A frame-work of design using Autopoiesis system

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Abstract: We are now in the artifacts world. Our environment is almost all made by artifacts. And some of these artifacts look like LIFE as the robots do. On the other hands, Industrial design is in front of this situation. So industrial design have to change about its focus, from artifact to hybrid system of artifact and human being. Industrial design only thought about artifact's form and function. But it must think about human Kansei and artifact's function at same time and same system.

It took more than 34 years that Autopoiesis as life-system by Humbert R. Maturana and Fransisco J. Varela who were neurophysiologists.

Autopoiesis talked about life system as autonomous feature and structure using cognitive view.

Autopoiesis has probability to covered not only living system but also mental-system of human beings and social-system. On the other hand, human-artifact system is able to think as a kind of living system or social system. So, we started to reconstruct industrial design theory based on autopoiesis. We tried to make some theoretical solution of design using this autopoiesis theory in this paper.

Key words*: *Autopoiesis, Embodiment, Enactive, Design Theory, Interface

1. Introduction

Our artificial environments had drastically changed and had multi-aspects by technological progress.

Changing points of expressing keywords are as follows;

-From Physical viewpoint to Psychological viewpoint.
-From Static thing to Dynamic system.

Recent industrial design theory has to be fundamental changed from product's viewpoint to whole human-artifact system's viewpoint. According to this change, industrial design expanded their boundaries from appearance (Form, Styling, Color, Surface finishing and so on) to relationship between human and artifact (User interface, Operability, Contents, Context and so on). In addition, industrial design covers human aspects such as image, feeling, affection, etc.

Also, industrial design is the human action for artifact condition, and it has some structure of relation (sometimes problem solving, sometimes creation) between human and artifact.

Now some problem is occurred in this structure. We industrial designers loose the way of doing.

But there is effective theory to solve this problem named "Autopoiesis" that is to talk about life-system and founded by Humbert R. Maturana, Francisco J. Varela in 1972[1].

"Autopoiesis" has probability to covered not only living-system but mental-system of human beings and social-system. On the other hand, human-artifact system is able to think as a kind of living system or social system. So, we started to reconstruct industrial design theory based on autopoiesis.

2. Objective

This paper's objective is to serve framework of industrial design theory that is constructed by industrial design methodology to catch up human's activity system and design process based on autopoiesis.

3. Autopoiesis

Autopoiesis was started in 1972 by neurophysiologists Humbert R. Maturana, Francisco J. Varela when they were at Chile Univ.

In Maturana (1980), Autopoiesis was defined through a definition of “living machines”.

He said “An autopoietic machine is a machine organized as a network of processes of production (transform and destruction) of components that produces [2].”

And also Varela picked up some special features (1979)[3].

He said as follows;

- Autopoietic machines are autonomous; Autopoietic machines subordinate all changes to the maintenance of their own organization
- Autopoietic machines have individuality; keeping their organization as an invariant through its continuous production
- Autopoietic machines are unities because of specific autopoietic organization; their operations specify their own boundaries in the processes of self-production.
- Autopoietic machines do not have inputs or outputs.

On the other hand, autopoiesis is producing system that the elements of autopoiesis produce some another element. This is self-organized property of closed system and just fit for the system of cells in living thing.
If there are some interactions between different unities of autopoiesis, both unities and medium operate in such interaction as independent systems, and by triggering in each other structural change, that situation is called structural coupling. (Fig.1) Think about human society, we are able to recognize human group as the element of autopoiesis. German sociologist Niklas Luhmann indicated “Social System” as autopoiesis in his book.

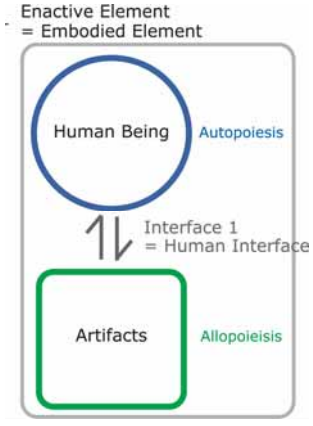

Fig. 1 Structural Coupling

4. How to adapt AUTOPOIESIS to DESIGN

Industrial design described relationship between man and artifacts. This relationship divided into two elements;

- Image: Some kind of vision in human brain. Representation of contents.
- User interface: Interaction between human function and artifact function.

