Self-Organization and Its Implications in Design System

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Se-Kyun Yoon* and Dong-Yeon Lee**

** Seoul Design Center, Design Development Support Team*
Seoul , Korea, sekyun.yoon@gmail.com
*** Korea University of Technology and Education, Dept. of Industrial Design Engineering*
Chonan , Korea, dyon@kut.ac.kr

Abstract: The concept of design in modern times is trapped in the mechanical, reductionist framework and thus falls short of explaining the complexity, unpredictability and diversity of design system. Therefore, we need to adopt a more comprehensive perspective in seeing design in its entirety, not in parts, to understand the concept of design and extend the horizon of our ideas regarding design.

This study is a meta-research extending the horizon of thinking about design. By employing the theory of self-organization, it attempted to find hidden order in a design system based on rules or characteristics of various relationships and phenomena taking place within a design system.

Through this, this study clarified that a design system is a self-regulating, self-organizing system that generates its own internal forms and orders. It is not a determined existence, but rather, a procedural structure that includes the constant flow of changes. The study also explained that aspects of disintegration, segmentation, dissolution and divergence that are found in a design system serve to create movements for the emergence of new orders with possibilities of new changes.

Key words: System, Design System, Complex System, Self-Organization, Paradigm.

1. Introduction

As the flow of the times always bring about changes, each era has witnessed the emergence of different design philosophies, styles and methods as part of the new design paradigm of the times. Essentially, the framework within which design ideas emerge is not rigid: it changes by evolving to reflect the demands of the times and society.

The concept of design in modern times is trapped in the mechanical, reductionist framework and thus falls short of explaining the complexity, unpredictability and diversity of design system. Therefore, we need to adopt a more comprehensive perspective in seeing design in its entirety, not in parts, to understand the concept of design and extend the horizon of our ideas regarding design.

This study takes particular note of the fact that convictions of modern design based on certainty and absoluteness have been replaced by possibility, relativity and variety. This study attempts to review the shift of design paradigms in the dimension of time series from the perspective of self-organization — which is core to complex

system theory — and to apply the rules or characteristics we may identify to find hidden order within design system. The purpose of doing so is to consider from an ontological view how the application of complex system theory to design is not just an issue of epistemological or methodological choice, but rather, a necessary choice due to an essential aspect of the design system itself.

Finally, this study explains the dynamic changes of design system from the perspective of the complex system and self-organization, and concludes that a design system is an organic, dynamical system that generates its own internal forms and orders.

2. The Concept of Design System

To establish the concept of a design system, the definition of a "system" must first be discussed. For the purposes of this study, a system is recognized the same light as the scientific term used in physics, chemistry or other natural sciences, and means a collection of parts unified in an organized manner[1]. The definition may vary in detail according to which theory is applied, but in any case, a system should include interacting parts and clearly defined relationships between those parts. For example, in thermodynamics, a system is defined as a part of the universe that the speaker is referring to. Other parts of the universe are called "surroundings." A system in thermodynamics includes matter and space, with the inclusion of several variables (temperature, volume, entropy, etc.) that can describe the state of the system.

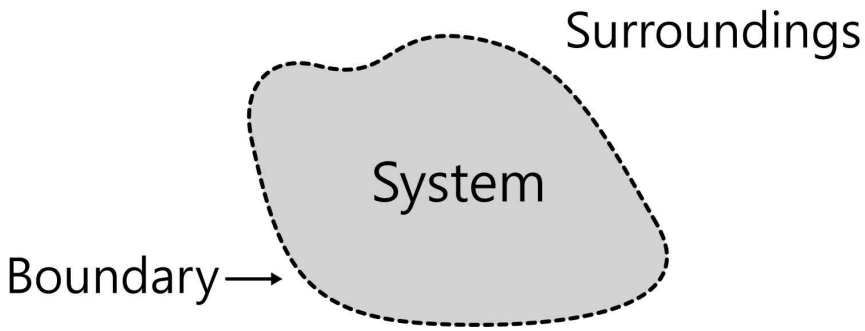

Figure.1 System Boundary

If we apply this definition to design, a design system may be defined as a systematically unified collection of design parts, such as human, material, visible or invisible components, that comprise design. These parts constantly interact with each other to maintain optimal status within the system and pursue internal consistency[2], but the system remains open to the possibility of interaction with its surroundings[3].

