

# REVIEW

By

**Corr. Member of BAS Prof. DSc architect ATANAS KOVACHEV**

**Head of Department Infrastructural Projects**

**University of Forestry, Sofia;**

**Head of Department Architecture and Urban Studies**

**Of the Faculty of Architecture at the Varna Free University Cherorizets Hrabar**

## CONCERNING:

The dissertation of architect NONA TSEKOVA on the subject: *Innovative Methods of Bionic and Biomimetic and their Transformations in Modern Architecture* for receiving the educational and scientific degree "Doctor" in Professional field 5.7 Architecture, Construction and Geodesy, Academic specialty "Theory and History of Architecture".

## The review is presented to me in my capacity of:

- member of the Scientific Jury, appointed by Order No. 429-RD of 30.07.2021 of the Director of the Institute of Art Studies, BAS on the grounds of Art. 30 (2) and (3) and Art. 31 (1) and (2) of the Act on the Development of the Academic Staff in the Republic of Bulgaria (ZRASRB), art. 6 (5) of the Regulations on the Terms and Conditions for Acquiring Scientific Degrees and for Holding Academic Positions at BAS and decision of the Scientific Council of the Institute of Art Studies, Minutes No. 7, item 7 / 30.07.2021.
- reviewer of the competition with a decision of the Scientific Jury from its first meeting, held on 04.08.2021.

## VOLUME AND STRUCTURE OF THE DISSERTATION

The dissertation has a total volume of 165 pages and includes: Introduction, 3 Chapters, Conclusion and Contributions. The literature that has been cited includes: 11 titles bibliography in Cyrillic; 39 Latin titles; 134 pcs. individual internet sources. Additional literature: 21 sources. After the appendices with bibliography and sources, there are 2 more appendices - "Dictionary of some modern architectural terms" and "Catalog of images" (105 pages).

## GENERAL CHARACTERISTICS OF THE DISSERTATION

**The study consists of:**

- **Introductory part, including the setting of the study** - relevance, study, object, subject, purpose, boundaries, methodology and expected results of the dissertation.
- **Three chapters**, including known and generalized systematizations, author's classifications, approaches and proposals. They are developed in the following order:

**The relevance of the research** is determined by the fact that bionics and biomimetic (biomimicry) are interdisciplinary fields of science. There are many branches of these terms and clarifying concepts such as "technical bionics", "architectural bionics", "biostatics", "biomechanics", "bioenergy", "bioinspired" design, "biomorphic architecture", "biophilia", "bio-utilization" and others. This leads to the need for their rethinking, a kind of arrangement and categorization, which determines the relevance of the dissertation. It is also supported by the state of modern design and construction techniques. Tools such as parametric design, combined with various technologies for digital fabrication and rapid prototyping, have not been as widely available for analysis and simulation in the recent past. Computer-aided tools for design and production ("CAD" and "CAM") provide increasing opportunities for the development of the topic, for analysis and application of the studied principles on more than one level - from purely formal and mechanical, to structural, interactive and ecosystematic - especially in the context of interdisciplinary research.

The relevance of the study can be confirmed by its close connection with other key topics for the evolution of architecture in the 21<sup>st</sup> century such as: sustainability (sustainable architecture), eco-architecture (ecological design, environmentally friendly systems and natural materials in architecture), the concepts of parametric/algorithmic design, for automation and interactivity in architecture, for the application of innovative "smart" materials.

**A comprehensive analysis of the "State of the matter" in theory and practice has been made.** The Bulgarian and world experience in the field of scientific research (dissertations, monographs, books, articles) and project searches related to modularity, sustainability and other aspects of inspiration and connection with nature, as well as analogies with its mechanisms and systems are studied.

**The object** of the research is bionic (biomimetic) approaches in modern architecture. Scientific and conceptual developments are considered, as well as exemplary research cases in individual architectural works of many Bulgarian and foreign authors.

**The subject of the research** are the transformations of the considered biomimetic methods and tendencies in the modern architecture. The emphasis is on modern manifestations where innovations prevail.