These two elements were key elements of design activity. But, this activity was not the answer of “relationship”. For example, think riding bicycle, designer designed bicycle’s form without man. Designer would design the bicycle with man. (Fig. 2)

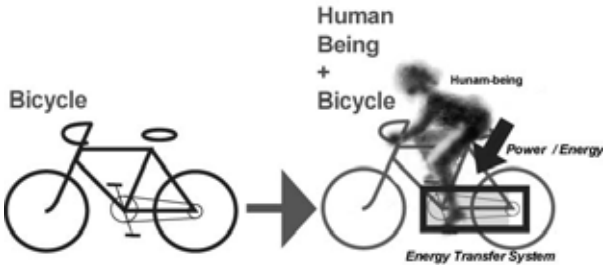

Fig. 2 Human -Bicycle System

That would be final answer to solve “relationship”. Image had meaning when man shows the bicycle without man. User thought user interface when he or she used and just talked only the part of direct operation was not total one.

Then, we tried to put autopoiesis into this problem. In autopoiesis theory, there was concept named structural coupling that explained relationship between an autopoiesis and the other autopoiesis. If we could think man as the autopoiesis and bicycle as allopoietic machine (an artifact), structural coupling between man and bicycle could explain “relationship”.

And the concept of “Embodiment” such concept also in the autopoiesis theory would explain the function in “relationship”.

Physiological definition of “Embodiment” is as follows;
Embodiment is feed-forward phenomenon that internal model in brain conform to reference copy in lower center of brain [4]. This phenomenon could be observed from external viewpoint of human body and brain.

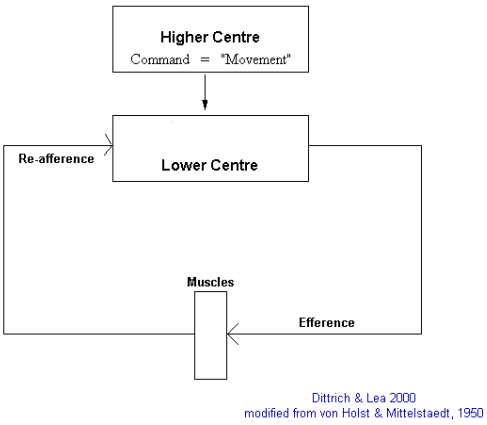

Fig. 3 Embodiment in human body and brain

If a man who rode the bicycle was in the situation of embodiment, a man and a bicycle is in the situation of new autopoiesis. We called that situation “Enactive”.

The new industrial design theory is talk about this enactive situation and has to explain design method and process in this enactive situation.

5. Embodiment and Enactive Interface

When one mastered the way of using some artifact completely and could use it without being aware, we call this condition "Embodiment". At this point, we argue that the artifact equips "Enactive Interface". The word "Enactive" expresses a condition when action and cognition occur at the very same time. We treat "Enactive Interface" as an ideal status of artifacts' user interface. (Fig. 4)

Our first goal is to describe this condition somehow in a situation when a person using existing tool that we know it can be embodied empirically. The issue is the way to describe. There is a neurophysiological model proposed, and we may be able to take neurophysiological way to observe the phenomena. But we want to start from very primitive level.

Interaction between human as autopoiesis to artifct as allopoiesis, we call that interaction user interface or human interface. If some embodiment condition occurs between human and artifact, enactive interface will be appeared between enactive element (embodied element) and environment.

When we use some tool, we have some purpose. And it is often that purpose is not to use the tool, to get some in the environment (sometime in the contents). Finally, we had experience of enactive interface in ordinary life. This is the reason why we treat enactive interface is the ideal status of user interface.

On the other hand, if enactive interface is occurred, meaning of user interface is changed. The situation of enactive interface is worked, user interface is out of cognition for human. If that situation is ideal, vanishing user interface is the ideal.

Meaning of industrial design or definition of design will be changed. “Image” will have function to imagine enactive situation. “User interface” will work to state transition to enactive condition. And “Design” will have new function such as;

Design is a trigger to state transition to embodiment (enactive) condition.

The same transition will be in the visual state. The concept of affordance, coined by J. J. Gibson, which has function of trigger to use equal to state transition to enactive condition.

