

Biomimicry Research Paper

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Abstract

Biomimicry has become more popular with upcoming research and technology. There are now ways that we can produce designs that reflect the world around us. This paper covers the history of biomimicry and how it has evolved through the years. It has stood the test of time through trends that come and go, and designers are constantly going back to nature to find inspiration. The different types of Biomimicry help to understand how it is used, and with what form it is used in. While biomimicry can be expressed through Architecture, it can also show in interior design. It also looks at the precedents that are presented in any interior design process and how with biomimicry this can be improved. Overall, nature in design is proven to improve the life and well-being of people and their communities.

When it comes to Interior design and architecture, trends are constantly changing. Biomimicry is a study that changes with the trends as well as changes our perspective, it's main focus is on functional solutions, which challenges us to take hold of the nature around us and use it to our advantage. This challenging yet inspiring topic has become the basis for many designs new and old. In an article titled *Biomimicry: Taking Cues from Nature*, Author Annmarie Martin describes Biomimicry as “Beyond bringing in a few plants indoors, biomimicry looks to the ultimate teacher--nature--to create products that help build more sustainable, less impactful interiors.” (Martin, A, 2022) Her perspective helps to understand how biomimicry is applied when it comes to interior design and architecture. This paper will explore the many ways that biomimicry is used as well as the history of it and how we can apply it in our everyday lives.

History of Biomimicry

There is no true date that relates to when biomimicry was invented or when it was first used. For as long as we know, scientists and architects have used biology to influence designs in buildings or even in decorations of the time. In the book *Biomimicry in Architecture*, Author Michael Pawlyn writes “The term ‘biomimicry’ first appeared in scientific literature in 1962 and grew in usage particularly among material scientists in the 1980s.” (Pawlyn, M, 2016, Pg. 2)

When it comes to the origins of Biomimicry, research points to the great artists of the Renaissance time. In many ways, it is seen that Leonardo de Vinci and Filippo Brunelleschi both studied the forms of animals and thus became pioneers of biomimicry. For example, Brunelleschi referenced eggshells in the early design phases of the Duomo in Florence, Italy. Biomimicry is woven throughout this period. Corinthian-style columns were normally decorated by some reiteration of the acanthus leaf, creating an elegant, expensive look. Fruits and flowers decorated

the interiors of the high society's homes. The Renaissance opened the doors to biomimicry in both decorative and architectural ways.

Since then, biomimicry has just recently come to the surface. The 1990's was a dormant time in the study, but since then research and projects have grown substantially. "Much of this activity has been in the fields of robotics and material science. The opportunity now exists for architects to fully embrace a source of innovation that has transformed other fields of design." (Pawlyn, M, 2016, Pg. 6) With the new pace of innovation and technology, these new approaches are becoming widespread. The outlook on what biomimicry is has changed, scientists and architects now see it as a way to sustainably achieve their goals.

Types of Biomimicry

To clarify, Biomimicry and biomimetics can be used interchangeably. Biomimetics is another way to describe what biomimicry is, just with an emphasis on the aesthetics of sustainable design and its solutions. 3 main types of biomimicry can help us sort through the different ways that it is used. "The First type is Copying form and shape; the second type is copying a process, like photosynthesis in a leaf; and the third type is mimicking an ecosystem's level, like building a nature-inspired city." (Abounaga, Mohsen M, 2022, Pg. 11). The third type plays a large role in urban design. The ways that biomimicry is used in cities vary on the climate. Every urban space is consistently affecting the environment in negative ways; however, we can work to solve these problems with the influence of nature in our designs.

The integration of biomimicry within urban spaces greatly affects the mental health of people in the area while also helping the environment. All over the globe, the use of this design influence positively affects its surroundings. Even if the geography of the area is flat and dry or

full of hills and cold, these traits can be easily integrated throughout the design. In fact, they can become the basis and inspiration for the design. “A vivid example of biomimicry in architecture is the art nouveau style by Architect Buckminster Fuller, in which biological structures were often mimicked. Biomimicry applications in architecture and healthier buildings aim regularly at reducing environmental impacts and enhancing human well-being through many elements as illustrated in Fig. 1.32b.” (Abounaga, Mohsen M, 2022, Pg. 35) Figure 1.32B is shown below and helps to better understand the role of biomimetic architecture as it relates to humans and their well-being.