A design system can adapt to changing environments like a living organism, and can adjust to flows of energy, achieve self-organization to maintain optimal status, and evolve and develop.

3. Implications of a Paradigm Shift in Design System

The term 'Paradigm' refers to a system of perceptions that fundamentally defines views or thoughts of a person or an era, or a way of generation or methodology to perceive or process objects[4].

According to Thomas S. Kuhn, who used the term in its broader sense as we use it today for the first time, there is a standard framework acknowledged by all scientists, not some individual scientists, in any given scientific era,

and he called that framework a paradigm. A paradigm is not newly formed in each era, but rather, generated from the traditional achievements of natural science and then declines to be replaced (paradigm shift).

We may recognize a paradigm shift when there is reflection on the conventional point of view and the seeking of a new order. Design system also involve paradigm shifts in the dimension of time series, and the most notable example is the process of formation, development, decline and replacement of design philosophies, styles or methods.

If we explain this process in accordance with Kuhn's theory, the argument would appear as follows: when a new paradigm arises, designers work and research to resolve and address problems arising from the paradigm. This is called normal science. When achievements in normal science accumulate, the paradigm is gradually dismissed and new, rival paradigms emerge. When we see how modernism based on certainty and absoluteness is replaced with post-modernist possibility, relativity and variety, and how mechanical plastic method is shifting to organic, ecological thinking, and determinism to non-deterministic possibility, we can better understand paradigm shift in design system. A single paradigm never lasts forever. New paradigms emerge and develop only to decline and be replaced.

The time-series process of formation, development, decline and replacement of paradigms resembles the growth of a living organism. We can explain paradigm shift with complex system theory, which considers nature and society from a holistic point of view. In the next chapter, we will take a closer look at complex system theory and view a design system from the theory's comprehensive perspective so that we may extend the horizon of our thinking.

4. Design System and Complex System

A design system is capable of adapting itself to changes in the environment. It changes rapidly as time flows. It is not a mere sum of independent behaviors of its parts, but rather, an intertwined world of relationships and interactions among them. Conventional theories are too focused on microscopic, linear or partial analysis to understand a design system in a broader sense. The complex system theory is a suitable alternative to overcome such limitations.

A complex system is central to complexity science: it is a new frame of thought of science, perceiving socio-economic phenomena or natural phenomena through a nonlinear, entire, organic and holistic framework instead of a linear, partial, mechanical or reductionistic one.

Complex system theory began with criticism of the existing establishment of the relationship between cause and effect that proposed that a single cause corresponds to a single effect[5]. While traditional mechanical scientific studies focused on finding similarity and simplicity by reducing a system into the most basic elements like atoms or molecules, complex system theory points out that there are parts that cannot be understood with analysis and reduction alone, and as an alternative to understand and solve the limitations of the existing science, focuses on explaining how the world is composed of diverse and complex parts from the holistic perspective that accepts nature and society as whole entities.

The most distinctive characteristic of complex system (as opposed to simple system) is that the whole and parts interact and cooperate in a complex system, and the parts change constantly. Complex system theory emphasizes the organic nature of the system, similar to life, and considers a system to be self-organizing[6]. It also underlines the irreversibility of time, non-equilibrium, non-linearity, accidentality, emergence and co-evolution.

Table 1. Comparison of Simple System and Complex System[7]

Simple System	Complex System
Reductionist	Holistic
Mechanical	Organic, self-organizing
Linear	Nonlinear
Reversible time	Irreversible time
Determinist	Accidental, unpredictable
Equilibrium	Non-equilibrium
Simplicity	Complexity
Object	Environment, context, process
Fixed	Emergent evolution
Natural selection and adaptation	

Complex system theory is noteworthy because the real world, including design system, has a distinctive similarity with complex system. The theory can also explain phenomena in design system and their causes, not with characteristics of individual parts, but through relationships among them and their interactions from a macroscopic perspective.

The repetition of "order in chaos, chaos in order," as the theory says, may also be found in design system.