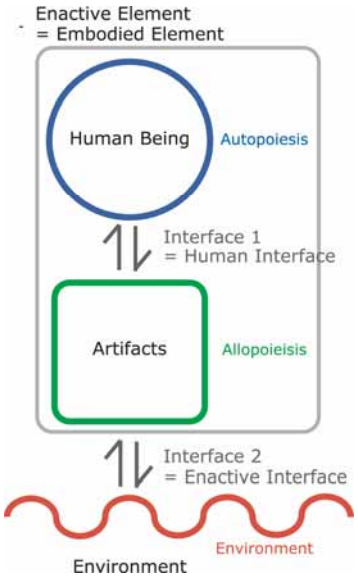

Fig. 4 Enactive Interface

6. Phenomenological Background

As we have mentioned before, we are going to apply autopoiesis theory to our research program. Autopoiesis is one of the newest system theories.

Historically speaking, there were several system theories that had an impact on empirical science. There were remarkable works like “Cybernetics” by Norbert Wiener or “General System Theory” by Ludwig von Bertalanffy. It is a fact that they enabled design of complex systems, not simple causal machines, in engineering field. But still, these system theories have a tendency to emphasize objectivity.

On the other hand, phenomenology is a philosophical tradition that tries to get rid of the issue of duality

between subject and object. And then, it respects subjectivity.

At this point, it seems like system theory and phenomenology are opposed each other. But at the same time, both fields stand against reductionism. This is one reason why we recognize relationship between system theories and phenomenology, and try to follow phenomenological thought.

The other, and more important reason is related to autopoiesis theory itself. Among various system theories, autopoiesis has different characteristics. One of them is “self boundary specification”.

To understand “Autopoiesis” and its applied concepts “Enactive Interface” or “Embodiment”, some know-how will be needed. For example, “Autopoiesis” can't be described from observer's viewpoint. Because autopoiesis specifies its own boundary. In other words, what we see is different from what the autopoiesis is.

And also, where “Enactive Interface” or “Embodiment” arises is a domain of first-personal experience, so that they deny objective description. So, to leverage “Autopoiesis” in research program, we need to tackle an issue of subjectivity, which is not addressed in science field very often.

Consequently, a philosophical realm called phenomenology will help to comprehend these concepts. Although phenomenology obviously belongs to the founder Edmund Husserl, at the same time it can be utilized as a thinking tool by anyone who wants to. In phenomenology, objectivity is not an assumption. It engages in a special effort to describe processes of constructing objective-world by subjectivity.

“Neurophenomenology”, which is proposed by autopoiesis theorist Varela, is a scientific methodology that combines neuroscience with phenomenological philosophy in order to study subjective experience or “consciousness”. His strategy of research is to describe the phenomena through subjective and objective accounts being mutual constraints each other.

Since users' experiences, our research targets are also subjective experiences, we able to refer to this methodology.

Following phenomenological tradition, we will utilize first-person statement to observe phenomena of embodiment.

7. Case Study

7.1. Objectives

To make new industrial design theory, we tried to find embodied situation in the using tool. Case study was done at the start point. We are at introductory period, so we picked up primitive tool as the target of our experiment. Our objective was to try to make sure if there exists such phenomenon as “structural coupling” that ensures “Enactive” approach.

7.2. Method

Experiment was using marker (Fig.5. industrial designers use when they draw sketches) and let novice user tried to use it. The task was to try to paint a squared area (75mm x 75mm) by grey color marker as well as good sample that displayed in front of the subject. For novice users, it is hard to paint evenly by grey color markers. The tasks were repeated for three times. During the tasks, the subject was asked to speak what she felt about the marker, her actions, and etc.

We took video twice. The first one was situation of using tool. After that, the subject was being interviewed while watching the first video. The second one was taking during this situation. Analysis was using protocols and action through video.

After enough training to draw, we prepared second trial again. This situation was not at novice level, but at expert level. A person (a subject) had no experience to draw using maker at the first try. The first trial was done in that situation. Then, the second trial was done after enough training. This task does not require so difficult skill.

