

NATURE’S LABORATORY: A BIOMIMETIC APPROACH FOR FUTURE ENGINEERS

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Abstract: *This article elucidates the role of cultivating cognitive observation in young specialists as a cornerstone of intellectual engineering. In this context, it explores the application of nature's adaptive mechanisms to engineering and the enhancement of structural solutions based on a biomimetic approach.*

Keywords: *biomimetics, creativity, optimization, interpretation.*

INTRODUCTION

As Uzbekistan embarks on a new stage of national development, establishing the essential prerequisites for the foundations of the Third Renaissance and fostering highly qualified, modern specialists in education and other sectors constitute critical contemporary imperatives. This objective is prioritized within the Concept for the Development of the Higher Education System until 2030, which states:

"The primary objective of this Concept is to establish the necessary conditions for building the foundations of the Third Renaissance in our country by training competitive personnel in the higher education sector, effectively organizing scientific and innovative activities, and expanding international cooperation. Concurrently, the higher education system must transcend its role as a mere repository of knowledge to become the primary driving force behind the socio-economic development of society."

In the current era of rapid technological acceleration, the training of young engineers must not be confined merely to instruction in drafting instruments or software applications. The primary objective of modern engineering graphics is to cultivate cognitive perceptiveness within future specialists. By analyzing the structural principles of biological forms found in nature, we can develop not only resilient buildings and devices but also nurture the great designers of the future. In this regard, implementing a biomimetic approach in engineering education yields significant efficacy.

Biomimetics, or biomimicry, refers to the replication of natural models, systems, and elements to solve complex human challenges. Etymologically derived from Ancient Greek,

"biomimicry" combines bios (life) and mīmēsis (imitation), literally signifying the "imitation of life." A closely interrelated discipline is bionics.

Biomimetics possesses a profound historical lineage; it is the art of operationalizing the 3.8 billion years of evolutionary experience and strategies utilized by birds and insects. These strategies are manifested across 10 to 50 million sustainable species with which we share this planet. Leonardo da Vinci (1452–1519), the Italian Renaissance polymath, drew inspiration from birds and bats to produce intricate schematics of flying machines. Similarly, the French engineer Sir Marc Brunel (1769–1849) patented the tunneling shield—a structure enabling underwater construction—by observing the shipworm (*Teredo navalis*, a marine bivalve mollusk that bores into wooden ships). This organism's shells enabled it to excavate through wood without being crushed when the newly exposed layers absorbed water and swelled. Historical precedents of this nature are abundant. Correspondingly, the integration of biomimetics into engineering and engineering graphics facilitates effective problem-solving for both technical and real-world challenges. To achieve this, researchers must demonstrate the following competencies:

- Observation, analysis, and empirical investigation;
- Synthesis and abstraction of empirically derived data;
- Engineering application and interpretation.

Phase 1: Observation and Functional Inquiry

Observation constitutes the foundational component of any empirical research. The investigator must analyze the subject not merely from an aesthetic or external standpoint, but from a functional perspective. Consider, for example, a tree root system: why does it branch in this specific configuration? Its biological function is to secure the tree firmly in the ground (statics) and to absorb moisture (resource allocation).

Inference: The root system distributes mechanical loads evenly across an extensive terrestrial surface area.

Phase 2: Geometric Abstraction

During this stage, the primary geometric foundation is extracted from the irregular contours of the biological form. By filtering out natural "noise," the researcher isolates the structural skeleton to delineate the core engineering model.

Phase 3: Engineering Graphics Interpretation

The extracted model is subsequently translated into a technical schematic regulated by engineering principles:

Scale and Proportion: The branching angles of the root system (e.g., 45° or 60°) are designated as the optimal structural angles for the foundation pillars of a building.

Phase 4: Technical Optimization and Simulation

The natural morphology is modified based on the mechanical properties of engineering materials (such as concrete and steel).

Digital Twin Generation: Utilizing computer-aided design (CAD) graphics software (such as AutoCAD, SolidWorks, or Revit), stress loads are simulated on the "root-foundation" model. While natural roots remain flexible, the building foundation requires structural rigidity; it is at this juncture that engineering corrections are introduced.

This pedagogical framework prevents the education of future engineers from being confined to the mechanical reproduction of basic components. Instead, it fosters cognitive perceptiveness, encourages students to actively discover knowledge rather than passively acquire it, and enhances both creativity and professional competencies.