Due to the lack of greater time distance, the actively developing terminology and research in the field of bionics on a global scale, most of the methods considered can be characterized as innovative in one aspect or another in various scientific schools.

**The aim of the dissertation** is on the one hand - a renewed systematization of bionic approaches and results in the field of modern architecture. On the other hand - it traces the characteristic transformations and their key features, as well as their possible relationship with regional (and traditional) construction and architectural techniques and methods.

In this regard, the following **tasks** are set:

- To study the development of key terms and definitions in historical aspect;
- To propose an update and clarification of the classification of biomimetic methods and the corresponding levels of inspiration from nature;
- To follow the bionic and bio-inspired trends in the Bulgarian architectural practice;
- To systematize the combined application of biomimetic principles on two or more levels (with increased degree of innovation) - through analysis of examples from world practice - and to seek its relationship with sustainable architectural concepts;
- To study and summarize the concept of symbioticity and to set a criterion for symbioticism in architectural design;
- To formulate characteristic transformations and the transformative potential of certain biomimetic methods in architecture;
- To reveal combinations between tradition and innovation in architectural design and to offer new opportunities for experiment, transformation and symbiosis in this direction.

**Borderlines of the study.** The time limits covering the studied approaches are the last decades of the 20<sup>th</sup> and the beginning of the 21<sup>st</sup> century (up to the present and the more and more intensively developing innovative and experimental approaches in the considered field). Single references to earlier periods are made in order to clarify terminology and certain relationships.

**The research methodology** includes: analytical review of literature sources; terminological systematization and synchronous analysis of academic points of view (when necessary and semantic analysis of certain concepts); selection and evaluation of key projects and artifacts; performing a comparative analysis of selected cases, according to their components, characteristics and structural relationships; experimental productions.

**Chapter One - *A Chronological Review of Terms and Definitions. Formulation of a degree of innovation and a proposal for a new type of classification of biomimetic methods.*** Its first section chronologically examines the main concepts and approaches that describe the topic - their introduction and development, gradation of application. In the next, second section, their categorization according to different authors is presented. A possibility for a new type of extended classification of the considered methods of bionics and biomimetic in architecture has been discussed in view of the modern increasingly dynamic development of the field, with its inherent multidisciplinary and multifaceted aspect. The proposed classification levels are tested in the analysis of the dialogue between space and material (material cover) in architecture in order to clarify these relationships through the prism of nature-inspired analytical and formative methods (biomimetic principles and systems). The author's extended categorization of the methods serves as a basis and framework in the selection of the analyzed examples and in the development of the other topics in the following chapters of the text.

**Chapter Two - *Bionics and Bio-Inspired Trends in the Bulgarian Architectural Environment. Analysis of Examples from World Practice. Interrelation with Sustainable Concepts.*** The first section focuses on the application of the considered methods in the Bulgarian environment - from traditions to modern concepts, supplementing the historical overview of the first chapter. The analysis develops again against the background and in comparison with examples and trends from the world architectural practice, with an assessment of the prevalence and availability of scientific interest, potential for development and connection with parallel trends in architecture (ecological, sustainable, organic trends and regenerative design, interactivity, parametricity, etc.). Possibilities for connection with traditional regional architectural and construction principles are discussed. The second section analyzes leading examples of architectural projects and concepts falling within the parameters described in the proposed classification. The focus of the study are the examples in which there is an accent on the application of biomimetic principles at a minimum of two levels (and respectively of a higher degree) - i.e. in which an increased degree of innovation can be seen. In this regard, the levels of bionic inspiration and application, the potential for development and transformation of methods in the direction of optimization, revitalization, sustainability, environmental friendliness, interactivity, multidisciplinary aspect, increasingly pronounced "holistic" design, etc. are analyzed. In the last part of the section a comparison is made with other contemporary trends that have points of contact with the latest levels of application in the proposed author's classification. Different approaches to ecological architecture and its connection with modern concepts of biomimetics in sustainable architecture are considered.

