

Review on Biomimicry Levels

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ABSTRACT: To design that inspire from nature, it should not only inspired or follow the form of the characteristic of nature itself. There three levels in Biomimicry, there are Organism Level, Behavior Level and Ecosystem Level. In order to create a design inspired or mimic the nature, these level need to follow and apply in design. However, the widespread and practical application of biomimicry level as a design remains unrealized, commonly the design use biology as a shape which is only using organism level but this is not biomimetic, it has to have some biology in it. The aim of this study is to understand the levels of biomimicry. Content analysis is adopted to identify the level in biomimicry of recreation. The outcome of this study will enhance the understanding of Biomimicry Levels, in order to enhance conditions conducive to life.

KEYWORDS: *Biomimicry Approaches, Biomimicry Levels, Organism, Behavior, Ecosystem*

I. INTRODUCTION

In 1997, Benyus defined biomimicry as being from the Greek ‘bios’, which means life, and ‘mimesis’, which means imitation. This field studies nature’s models and imitates or takes inspiration from its designs and processes to solve human problems. Biomimetic is frequently used in scientific research to explore forms, connections, structures, as well as biological mechanisms and processes. It is not a new concept, but a technical term used in different fields of science

Bio – integration had been exploring by many disciplines where they try to understanding on order to allow for the establishment of system, process and sustainable product [1]. Biomimicry is a one of disciplines that can be use in sustainable development [2], [3]. There are numerous of inspiration or lesson from biomimicry, for example on how to “designing with nature” that can help to give an idea for designing the sustainable environment. [4]. It is clear that designing based on natural or ecological principles can give many benefits to nature and also can improve the environment performance. However, practical application of biomimicry as an approach in design method remains largely unrealized, as demonstrated by the small number of built case studies. [5]. The biomimicry inspired design is not designing based on forms from the nature but understanding and have a knowledge about biomimicry approach of their level as well.

To achieve the biomimicry approaches, there are three levels of mimicry, these are; form (Organism), process (Behavior) and Ecosystem [2]. These three levels help to identify kinds of biomimicry that have evolved and also there is a framework as a reference for designers who wish to apply biomimicry method to improve the sustainability for environment and also know which approach to use. This will help designers determine which aspect of “bio” to “mimic” [6].

1.1 LITERATURE REVIEW

To have a full emulation of nature engages at least need to follow three levels of biomimicry: organism, behavior and ecosystem level.

The organism level entails the designer looking at the form of a specific organism analyzing how it functions; the designer can choose to mimic a part or the organism as a whole.

The behavior level, involves the imitation of how an organism interacts with its immediate environment in order to build a structure that can fit in without resistance in its surrounding environment.

The third level, involves mimicking of how an organism interacts with the environment and how many components work together; this tends to be on the urban scale or a larger project with multiple elements rather than a solitary structure [6].

Through each level there are five dimension which determine at which extent the mimicry exists. The design is listed as bio- mimicry in the way it looks like (form), what it is made of (material), how it is made (construction), how it works (process) and what it's capability (function). These levels are very important and they complete the biomimicry approaches.

1.2 METHODOLOGY

Content analysis is adopted to identify the Biomimicry Level in design. The selecting content are from case studies. The case studies chosen based on their study about Biomimicry approach and biomimicry level of three levels; Organism Level, Behavior Level and Ecosystem.

II. RESULT AND DISCUSSION

The data collected from the content analysis, the result will be discussed. Table 1 shows the content analysis from previous authors