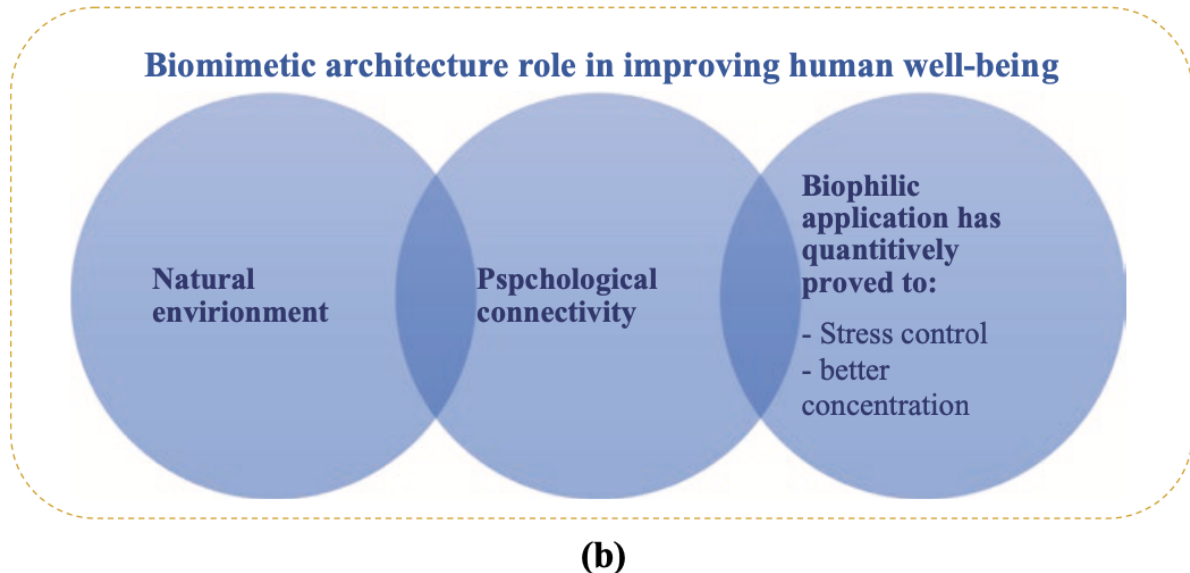


Figure 1: Abounaga, Mohsen M. (2022) Biomimicry's applications to enhance well-being impacts. (Image source: developed by authors after Uchiyama et al.) M. Abounaga, S. E. Helmy, *Biomimetic Architecture and Its Role in Developing Sustainable, Regenerative, and Livable Cities*. Pg. 35, Chapter 1.

Biomimicry in Interior Design

Architecture and Biomimicry go hand in hand, however when we look at Interior design, the term changes to biophilic design. Rather than mimicking nature in the whole of the design, Biophilic design captures the attributes of nature and how we as humans can use them. There are many ways that as designers this is already being used in design. By incorporating natural light

in things such as windows, sunrooms, and sunlight, biophilic design is displayed. The Pocket Universal Principles of Interior design gives more examples of Biophilic design. “Biophilic design incorporates natural elements like plants, light, air, water, sound, smell, scent, and materials to enhance living conditions. It improves health and productivity and reduces stress by creating a connection with nature. Examples of biophilic design include maximizing natural light, incorporating green walls and planters, utilizing water features, integrating sounds and scents of nature, using natural materials, and incorporating art inspired by nature. These elements create a harmonious and calming environment, improving comfort and concentration.” (Harris Smith & Grimley, 2024) This is a great tool that can be used in any design. Again, it not only adds to the use, but to the mental health and wellbeing of the people it serves.

This idea of design has changed perspectives to see the resourcefulness of nature, and why we should pull ideas from it. Mike Pawlyn in his second edition of *Biomimicry in Architecture* explains how easy it is to source these new ideas. “Nature makes extremely economical use of materials, often achieved through evolved ingenuity of form. Using folding, vaulting, ribs, inflation, and other means, natural organisms have created effective forms that demonstrate astonishing efficiency. The many manifestations of this in natural organisms provide a rich sourcebook of ideas for structures that could be radically more efficient than those found in conventional architecture” (Pawlyn, M, 2019, pp. 8-43).