**Chapter three - *Transformation and Transformative Potential of Biomimetic Methods in Architecture. Symbioticity and Author's Criterion for Symbioticity. New***

### ***Opportunities for Experiment and Symbiosis - a Combination of Tradition and Innovation - Discussion of Hypotheses.***

In the first section an author's criterion for symbiocity is introduced. The possibility of its use as an auxiliary tool in architectural design and research tasks for the purpose of optimization analysis through a bionic prism (of the efficiency and general behavior of architectural systems), as well as for the direction of potentials for new design approaches, for opportunities for innovative, experimental combinations with increased stability characteristics is discussed. The symbiotic criterion proposed by the author is tested by using it in the analysis of selected natural materials (with examples of traditional and modern methods of application) and to what extent their use can have such a character. The focus of the second section is in the final discussion - "guidelines for the types and nature of possible transformations of traditional techniques through bionic analytical principles and design approaches." The possibilities for a combination of biomimetic and sustainable approaches for the use of natural materials in architecture and their symbiotic and transformative potentials are discussed. Based on reasoning and comparative analysis, hypothetical alternative directions of development and design thinking are proposed - potential transformations based on a combination of regional influences and innovative bionic strategies.

The **Conclusion** summarizes the main lines of development of bionic methods and transformations reported in the analysis process. Some cultural and social reflections of biomimetic concepts in architecture are also presented.

### **CONTRIBUTIONS:**

#### **The key contributions of the dissertation are:**

- 1.** A revision of basic and actively complementary terminology has been carried out - in order to clarify its mutual semantic connection, from a contemporary point of view, and to trace its positioning in an architectural environment.
- 2.** An author's categorization of the methods of bionics and biomimetics in architecture of 4 main degrees has been created.
- 3.** The modern bionic tendencies in the Bulgarian architectural environment are traced and generalized.
- 4.** A comparison has been made between the high levels of application of the considered bionic methods with other modern architectural tendencies (ecological and sustainable architecture), points of contact and directions of complementarity have been determined.

5. An author's criterion for symbiocity in architecture has been developed. It is also considered as an additional tool for heuristic analysis and guidelines for optimization in general architectural theory and design.

6. Two hypothetical transformations have been proposed - bionically inspired and based on architectural approaches based on traditional techniques - a new combination of materials and strategies for increased efficiency and improved behavior and sustainable characteristics of the architectural "organism".

7. The directions and levels of transformation of the considered bionic approaches and the potentials for future development and subsequent research are summarized.

**I fully accept the candidate's scientific contributions. They can refer to:**

- enrichment of existing knowledge by obtaining confirmatory facts;
- obtaining and proving with new means existing facts and problems.

## **PUBLICATIONS ON THE TOPIC OF THE DISSERTATION**

**6 articles** have been developed on the topic of the dissertation.

- **Цекова, Н.** Триизмерно принтиране и архитектурното образование в България. – списание „Архитектура“, 2017, № 5, 36-40.
- **Tsekova, N.** Biomimetic principles in sustainable architecture design, using natural materials as straw, clay and mycelium. - In: Final Papers, Arquitectonics 2017: ISBN 978-84-697-8413-6, online publication
- **Цекова, Н.** Бионика и Биомиметика в съвременната архитектура и дизайн. - списание „Архитектура“, 2018, № 2, 24-30
- **Цекова, Н.** „Еко, био-,органик“...но в български архитектурен контекст. – списание „Архитектура“, 2019, № 2, 16-21
- **Цекова, Н.** Бионика и Биомиметика в съвременната архитектура и дизайн. От сетивното към технологията. Трета Международна научна конференция „От сетивното към визуалното – в търсене на идентичността“, Велико Търново, 1 – 2 декември 2016 г., ВТУ”Св. св. Кирил и Методий”, Факултет по Изобразително изкуство, ISBN 978-619-208-141-6, (дигитално издание, 2018г.).
- **Цекова, Н.** Пространство и материал в архитектурата – взаимовръзки от биомиметична гледна точка, Изкуствоведски Четения 2018 – „Изкуството в Европа – Модели и идентичности“, ИИИЗк, София, 2019, ISBN 978-954-8594-78-3

