Islamic Art

Biological Principles of the Formation of Phenomena: Modeling Nature in the Process of Architectural Form

Abstract

The emergence of new computer theories and methods derived from biological systems, during the last few decades, have made it conceivable to deepen the principles and rules of the form of production process. The modelling and pattern making process are beyond the shape arena today and the total knowledge that exists in the way biological components are formed have become a valuable field for pattern production. Such a new patterning of nature is possible through a method entitled algorithmic design, in which computing is applied as the main structure of computer activities, through algorithms, codes and programs; equivalent to what is recognized in nature as a genome. In this research, the main goal is to provide a specific framework and a systematic method of the role of reproductive systems in the process of producing an architectural form. For this purpose, by using the descriptive-analytical method based on library research, the topic under study has been premeditated, categorized and described; moreover, the characteristics and mechanism of reproductive systems are studied and compared in the field of form production. The result is that reproductive systems, inspired by the biological principles of the formation of phenomena, can play a major role in the processual production of architectural form in an algorithmic way.

Research aims:

١. Studying the mechanisms of reproductive systems.

٢. Examining the role of algorithmic systems in the architectural form production process.

Research questions:

١. What are the coordinates of reproductive systems?

٢. How can reproductive systems be used in the process of producing an architectural form?

Keywords: form production process, reproductive systems, computing, algorithm.

Introduction

In the last century, many computer theories and methods such as self-working cellular machine and other systems inspired by the formation process of biological phenomena have been proposed. This is while the methods governing the creation of architectural form have been mostly formal and superficial, even if they have been deepened, they have remained only in the form of a theory and have not gone beyond. Conceivably the reason for this can be seen as the superficial selection of complex and intractable subjects in terms of weakness in scientific fields or the lack of technical facilities for implementation (Taraz, ٢٠١١). Nowadays, according to the technical and scientific developments of the last few decades, scientific fields have increased their participation with architecture and biology is one of these fields. By understanding the scientific scope and the transitional movement from the field of biological knowledge to architecture, the way can be opened to understand deep layers such as how they form and grow and develop instead of imitating the basic formal and mechanical levels of organisms (Kabli and Khandan, ٢٠١٤: ٣٠). Christopher Alexander states that without an understanding of patterns, a person is not successful in using possibilities when faced with a wide range of different conditions (Qarouni, ٢٠١٤: ٢٤). On the other hand, the study and programming of these patterns in digital tools has made it possible to produce patterns similar to what occurs in nature in formal fields and enter them into the design stages. Therefore, now it is possible to summarize the most complex natural issues in the form of algorithms and turn the spatial complexity into computational complexity (Khabazi, ٢٠١٦: ١٦) and modeling of biological processes can be placed on the path of computing through code and programming to produce a form. In general, the combination of biological knowledge with algorithmic architecture leads to the production of new scientific and design topics and opens the path of research, the fields of creativity and innovation for the production of forms. These new fields and topics enter algorithmic channels and find increasing production possibilities (Khabazi, ٢٠١٥: ١٢٧). However, the use of this knowledge in the paradigm of contemporary architecture and the biological-scientific view of nature have opened a long way for designers to research and explain the characteristics of this architecture and while there are few published theoretical texts about it, this phenomenon is not an easy task. Since this stream is constantly changing and growing, new features can be studied and written for this architectural stream.

Research history shows that computer systems have been influencing the field of architecture and form production process for about half a century. Such systems first started with theories such as artificial neural networks (١٩٤٣), automatic cellular machines (١٩٤٠s), genetic algorithm (١٩٦٠s) (Holland, ١٩٩٢), El systems (١٩٦٨). Although the first step was taken in the ١٩٤٠s, these theories were mainly developed in the ١٩٦٠s and ١٩٧٠s along with the advancement of technology. In the last decade of the ٢٠th century, the same theories founded a large part of the research on the techniques and tools of Form ٢ reproduction, which were based on theories such as self-working cellular machines, genetic algorithms, and systems. These methods are used by designers and scientists such as John Frazer (١٩٩٥), Makoto Watanabe (١٩٩٥), Michael Rosenman and John Gero (١٩٩٦) and Martin Hemberg, Una-Meh O'Reilly and Peter Testa (٢٠٠١).

In the first two decades of the ٢١st century, a new generation of pioneering architects such as Michael Hensel, Achim Menges and Michael Weinstock (٢٠١٩-٢٠٠٨) (Hensel, ٢٠١٤) from the London Architectural Association founded the Emerging Technologies and Design Principles group in which they are currently promoting a new approach in the field of architecture that defines a mutual relationship between new biological concepts such as emergence, self-organization, latest design, construction and production technologies, which, along with other researchers such as Neri Oxman (material ecology) (Oxman, ٢٠١٩)), (Oxman, ٢٠١٢) Jenny Sabin and Peter Lloyd-Jones (Lab Workshop), (Sabin, ٢٠١٨) Andrew Kudles (Materials System) (Kudless, ٢٠١٧), Tom Wisecombe (Emerging) (Wiscombe, ٢٠١٧) and Chris Bass (Bosse, ٢٠١٩) are shaping the boundaries of a new paradigm in architecture.

The present research using the analytical descriptive research method, after studying and collecting the necessary documents from various library sources including articles, theses, books and scientific research journals of prestigious foreign and domestic universities, first by classifying the system generative systems into six parts, including algorithmic, parametric, Lindenmeyer systems (L-systems), cellular automata, fractals and shape grammars, aim to analytically describe the characteristics and mechanism and operation of various types of generative systems as well as relationships The ruler between their components is presented in the form of tables, diagrams and pictures, then a comprehensive comparison is made between all types of systems. This is with the aim of presenting a specific framework and a systematic method of the role of computer systems inspired by biological principles in the process of producing architectural form.

Conclusion

Reproductive design as a generative tool, based on the rules governing the complex systems of nature, including evolution, self-organization and growth, enables the formation of complex formal and conceptual architectural combinations through the implementation of a simple set of operations and parameters. In this way, by writing the designer's idea as an algorithm, a code can be produced for any idea. By using a set of rules or an algorithm in the form of a code, it is possible to produce an architectural form in a self-organized process. In other words, the reproductive system is a production system that does not determine the design product itself, instead, it governs a higher level characteristic that encodes the "making" of the product or the design method and thus precedes the formation of the form. In other words, they consider the form itself, which indicates a fundamental change from the side of modeling a pre-designed object towards the modeling of the logic governing the design. In this way, the design space is opened for the exploration of design options and decisions; in addition, they promise the possibility of transferring some of the tasks and intelligences in design by coding from humans to themselves.

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http://Jenny Sabin,jennysabin.com

http://Chris Bosse, chrisbosse.de

http://Neri Oxman, materialecology.com

http://AndrewKudless, matsysdesign.com

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