Research on the Application of System Engineering Theory in Graphic Creative Design

Hongqiong Zhang1,a
1Chongqing College of Architecture And Technology, Chongqing, 401331, China.
aCorresponding author’s e-mail: 343477309@qq.com

Abstract: "System engineering" is one of the most important academic terms contemporarily. It is to make reasonable use of all resource conditions, optimize the configuration of the structure, and conduct process management to scientifically use resources. Through the practical process of research-based sketching and design transformation, the article uses plant ecological structure as the original experimental sample, and based on system thinking, explains the deconstruction, reorganization and final visual presentation of graphics from multiple dimensions of overall, three-dimensional, structural and dynamic. Explore and put forward a comprehensive hierarchical system model of "objective-deconstruction-reorganization-optimization and integration" to optimize graphic design behavior patterns and improve the effectiveness of design strategies.

1. Introduction
Based on biological science research, Austrian biologist Ludwig von Bertalanfe put forward the idea of treating organisms as a system as a whole, thus forming a systematic thinking. With the further deepening of related research, system thinking has been widely used and achieved broad development in many disciplines such as natural sciences and social sciences. As a theoretical paradigm, system thinking represents "a new way of organizing and arranging knowledge that we have already acquired and hopefully acquired in the foreseeable future" [1]. It has the function of organizing and integrating different dimensions of thinking and is to solve complex problems. An important and powerful theoretical tool for the collection of things. When applying system thinking to design practice, first of all, the design object should be regarded as a “system”. Chekerland once proposed that “the world is a system” and “a system is one of the ways in which everything exists. [2] This shows that as long as it is an objective object that exists in the real world, and it can be regarded as a complete system for research.

To a certain extent, creative graphic design can be regarded as a work process of creative practice. Therefore, it is also a design form that is finally presented by the internal integration and optimization of various constituent elements. Therefore, the work process of graphic creative design is a systematic project. Through the practical process of research-based sketching and design transformation, the article proposes a comprehensive hierarchical system model of "objective-deconstruction-reorganization-optimization and integration", using plant ecological structure as the original experimental sample, and based on the system engineering theory from integrity and correlation. The three aspects of sexuality and environmental adaptability explain the interactive relationship between system thinking and graphic creative design, including the overall planning of the system's internal structure, element relationships, design implementation and visual presentation. Ultimately, it achieves the optimization of the graphic design behavior mode and enhances the effectiveness of the design strategy.
2. Understanding and handling design issues as a whole

The holistic principle of system engineering theory is to look at the overall situation (system as a whole) first, and then look at the parts (system elements). Always grasp individual trends and eliminate unfavorable parts under the guidance of the overall situation. The whole experiment process is to analyze the biological structure, element shape and reorganization method of each local element under the overall guidance and pay attention to the internal relevance between them. As a multi-variable dynamic system, if the internal relationship between the variables in the system is separated to study one of the variables in isolation, and the rest remain unchanged, it will inevitably lead to aggravation of the overall system problems. Therefore, in the design process, the entire design should be considered as a system to study, starting from the overall situation, thinking about the key issues that affect the design from a macro perspective, and dividing the internal factors of the system into primary and secondary divisions, so that the entire design process is to solve the reality the problem is the analysis of each sub-proposition, which is also a hierarchical processing of the problem. This kind of design thinking is more helpful to make the design focus on solving the most core problems, and avoid the past designers blindly starting from experience, looking at and solving design problems in one-sided, isolated and scattered ways, laying a good thinking foundation for completing the design. [3] Secondly, it conducts micro-analysis from the perspective of different disciplines, analyzes the structure, function and development law of the object from the perspective of biology; dissects the research object from the perspective of botany, analyzes its ecology, system evolution and classification, etc.; combines bionics In the process of designing design and design geometry theory, the physical elements of the research object, namely function, structure, form, color, etc., are diversified from a humanized point of view. At the same time, they pay attention to the various elements inside the system. The structure of the proportions; this link requires the use of mathematical thinking. For example, Joseph Miller-Brockman mentioned in the book "The Graphic Artist and His Design Problems" in 1968 that "the proportions of various form elements and the distance between the elements is almost always logically related to the numerical progression used.” Therefore, the extraction and reorganization of the elements to the final visual presentation are all closely related to the mathematical logic. In addition, we need to pay attention to the guiding significance of design geometry for practice.

