples of innovation that took advantage of prototypes. By applying new technologies such as acceleration and vibration measuring meter to game machines, it became a game everyone can enjoy by moving their bodies. It sold 1 million in Japan in 2 months after the launch, which was twice the number of Xbox 360 and 4 times as many sales units as PlayStation 3. The problem in improving sales of game machines was the existence of the mother of a child who was a conventional main user. The idea the developer thought to dispel the negative image they had in the game was to involve them to play the game so that everyone can enjoy.

Although insight is for users because problem exists around their environment, design goal should be defined in this phase are those of practitioners who solve the

problem, and it is necessary to have originality. Strong originality of individual sometimes can be a bias that will stick to own idea and narrow horizons, but in collaboration of teams, it is possible to switch to ideas with collaborating with others values. The type of discovery they can generate in this phase is how they want to approach the user's problem solving so that problem awareness will be polished. Therefore, this attitude always has the attitude to get discovered, high quality communication leads to high quality challenge and assignment setting.

3.3 Ideate

Next, in this phase, it aims to define the problem along the extracted insight and the unique approach and design goal with originality to the solution. Establishing an approach is to set the scope for doing ideation, and in order to create a challenge, each team members needs to be aware of themselves and their characteristics and strengths and quality in communication within the team is required in the communication.

In this step, they aim to embody the approach which broke the bias with concreting ideas for problems created with POV syntax, and methods have been created for alternative design creation that designers have conceived so far. Generally, the method of idea generation is divided into two steps: divergence and convergence. Divergence is a phase that carries out approaches to break the mental block and bias that a person unconsciously sees as common sense. It emphasizes the quantity rather than the quality to promote the creation of a large variety of ideas. In convergence, they integrate the ideas created and evaluate and decide based on the axes such as appropriateness and originality in problem solving. And it should be supported by discoveries reproduction that is about ideal but concrete solution.

When divergence and convergence are carried out, it is necessary to recognize the characteristics possessed to use them appropriately. This is because there is a concern that high quality output can not be obtained due to inability to switch between divergence and convergence. The ideation begins with brainstorming (Osborne, 1957) and brain lighting, and then a co-creation session such as KJ method and dynamic framing is held to share and integrate the ideas issued.

In the co-creation session, visualization of ideas into words and diagrams can break the bias and create a shift of the viewpoint leading to new ideas. For example, Hamaguchi of Ziba Tokyo, when created the concept of USB Flash, found a new idea area in data storage by destroying the existing bias. At that time, with the development of digital cameras and PowerPoint, the data became larger and there was a background that it was necessary to think of the means of data sharing after the floppy disk. (Hamaguchi, 2013) The figure below is a frame of USB Flash visualized by dynamic framing: the vertical axis shows the user experience in data handling, the horizontal axis shows the size of the data capacity to handle, plotting

the idea created from brainstorming in addition. Then the idea settled in quadrant of "network". Because of the background of the development of the Internet and wireless communication, it was a bias that the experience of transferring data becomes intangible and the data size becomes large. That's why it came to the idea of attaching USB to flash memory by paying attention to the quadrant "data is tangible and large in size" contrary to the bias. This viewpoint shift encourages developer's ideation because the direction setting give them efficient mindset to ideate not only in the range of direction but also beyond the range.

In convergence, developer categorize and evaluate ideas with finding common points and differences in order to narrow them down. Main ideas will be refined by focusing on evaluation axes that developer will provide being based on the project's terms they have been handled so far. Because of the axes, developer can cause continuous discoveries directing the creation to embodiment that make idea optimize.

In this phase, thinking process is vague and pros or cons are unclear that let developer confused. However, when every factors, divergence, convergence and essence of problem, are united and one suitable answer comes out, developer find the way to promote the idea to embody and solve user's problem in reality. Since this process support the process itself as a media of discovery, ideas can be associated and it can lead to consequences.

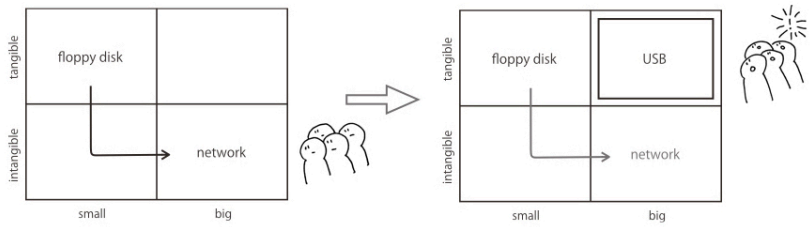

Fig. 2. The process creating the concept of USB Flash Memory by breaking the bias in market

3.4 Prototype

The prototype creates a common recognition within the team to the idea by materializing the idea formed as an image. By quickly making, you can find the deviation of recognition and improvement points of detail, make it quickly and change it, use simple materials such as post-it, Lego and role playing which cost less money than normal prototype. Being iterative makes you learn rapidly, which enables to investigate many different possibilities. Prototypes are most effective

when others, including teams and users, get experiences from them and give feedback. At the same time, the developer can move his hand to reconsider the ideas by himself, and give feedback instantly. Moreover, he can realize more realistically and infer how the user behaves, thinks and feels through the actual interaction with the output.

In the development process of Wii released by Nintendo, countless prototypes were repeated. The ideas that the developers thought of were prototyped using styrene foams and clays, aiming at "a design not to be disliked by anyone". While creating various things such as super lightweight materials and single-button design, the idea went to create a controller that can be used with one hand like a remote control, when a controller for both hands were commonly used. Thereafter, the design of the present controller emerged as the result of repeated prototyping for the number, the position and the shape of the button.