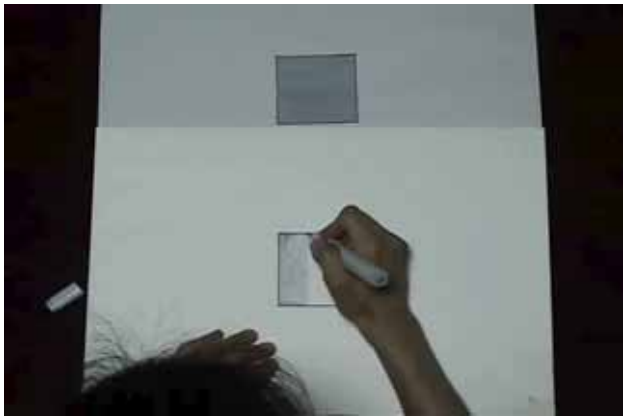

Fig. 5 Situation of case study

7.3. Result and Analysis

We recorded the subject’s comments and sorted them into three categories. Those are comments about “Tool use”, about “Finishing” and about “Environment”. These categories are decided through investigating subject’s comments. But at the same time, we had some hypothesis. That is change of subject’s consciousness, which we expected that we would be able to observe by subject’s comments. And the transition of amount of comments might be observed as tasks go on. This

transition might occur during the process of embodiment arise.

Table 1. Number of Comments

	Task 1	Task 2	Task 3	Expert task
Tool use	77%	67%	61%	20%
Finishing	23%	33%	39%	55%
Environment	0%	0%	0%	25%

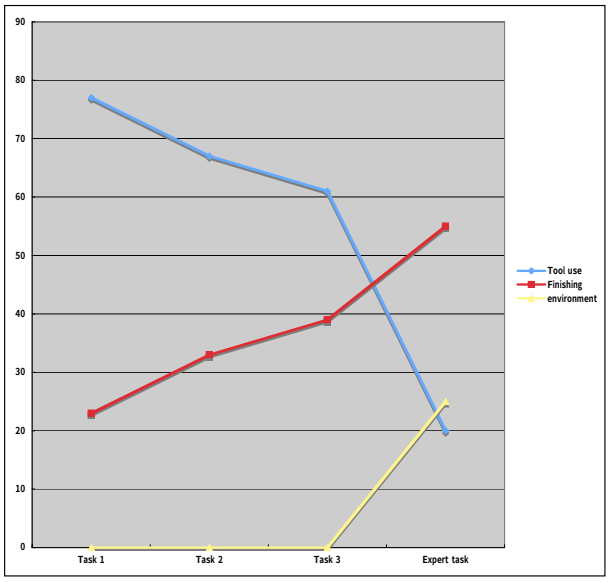

Fig 6. Graph of Number of Comments

Table 1 shows the result that the number indicates appearance ratio based on number of comments in the protocol. Task number means trial number. Tasks 1 to 3 are novice level and fourth one is expert level. Fig. 6 shows the comment appearance ratio as vertical axis. Horizontal axis shows task trial number.

We categorized comments in protocol by type of action. All of us (3 members) checked categories and dividing into classes for each word. Categories were 3. The first one is “Tool use”, the second is “Finishing” and the third is “Environment”.

The result shows that “Tool use” decrease as proficiency of skill. On the other hand, “Finishing” increase. “Environment” appears at the expert level of task.

Tool use indicates that the subject concentrated on user interface level. The first try was just concentrated on user interface by subject and decreasing means vanishing user interface transition. Finishing indicates some recognition was shifted to enactive condition.

7.4. Case study’s conclusion

According to numbers of finishing words increase and numbers of using tool words decrease, we found the sequence of getting embodiment when using tool as result of this case study. In this case, this test subject’s focus was changed from tool use to finishing or environment. That result showed consciousness of test subject changed user interface (tool conscious) to enactive interface (environment conscious).

8. Discussion

We just found some elements of embodiment. Needs more experiments to get industrial design methodology. But before that experiments, we tried to find artifacts divide. Because enactive interface would be fit not all artifacts and men.

Generally speaking, we found new concept for the definition of user interface. User interface was some usability or operability between man and machine. But at enactive viewpoint, user interface is vanished.

During protocol analysis, we found some hint to categorize of all artefacts for design. This hint was in the contents of category from protocol.

So, we try to make new industrial design theory based on autopoiesis.

9. Conclusion

Through the case study, we found the possibility to say such “enactive interface” concept and model.

Through thinking enactive interface model, we found new meaning of user interface and industrial design. These model and concept were new thinking such as collaboration with ordinary industrial design theory and autopoiesis.

We have just found some elements of embodiment. We need more experiments to get industrial design methodology.

10. References

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