CONCLUSION

In the contemporary twenty-first century—characterized as the "Information Age"—data can be retrieved and analyzed instantaneously. In an era where artificial intelligence is increasingly becoming an indispensable component of human existence, streamlining complex tasks, and where technological automation is anticipated to exacerbate structural unemployment, nurturing a future generation that is creative, professionally competent, critically minded, and proficient in problem-solving remains an urgent mandate. Cultivating these students as self-didacts (autonomous learners) who can recognize viable, ecologically sustainable solutions within nature is the cornerstone upon which the monumental engineering breakthroughs of the future will be built.

References

1. Annex to the Decree of the President of the Republic of Uzbekistan, No. UP-5847, dated October 8, 2019.
2. Biomimetics. (2026, April 18). In Wikipedia. https://en.wikipedia.org/wiki/Main_Page
3. Kennedy, E. (2017). Biomimicry: Design by Analogy to Biology. *Research Technology Management*, 60(6), 51–56. <https://doi.org/10.1080/08956308.2017.1373052>
4. Bakhtiyorovich, Ismonov Khurshidbek, and Ruziyev Nuriddin Mukhammadaliyevich. "Pairing, Their Own Aspects and Corresponding Methods of Work with Pairing in the Autocad Software." *International Journal on Orange Technologies* 3.12 (2021): 211-216.
5. qizi Abduraimova, Muazzamoy Abduqodir. "PERSPEKTIVA." *INTERNATIONAL CONFERENCES*. Vol. 1. No. 11. 2022.
6. Xurshidbek, Ismonov, Rustamov Umurzoq, and Abduraimova Muazzamoy. "MARKAZIY VA PARALLEL PROYEKSIYA ORTOGONAL PROYEKSIYALAR VA

MODELNI KO ‘RINISHLARI." *Educational Research in Universal Sciences* 1.4 (2022): 70-81.

7. Ismonov, Xurshidbek Baxtiyorovich, and Muazzamoy Abduqodir qizi Abduraimova. "ORTOGONAL PROYEKSIYALAR VA MODELNI KO ‘RINISHLARI." *Educational Research in Universal Sciences* 1.3 (2022): 288-296.

8. Qizi, Abduraimova Muazzamoy Abduqodir. "PROJECTION AND AXONOMETRY."

9. "UMUM TA'LIM MAKTABLARDA CHIZMACHILIK FANINI O'QITISHNING HOZIR HOLATI." *Oriental Art and Culture*, Vol. 5, No. 6, 2024, pp. 65–69.

10. Khakimjanovch, I. M. A., & Abduqodirovna, A. M. Capabilities OF Computer Graphics. General Information About Graphic Programs. *Galaxy International Interdisciplinary Research Journal*, 12(11), 114-117.

11. Mirzaev, S. O. Methodology for Organizing Exhibitions AND Creative Activities in Primary Schools. *Galaxy International Interdisciplinary Research Journal*, 13(12), 150-154.

12. Ismonov, X. B., & Abduraimova, M. A. AUTOCAD DASTURIDA TUTASHMA BILAN ISHLASHNING MAQBUL USULLARI.

13. Ismonov, X., Rustamov, U., & Abduraimova, M. (2022). PERSPEKTIVA. PERSPEKTIV MASSHTABLAR. *Science and innovation*, 1(C6), 164-171.

14. Olimovich, M. S., Baxtiyorovich, I. X., & Shokirovna, Z. M. (2020). Problems of teaching fine arts and its history. *ACADEMICA: AN INTERNATIONAL MULTIDISCIPLINARY RESEARCH JOURNAL* Учредители: Diva Enterprises Private Limited, 10(4), 69.

15. Mirzaev, S. O. Methodology for Organizing Exhibitions AND Creative Activities in Primary Schools. *Galaxy International Interdisciplinary Research Journal*, 13(12), 150-154.

16. ОЛИМОВ, Л., МИРЗАЕВ, С., & ДАРМОНОВ, И. ТАСВИРИЙ САН'АТ МУТАХАССИСЛИГИ ТАЛАБАЛАРИГА АДСОРБЦИЯ ҲОДИСАСИНИ ЎҚИТИШ. ИЛМИЙ ХАВАРНОМА. НАУЧНЫЙ ВЕСТНИК Учредители: Андижанский государственный университет им. ЗМ Бабура, (3), 111-112.

17. Mirzayev, S. O. TASVIRIY SAN'AT DARSLARINI MAZMUNLI TASHKIL ETISHDA SINFDAN VA MAKTABDAN TASHQARI ISHLAR SAMARADORLIGINI OSHIRISH.