The process of learning by themselves while making prototypes can be regarded as the activation of the psychic system of the individual. By separating the invisible thoughts and concepts from themselves by giving a form to them as the prototypes, it is possible to obtain metacognitive overview so that the instant feedback can be given. Besides, by giving a material form, individual sensory differences arising from the ambiguity of the concept are removed and concrete expression can be made. Therefore, it is possible to prevent occurrence of discrepancy and disagreement within the team, and to rapidly renew ideas from the learning and discovery obtained. In this process, the discoveries are made from communication mediated by the substance, prototype, and rapidly assemble it to the next discovery like a chain.

The process of learning by themselves while building prototypes can be regarded as the activation of the mental system of the individual. By separating from themselves by giving a prototype form to real thoughts and concepts, it is possible to obtain real-time feedback in order to overlook metacognition. By giving a material form, sensory individual differences arising from the ambiguity of the concept are removed and concrete expression can be made. Therefore, it is possible to prevent occurrence of disagreement and discrepancy within the team, and to quickly add ideas from the learning and discovery obtained. Meinel and Leifer, who provided 4 rules of design thinking, mentioned that “The Tangibility Rule: Making Ideas Tangible Always Facilitates Communication (Plattner, Meinel and Leifer, 2013)” as one of rules of design thinking. On this process, we can get discovered from communication mediated by a substance called prototype and quickly assemble it to chain it to the next discovery.

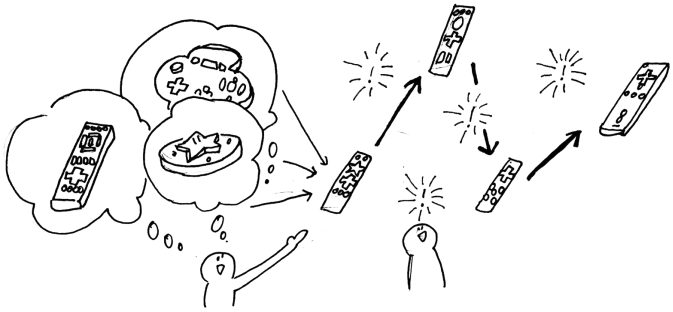

Fig. 3. Improvement of the Remote Controller of Wii through Prototyping

3.5 Test

Lastly, test is iterative process that provides evaluation and feedback. This process can be said to be most critical in design thinking in terms of human-centered design, because the developers can not see whether their ideas and designs or targets are appropriate without feedback on the idea from the end users. It is a necessary element for creativity to receive evaluation from others who would become users. According to Iba, creativity requires certification from others about the novelty and the originality (2010). Psychologist Csikszentmihalyi also highlights the cultural rule system about the essence of creativity and the need of support from people who evaluate the idea (Csikszentmihalyi, 1996). In creative systems theory, it is essential that existence of others is indispensable as an object of communication, not only to activate the reproducing networks of discoveries, but as an existence giving evaluation and feedback to improve the quality of the discover.

In the user test of Spotify and SoundCloud, the music streaming service, the usability of each function was compared and verified from the viewpoint of seven items regarding some operation to "create a playlist". It is sure that the developers are designing their services with confidence. That's why users can test them in their living environment and make relative evaluation with other companies to make their outputs more refined. The makers may not have the bird's-eye view of the communication that happens in the system that they are configuring, but by putting a third person who gives a bird's-eye view of those and can give the evaluation, they can give attention to the blind spot.

Through this phase, practitioners can get user's feedback that what is effective and what is not valid for the ideas. Based on the learning, they can go back any phases and make modifications to the idea. Therefore, testing make it possible to

generate the reproduction of discoveries to refine ideas by conducting the process of design thinking again after reflecting practice based on user's feedback.

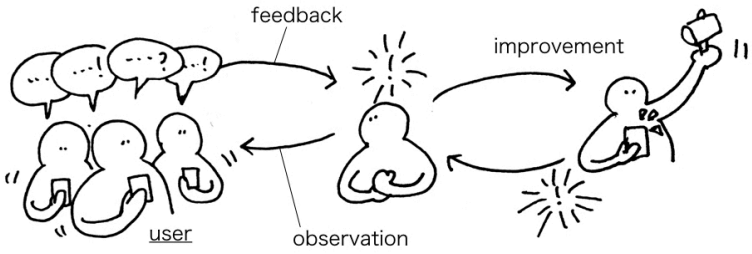

Fig. 4. The Process of User Test with Discoveries

4. Conclusion

Design thinking is a technique to create ideas by making use of the sensibility of designers and to cultivate creativity based on the idea of human-centered design. In this research, we mainly interpreted five processes in design thinking from the viewpoint of creative system theory, not the value in the output created by it. Thereby clarified the functions of each process. In Empathy, communication with the user by observation and interview becomes a stimulus for the psychic system, and it is possible to create "creative communication" which interlinks the discovery interactively by the attitude of empathy. To set users' problems as Define, it can be realized when each team member communicates being aware of their characters to select the unique solution to approach with. Ideation allows them to put the concept into a concrete idea by separately using divergence and convergence modes. Obtaining metacognitive overview by making it visible leads to the linkage of creation, gaining the discoveries again. In prototype, the idea is transformed from image to material, brushing it up in the process, and test gets evaluation of the output from the user. New external stimuli and discoveries are created by overlooking and evaluating ideas and designs.

As mentioned above, although the framework including design thinking is effective for problem solving, it will give you the better effect by practicing with understanding the important constituent elements in the process like discoveries. As our future work, we aim to maximize the effect of the practice, deepening the recognition of the functions in each process and to adopt a more concrete and feasible framework utilization method.

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