Taking the golden section rectangle structure as an example, a line segment is divided into two parts. The ratio of the entire line segment AB to the longer part AC is the same as the ratio of the longer part AC to the shorter part BC. This gives an approximate ratio of 1.61803: 1 (Figure 1), which provides strict logical thinking for the standardization and aesthetics of the design. [4] For example, in the late 19th century, the German psychologist Gustav Fechner found that the side length ratio of an ordinary rectangle is similar to the golden ratio and most people prefer rectangles with side length ratios close to the golden ratio (Table 1). This also shows that when designing deconstructed objects, attention should be paid to the ratio between humans and nature, and mathematical logic thinking should be used for reference. Finally, a comprehensive theoretical interpretation of the design results from the perspectives of cultural studies, sociology, and history, including its value and significance.

![Figure 1. Golden ratio](Figure 1. Golden ratio)
Source: Kimberly Elam 《Design geometry》
Table 1. Table of common scales for rectangles

| Width/Length | Most preferred rectangles | Less preferred rectangles |
|--------------|---------------------------|---------------------------|
|              | Fechner(%)                | Laro(%)                   | Fechner(%) | Laro(%) |
| 1:1          | 3.0                       | 11.7                      | 27.8       | 22.5    | Square   |
| 5:6          | 0.2                       | 1.0                       | 19.7       | 16.6    |
| 4:5          | 2.0                       | 1.3                       | 9.4        | 9.1     |
| 3:4          | 2.5                       | 9.5                       | 2.5        | 9.1     |
| 7:10         | 7.7                       | 5.6                       | 1.2        | 2.5     |
| 2:3          | 20.6                      | 11.0                      | 0.4        | 0.6     | Golden ratio |
| 5:8          | 35.0                      | 30.3                      | 0.0        | 0.0     |
| 13:23        | 20.0                      | 6.3                       | 0.8        | 0.6     |
| 1:2          | 7.5                       | 8.0                       | 2.5        | 12.5    | Double square |
| 2:5          | 1.5                       | 15.3                      | 35.7       | 26.6    |
| Sum          | 100.0                     | 100.0                     | 100.0      | 100.1   |

3. Grasp the correlation between design objects and optimize the structural relationship between elements

The process of deconstructing and refining natural objects is the process of recombining, analyzing, and optimizing the deconstruction of its internal elements. You cannot simply treat the refined element symbols as individuals or simple combinations and superimpositions in form. Instead, you must follow a certain organizational structure to find a certain inherent law of natural objects, such as the number of branches of each crape myrtle flower and biological attributes such as the number of petals, fruit shape, leaf and stem texture and quantity (Table 2), these laws are reflected in the design, that is, to create an optimized element structure to satisfy the overall function and make the final result more optimization.

The structural principle points out: the system function is closely connected with the system structure, the structure is the internal representation of the system function, and the function is the external manifestation of the system structure. [5] The organization and arrangement of various elements within the system will form different system structures, and different structures will produce different functions. Corresponding to the visual presentation of graphic creative design, different structures can deduce a variety of visual graphics, and then choose the best graphic scheme according to the goal (Table 3). A good system, its overall function must be "greater than" the "total" of all essential functions; a bad system, its overall function must be "less than" the "total" of the functions of each element. That is: 1+1=2, 1+1≠2 , 1+1>2, 1+1=0, 1+1<2 with multiple results.

