

From Bioinspiration to Biomimicry in Architecture: Opportunities and Challenges

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Contributor: Natasha Chayaamor-Heil

The term “bioinspiration” defines a creative approach based on the observation of biological principles and transfer to design. Biomimicry is the recent approach, which describes a large field of scientific and technical activities dealing with an interdisciplinary cooperation between biology and other fields with the goal of solving practical problems addressing innovation or sustainable development. Architecture has been influenced by many aspects of natural and social sciences, among these, biology is currently blending into design activities. Bioinspiration has evolved and shifted architectural practices towards numerous innovative approaches through different bioarchitectural movements from the past until the present. However, there is a blur of biomimicry within bioinspiration in architecture between the direct copy of mere natural forms and the true understanding of biological principles, which is the pivot of sustainable development. The main challenge remains in the gap between the profound knowledge of biology, its related scientific fields and the creative process of architectural design, including cross-disciplinary collaboration between architects and biologists. This entry presents main bioarchitectural movements and how it leads to today’s biomimicry. It proposes to define biomimicry methodologies and how this approach applies to architectural design contexts through the study of existing case studies. The opportunities, challenges and the future outlook of the field will also be discussed.

architecture

biology

bioinspiration

biomimetics

biomimicry

interdisciplinarity

analogical design process

sustainability

Historically, various forms of nature were used as part of architectural decorations, as symbols, representations of religion, spiritual beliefs, political power and aesthetics ^{[1][2][3][4][5][6]}. Hitherto, the period of modern architecture, in the New World countries such as America and New Zealand, there are some buildings made in the form of animals to represent their identity, related to commercial aspects, attractions, or activities in relation to the typology of the building. Whether to reflect the role of the building, such as a fisheries department shaped like a fish ^[7] or just for roadside attractions zoomorphically shaped like a dog ^[8]. In some Oriental countries, elephants or bamboos are also used as symbolism in ‘Feng Shui’ architecture as domestic decoration for spiritual belief and fertilization ^[9].

Architects invariably search for new means to explore and develop their ideas, not only to achieve the design aim but also to express the culture and technologies of their time to set the standard for prospective ways of living. It is a known fact that architects often obtain inspiration from nature for various contexts in their designs ^{[1][2][3][4][5][6][7][8][9]}. The relationship and connection between architecture and nature is one that has brought forth many questions, criticisms and solutions. Several examples in the past demonstrate the relationship between architecture and nature. Presently, architecture moves beyond spiritual, symbolic and aesthetic uses of natural forms to more

sophisticated 'bioinspired' performance-based building design towards sustainable development. New form of designs was introduced several years ago which requires modern man to look at the biological functions or processes found in nature for inspiration, which are "biomimetics" or "biomimicry". These novel bioinspired design approaches involve an understanding of natural sciences, biological processes or the entire biological ecosystem beyond only mere formal or appearance imitations [\[10\]\[11\]](#).

Note that 'biomimetics' and 'biomimicry' are based on the same scientific methodology, which is an interdisciplinary design approach through the understanding of a biological role model. In particular, 'biomimicry' stresses the interconnectedness of systems to solve complex problem in design and today's environmental challenges. In fact, animals and plants know how to implement strategies to adapt to their environment and their transformations develop within a sustainable ecosystem. Nowadays, technical advances at a very small scale (micro, nano) allow us to have a deeper understanding of the functioning of nature and provide a new source of knowledge and inspiration for architecture [\[12\]\[13\]](#). Admittedly, the architects have always been inspired by nature, it is still the case today and it will probably be in the future. However, we must distinguish a primarily formal bioinspiration with only an aesthetic or symbolic aim to biomimicry whose objective is innovation and sustainability. It is also necessary to distinguish among several bioarchitectural movements from the past to the present and how they lead to today's biomimicry framework, because there is a great deal of terminological confusion due to the fact that we often associate terms from the life sciences with certain architectural design activities [\[14\]](#).

Nature presents such a multitude of phenomena that the length of time for research and maturation of a possibility of transfer to architectural design can be complex. Biomimetic design activities necessarily require multidisciplinary expertise involving biologists, architects and other scientific fields, which is still the main constraint within architectural design practices. Focused methodologies for analogical transfer and interdisciplinary exchanges can facilitate biomimetic design process and implementation in architecture [\[14\]\[15\]\[16\]](#). Moreover, the use of computational design and digital fabrication have recently supported architects in studying and simulating biological models, helping to transfer them better into architectural design contexts [\[17\]](#).

This entry presents principal bioarchitectural movements and how they lead to today's biomimicry framework. It aims to define biomimicry methodologies and how this approach applies to architectural design contexts through the study of existing case studies. The paper is divided into five sections; (1) Introduction; (2) Bio prefix in architecture; (3) Biomimetic design methodologies and tools; (4) Biological analogy and architectural design; and (5) Discussion and the outlook of the field.

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