Biomimicry has grown to be very popular in the modern age. We now have the tools and resources that in the past century, people didn’t have. The use of nature is not a building design trend that has come and gone. But because of the new technology and research, we are now able to look at biology in a new way for design. In Thomas Button’s thesis; *Biomimicry: A Source for Architecture Innovation in Existing Buildings*, he explains a form of biomimicry and how it has

been used in modern building design. “Examples of biomimicry in architecture exist in different forms, such as using biomorphic forms, which is the design of a building form that captures a form found in nature. An example of this is



the TWA terminal, by Eero Saarinen, at the *Figure 2: Photo of the TWA Hotel from above at John F Kennedy Airport in New York. Photo courtesy of the TWA website.*

John F Kennedy Airport in New York, where the building form represents wings and flight.” The building is shown in Figure 2. Another example of biomimicry used in architecture is the Waterloo International Terminal. Figure 3 shows the similarity between the pangolin and the structure of the airport terminal. Now unused, it was built in 1993 and designed by Nicholas Grimshaw & Partners. In the book *Regenerative Urban Design and Ecosystem Biomimicry*, the author explains the science behind Nicholas Grimshaw & Partners’ design. “The terminal had to be able to respond to changes in air pressure as trains entered and departed. The pangolin and the snake do not have to deal with internal air pressure changes, but after determining that a flexible building was needed, the architects studied the scale arrangements of these animals to understand what makes them so flexible. They used this study to design the fixing arrangement of the panels of the terminal.” (Maibritt Pederson Zari, 2018) From just these two studies it is obvious of the vast design opportunities nature gives us.



Figure 3: Maibritt Pederson Zari. (2018) Pangolin (left); Waterloo International Terminal (right). Photo courtesy of *Regenerative Urban Design and Ecosystem Biomimicry* by Maibritt Pederson Zari.

Design Precedents

To be successful in improving design with biomimicry it is important to look at how it will affect the design process. A big part of this process is time frames. People strive for, but more often expect quick deadlines and results. Biomimicry challenges this precedent of design. It challenges designers to look at the way that nature functions and how nature displays itself, even if it takes time. This is the beauty of nature; it takes only what it needs and gives all that it can. Nature is on its clock; it takes its time. Incorporating this into design will take patience, time, and lots of research, something that designers tend to lack. In the book *Applying Biology to Design Concepts*, the author states, “Compared to industrial design processes where research and development phases may last for several years to create much shorter life products, compressed building design phases do not honor the gravity of the task at hand. That is, to create buildings and spaces that are fit for purpose, fit for people, and fit for a site long term. Addressing these two barriers alone would likely improve the quality of built environment design. Simultaneously, they increase the demand for a more biomimetic perspective, while permitting the time for its inclusion.” (Zari, Maibritt Pedersen, et al., Taylor & Francis Group, 2020) To achieve the improvements and advantages that nature in design can give us, time and patience, seem to be

the biggest challenge. Author Rossin, K, J gives her solution to this problem: adding a biomimicry stage in the design process. “Through a series of graphic comparative analyses, it was deduced that interior designers should graft a biomimicry phase into the programming stage of the design process. This would allow practitioners to biologize their design challenges by asking nature “What do you want your design to do?” not “What do you want to design?”” (Rossin, K. J.,2010). It is easy to see how beneficial this could potentially be to architecture and interior design.

To conclude, Biomimicry is a study that changes with the trends as well as changes our perspective, its focus is on functional solutions, which challenge us to take hold of the nature around us and use it to our advantage. This study has covered many topics in and around biomimicry; the history, the precedents, challenges, uses, the impact, and the future. However, with all of these topics, there is a common theme that is strung throughout: Nature was designed to teach us how to make an impact, whether it be on a small or large scale. Henry Dicks says this towards the end of his book, *The Biomimicry Revolution: Learning from Nature How to Inhabit the Earth*: “There is a broad assumption shared by many that biomimicry is simply a strategy for technological innovation, albeit one oriented toward sustainability. Over the past few years, a small number of philosophers sought to question this narrow and reductive interpretation of biomimicry, suggesting that to embrace biomimicry is to embrace not only a new strategy for technological innovation but also a broader philosophical shift in both our thinking about and our relation to nature.” (Dicks, H, 2023) This helps us to understand the many impacts that nature can have on our designs, and how through those designs, we can impact the world.

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