5. Design System and Self-Organization

While complex system theory aims at explaining the chaotic state of turbulence, which occurs when a system changes from one form into another, the theory of self-organization aims to provide a more detailed explanation of the dynamic process of creating innovation and new order from the chaotic state (Stacey, 1993). The theory of self-organization, therefore, is inevitably based on complex system theory, as complex system theory is a new viewpoint on understanding dynamic changes of a system (Jantsch, 1980).

Originated from biology, the concept of self-organization means that a life does not merely exist machine-like, but rather, forms and organizes itself through a process of growth, variation, grafting and interbreeding. Self-organization is the process of an unbalanced system creating an organized order in itself through the collective interactions of its parts. Today, the concept is no longer confined to living organisms, but rather, is studied in a wide range of fields of natural and social sciences. It is applied to explaining various social phenomena, as well.

The collective efforts of scientists to achieve an in-depth understanding of phenomena and objects from the perspective of self-organization is a new methodological attempt in that it enables us to recognize phenomenon that could not be observed or understood through conventional theories, and tries to overcome the existing paradigms that focused only on phenomena themselves.

When we see design system within the framework of self-organization and its dynamic principles, we can see that the environment surrounding design system today is taking the form of dissipative structure[8], where modernism and the more standardized view of plasticity is dismantling, and uniform, firm value system are rapidly disappearing. Therefore, we can say that design system is characterized by a dynamic, unstable non-equilibrium, not a static, mechanical equilibrium.

Non-equilibrium, which is a prerequisite for the emergence of dissipative structure, can be generated only in an open system, not in an isolated or closed system. A design system, therefore, is an open system in which materials and energy can enter and exit. It constantly interacts with the surrounding environment to form and organize itself like a living organism. A design system as an open system enables exchanges between individuals and society, between inside and outside, and changes by reflecting the changing demands of stakeholders and the times as the society changes.

Also, a design system creates constant changes within the flow of time, not unlike all the other systems that involve time dimensions. These changes occur by chance, not by any certainty that can be predicted with deterministic natural principles, and form a new order in a nonlinear fashion.

As discussed above, a design system is an open structure in which each part is connected in a nonlinear fashion. It is a self-organizing system that creates changes and acquires variety by itself. A design system as a self-organizing system does not maintain the existing order, but rather, rapidly adapts itself to a changing environment. It constantly seeks self-innovation in anticipation of changes in its environment, responds to the changing environment in a creative manner, and eventually forms new orders. New orders include new design philosophies, styles and methods to adapt to a new environment.

6. Conclusion

This study is a meta-research extending the horizon of thinking about design. By employing the theory of self-organization, it attempted to find hidden order in a design system based on rules or characteristics of various relationships and phenomena taking place within a design system.

Through this, this study clarified that a design system is a self-regulating, self-organizing system that generates its own internal forms and orders. It is not a determined existence, but rather, a procedural structure that includes the constant flow of changes. The study also explained that aspects of disintegration, segmentation, dissolution and divergence that are found in a design system serve to create movements for the emergence of new orders with possibilities of new changes.

This is significant in that it offered a new ontology and epistemology in understanding a design system by recognizing self-organizing phenomenon in changes and adaptations of a design system that were not observed nor understood properly with the conventional theories.

Despite this, we still have a long way to go before complex system theory or scientific externalism can be firmly established as a methodology of design philosophy. In addition to the obscurity of the definitions of self-organization and complexity, the limitations of complex system theory in that it is still too deeply associated with science also had an impact.

7. References and Citations

[1] Wikipedia, http://ko.wikipedia.org/

[2] The process of adjusting conditions of two parties to achieve maximum efficiency.

[3] All intellectual systems are always open to possibilities of non-systems or other systems.

[4] D.S. Cho, B.Y. Kim. (2006) *Design Evolution for 21st Century New Renaissance,* Hans Media, p.50.

[5] Complex system network, http://www.complexity.or.kr/

[6] W. Y. Ryu. (2002) A study on the time-based processes in Digital Architecture, *Master's Thesis*, Seoul National University, p.16.

[7] J. M. Kim. (2000)The Architectural Concepts and Design Properties as a Complex System (1), *Journal of Korean Institute of Interior Design*, vol. 22, p.126.

[8] Dissipative structure means a structure changing in unstability an opposed to the concept of stable, static equilibrium. Ilya Prigogine said all structures in the world can be categorized either of the two structures.