Table 2. Analysis of Plant Structure Guided by System Thought
Annotate: Author draws

| Vegetation | Structural analysis | Microscopic analysis |
|------------|---------------------|---------------------|
| ![Vegetation](image1) | ![Structural analysis](image2) | The whole shape is a standard round shape, each flower has six branches, and they are arranged in sequence with the stamen as the center. |
| ![Vegetation](image3) | ![Structural analysis](image4) | The shape of the blade is rectangular, with obvious openings at the tip, and the blade lines are clear, staggered and symmetrically distributed. |
A single petal grows in a trapezoid as a whole, and each petal has two parts.

The leaves under different viewing angles are symmetrically distributed with the branches as the central axis, and are basically rectangular, with the tips separated inward.

Therefore, after micro-analysis and deconstruction of the internal objects of the system, what needs to be done is to optimize the internal structure of the system, and at the same time need to consider the attribute characteristics of the system. This step can learn from the analytic hierarchy process in the system analysis method (Figure 2). Most of the various elements in the design have diversity and differences. How can we fully tap the advantages of each element, highlight the differences and unify them in the whole to establish the best structural form, which requires the designer to have a strong insight, abstraction and logical thinking ability. Taking the graphic design transformation of crape myrtle flower as an example, it fully analyzes the internal relationship of the various elements of the plant itself, the growth mode, the positional relationship in the three-dimensional space, and the functional interactive relationship. Since the shape, color and other elements in the design process are closely related and touch the whole body, in order to create the most optimized structural system between the design elements, the designer needs to continue to work on the premise of clear design goals. Explore and practice in order to come up with the most accurate plan to convey the theme.

Table 3. Analysis of Plant Structure Guided by System Thought

| Annotate: Author draws | Size 250*250mm | Shape | Basic structure 1 |
|------------------------|----------------|-------|-------------------|
| | | | |
| | | | |
| Size 250*250mm | Shape | Basic structure 2 |
| Size 300*450mm | Determine the unit shape | Basic structure 3 |
4. Grasp the dynamic changes of design objects and the adaptability of the environment

The system is always in a dynamic loop state. Therefore, it is necessary to maintain an open mind in the design process, place the things to be analyzed and designed in a constantly changing dynamic environment, accurately grasp the environmental elements from a dynamic perspective, and continuously adjust and improve the plan to achieve the ultimate optimization the purpose of the system. For example, the practice of graphic creative design based on physical anatomy, as a system, its meaning, aesthetic value, commercial value, etc. generally cannot be interpreted on its own, it needs to be placed in a specific design context or objective conditions Next, analyze the impact on other works, etc., that is, consider the work as a systematic environmental factor. The system can maintain its own stability only if it keeps itself in a state of exchange of energy and information with the outside world. A reasonable design process must emphasize multi-dimensional and multi-perspective cognition and adhere to the observation and design practice of "whole-micro (partial)-whole" (see Table 2). Graphic creative design based on research-based sketching first needs to put forward design goals and problems under the premise of fully understanding the overall system; secondly, propose the conditions and corresponding design plans that can solve the goals and problems, and the establishment of this plan must base on the refining, generalization and induction of the various elements within the system, the most optimized structure is finally selected to ensure the realization of the ultimate goal of the design plan.

In summary, as a complex system, design requires us to look at and solve its problems from a more rational perspective. System design thinking is a methodology used to guide the orderly development of design and cannot be simply understood from the technical level. Taking the crape myrtle flower as the practical design object, a complete set of graphic creative design practice system is refined (Figure 3),
and a comprehensive hierarchical model of goal-deconstruction-reorganization-optimization and integration is proposed, and the research is digging deeper from the perspective of different disciplines. The internal structural characteristics of the object, the integration and optimization of the system structure, and the comprehensive mathematical logic thinking to optimize the proportional structure of the elements are finally presented visually. The design practice process under the guidance of system thinking will be more orderly and purposeful. The practice process follows the research from the inside to the outside, from the shallow to the deep, from the surface to the inside, so that designers can see things through phenomena in practice. Essence, so that the design works closer to the original target positioning.

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