**In connection with the dissertation, 3 reports have been prepared and submitted at home and abroad:**

- **Цекова, Н.** „Бионика и Биомиметика в съвременната архитектура и дизайн. От сетивното към технологията“. III-та Международна Научна Конференция „В търсене на идентичността“, Велико Търново, 01-02. 12. 2016 г.
- **Tsekova, N.** Biomimetic principles in sustainable architecture design, using natural materials as straw, clay and mycelium, International conference Arquitectonics: Mind, Land & Society, ETSAB, Барселона, Испания, 31.05.-02.06. 2017 г.
- **Цекова, Н.** „Пространство и материал в архитектурата – взаимовръзки от биомиметична гледна точка“. Международна научна конференция - Изкуствоведски Четения 2018 – „Изкуството в Европа – Модели и идентичности“, модул Ново изкуство, ИИИЗк, София, 28-30.03. 2018 г.

## **SUMMARY:**

The dissertation has gained publicity through its presentation in articles and reports. The articles have been published in the journal *Architecture* and in Proceedings of scientific conferences. The reports were presented at international conferences in Bulgaria and at an authoritative International Forum (Barcelona). All materials reflect parts of the dissertation. It is worth noting that they are all developed independently.

## **ABSTRACT**

It is prepared according to the requirements and reflects the main content of the dissertation, which gives the opportunity to outline the achieved contributions.

## **RECOMMENDATIONS**

1. I recommend that the dissertation be published as a separate **monograph** in Bulgarian and, if possible, in a foreign language. It will be used by a wide range of users - scientists, doctoral students, students and specialists from various specialties working on the topic.
2. Despite the sufficient in quantitative and qualitative terms number of publications for educational and scientific degree "Doctor" to arch. NONA TSEKOVA I have a recommendation to increase her publishing activity by publishing **scientific studies and articles** in our country and - especially abroad in authoritative journals (referred to in world-famous databases and/or with Impact Factor), which will allow to cite her research, conclusions and suggestions, and will establish her as a scientist with positions in the field in which she works.

## QUESTIONS:

I have the following **question** for the doctoral student:

**1.** In which directions do you see the development of work with the expansion of similar problems, "giving a hand" for new research by you or other authors and specialists, outlining topics with various aspects in different scientific fields.

## CONCLUSION

The qualification of **arch. NONA TSEKOVA** and her work so far allows me to state that **an important and useful dissertation for theory and practice** has been developed, and the doctoral student shows with this work that she can analyze, synthesize and predict problems, formulating conclusions and suggestions in the field.

I accept the **dissertation of arch. NONA TSEKOVA as completed**. In its current form, it is **a study on a topical issue for Bulgarian science and practice at the present stage**, developed independently by the doctoral student.

According to its structure and formulated contributions, the dissertation **covers the criteria for obtaining the educational and scientific degree "Doctor"**, which at the present stage is the third degree of education in our country.

**The requirements of ZRASRB** (promulgated SG, issue 38 of 21.05.2010, with subsequent amendments and additions), the Regulations to it and the normative documents of the Institute of Art Studies, BAS in this field **have been complied with**.

**As a member of the Scientific Jury and a reviewer of the dissertation, I give my positive vote "FOR" awarding the educational and scientific degree "DOCTOR" to arch. NONA TSEKOVA in Professional Field 5.7. Architecture, Construction and Geodesy, Scientific specialty "Theory and History of Architecture"**.

**Reviewer:**

.....

**(Corresponding Member of BAS, Prof. DSc architect ATANAS KOVACHEV,  
Foreign member of the Russian Academy of Architecture and Civil  
Engineering)**

**Sofia, 21 September 2021**



Sofia, September 21, 2021