Table 1: Content Analysis from previous author

No	Author	Biomimicry Level
1	Benyus , 2007	1. with deep biomimicry level we are mimicking what all well-adapted organisms have learned to do.
2	Zari, 2007	1. a design may imitate the characteristics of an individual organism, it may be inspired by how the organism behaves, or the design may draw from the entire ecosystem of an organism and its surroundings.
3	Zari , 2007	<ol style="list-style-type: none"> 1. There are three levels of mimicry; the organism, behaviour and ecosystem. 2. The organism level refers to a specific organism like a plant or animal and may involve mimicking part of or the whole organism. 3. The second level refers to mimicking behaviour, and may include translating an aspect of how an organism behaves, or relates to a larger context. 4. The third level is the mimicking of whole ecosystems and the common principles that allow them to successfully function. Within each of these levels, a further five possible dimensions to the mimicry exist.
4	Biomimicry Guild, 2007	<ol style="list-style-type: none"> 1. three levels of biomimicry that may be applied to a design problem are typically given as form, process and ecosystem 2. In studying an organism or ecosystem, form and process are aspects of an organism or ecosystem that could be mimicked. 3. Ecosystem however is what could be studied to look for specific aspects to mimic.
5	Van der Ryn, 2005 Reed, 2006	<ol style="list-style-type: none"> 1. biomimicry at the organism level may be inspirational for its potential to produce novel architectural designs [8] 2. the possibility exists that a building as part of a larger system, that is able to mimic natural processes and can function like an ecosystem in its creation, use and eventual end of life, has the potential to contribute to a built environment that goes beyond sustainability and starts to become regenerative [9]
6	Mazzoleni & Price, 2013	1. This kind of biomimicry exceeds an analogy and performs / functions in different levels (such as organism, behaviour and ecosystem) [10]
7	Pawlyn , 2011	<ol style="list-style-type: none"> 1. The first level of biomimicry is the mimicking of natural form. This type of mimicking is to copy an organism for its morphological attributes like its visual shape, components, materials or how it looks. In a single word, first level is to copy an organism's design. 2. The second level is to mimic the natural processes. This level is to reproduce a biological entity's emergence or actions and

		processes within its environment. 3. The third level is the mimicking of natural ecosystems. This is a more complicated set of processes than the first two levels.[11]
8	Biomimicry: A Tool for Innovation,” 2007-2010	1. The biomimicry approach is a practical framework that allows the designer to evaluate problems by asking nature to “model, measure and mentor, and then mimics form, process and ecosystems at all levels of design”

It is expected that some overlap between different kinds of biomimicry exists and that each kind of biomimicry is not mutually exclusive. For example, a series of systems that is able to interact like an ecosystem would be functioning at the ecosystem level of biomimicry. The individual details of such a system may be based upon a single organism or behaviour mimicry however, much like a biological ecosystem is made up of the complex relationships between multitudes of single organisms.

There are three Biomimicry Level that highlighted by those authors in Table 1. First is Organism Level, the organism level refers to a specific organism like a plant or animal and may involve mimicking part of or the whole organism. The second level refers to mimicking behaviour, and may include translating an aspect of how an organism behaves, or relates to a larger context and the third level is the mimicking of whole ecosystems and the common principles that allow them to successfully function.

From existing biomimicry and literature, different approaches evolved in biomimetic design, which lead to different outcomes. Most of the mimicking outcomes are applied at organism levels such as developing a material or product. [1] stated that developing a product without considering its relation to the ecosystem produces a non-sustainable system, especially in life cycle analysis. For instance, applying biomimicry in a design as a system will be successful if it can imitate the natural process. This approach can drive beyond sustainability and starts to be regenerative in the built environment [6]. Zari and Storey [7] stated that to design within biomimicry, the ecosystem should be considered to design a sustainable system.

If we can biomimicry at all three levels; organism, behavioral, and ecosystem, the designer begins to do what all well-adapted organisms have learned to do, which is to create conditions conducive to life. Creating conditions conducive to life is not optional; it is a rite of passage for any organism that manages to fit in here over the long haul.

By understanding what is Biomimicry level, and why we need to apply all this level into the design, it will give us an information or knowledge about biomimicry itself. All this level already mentioned by previous researcher, however it still unrealized. By using these Biomimicry framework, the design that will come out not just imitating or being inspired by natural-looking forms, textures and colors but it has to have some biology in it.

III. CONCLUSION

A biomimicry design could be easily inspired by organism shape, but it need not and it has nothing to do with appearance. The designer need to develop deeper and more responsive understanding the nature and come out with the design that beyond the formalistic characteristic of nature. It is important for the designer to understand what are these Biomimicry Levels. The paper also identifies that using biomimicry level will help us discover sustainable and effective solution to the most important issues in environment.

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