

## **Biomimicry: Finding Inspiration for Innovation in Nature**

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Currently, in popular culture, there is a positive trend of green awareness. As global warming and humanity's impact on the environment have become more apparent, people have started to grow in their attentiveness towards the Earth's current dilemmas. Yet, still unheard of by the general public, and even by many professionals, is the concept of "biomimicry." Coined by Janine Benyus, biomimicry is the idea of imitating the processes of nature in human technology and architecture. By mimicking nature, there is hope that innovative and sustainable design will result. The use of biomimicry requires certain guidelines to be met so that the use of biomimicry contributes to sustainability and efficiency. The definitions for biomimicry, its guidelines, and the current uses of biomimicry in technology and architecture will be discussed in this paper.

Janine Benyus's book, *Biomimicry*, defines biomimicry in three ways: nature as a model, nature as a measure, and nature as a mentor (1). By this she means that biomimicry "is a new science that studies nature's models and then imitates or takes inspiration from these designs and processes to solve human problems, uses an ecological standard to judge the 'rightness' of our innovations, [and] it introduces an era based not on what we can extract from the natural world, but on what we can learn from it" (Benyus 1). Biomimicry, therefore, is a paradigm shift from thinking we, as humans, have all the

answers and instead looking to nature as the supreme source of knowledge and solutions.

Presently, biomimicry is mostly theoretical, as the amount of research and proven uses of biomimicry is minimal at the moment. However, the potential of biomimicry is strong. Especially when combined with engineering, biomimicry could increase efficiency of energy use and decrease our ecological footprint significantly. Maibritt Pedersen Zari, a professor of architecture at Victoria University, believes "design that mimics how most ecosystems are able to function in a sustainable and even regenerative way, has the potential to positively transform the environmental performance of the built environment." However, what is crucial to productive biomimicry is adaption of the biology to technology, not just reproduction of its forms. For instance, designing a ship in the shape of a leaf could be defined as biomimetic, but it does not adopt the chemical and biological processes of a leaf. If a design lacks the aspects that make nature sustainable, then the design really isn't sustainable. Therefore, there are a few guidelines established by Benyus and others in order to assure "correct" and useful biomimetic design.

First of all, the guidelines are designed to fit the goal of biomimetic design, which is "to produce engineering that has basic attributes of biological systems such as low energy usage, easy recycling, extreme

durability and versatility from few readily available starting materials” (Vincent). The guidelines, which are defined by Benyus, are also based on what many organisms already do— more precisely, what makes the natural world interact in a balanced, yet functional way. First off, some organisms use waste as a resource. This ensures that there is no excess waste that is polluting the environment and it also minimizes the amount of available resources consumed. Many organisms also are efficient users and gathers of energy. Efficient use of energy is very important, especially in the current age where society is consuming energy quickly and unsustainably. The goal to use energy with little of it wasted is crucial. Along with being efficient energy users, most organisms use materials sparingly. Whereas in the United States we live off the glamorization that “bigger is better,” most organisms do not exceed nature’s limits. It is also important to keep toxins in mind. Many organisms have poisonous substances for defense, yet they keep the toxins out of their homes. We capitalize on synthetic, hidden toxins and are surrounded by them every day. By mimicking the traits of the aforementioned organisms, we would be careful with how materials are used and how they intoxicate our living environment. A limiting factor in nature is the fact that a majority of organisms must “buy” locally—that is, they can’t travel far distances to get the resources they need. Therefore, we should do the same. This would minimize on transportation energy and support local economies. All of these traits that organisms exhibit are guidelines that we as a human race could use to create technologies, systems, and buildings more sustainable.

To begin to apply biomimicry, it is important to have some scientific knowledge of the organisms that are inspiring the design. Although it may be easy to mimic the forms and shapes of different organisms, when chemical processes get involved, some professional help is needed (Zari). The Biomimicry Institute has made finding solutions to problems easier by creating a database called *Ask Nature*. This database allows the user to search for the problem, and the search engine will give results of solutions found in nature. This public database allows biomimicry to reach all levels of education and is a good introduction for serious innovations.

There are numerous ways of categorizing and judging different types of biomimicry. Maibritt Pedersen Zari believes there are three levels: organism, behavior and ecosystem. The “organism” level is usually represented when a part or whole of an organism is mimicked. Then there is the “behavior” level, which is mimicking how an organism works in the ecosystem. The “ecosystem” level is mimicking the general principles that allow an ecosystem to function. In terms of building design, there is a second “dimension” to the ecosystem level. It basically entails applying a general ecosystem principle of all ecosystems to the built environment. This has promise to decrease a building’s environmental impact since the building would balance the resources used with its waste and make contributions to the environment like an organism would.

Benyus also outlines several factors to consider when applying a natural trait to an engineered innovation. She suggests that the process should mimic the manufacturing process that organisms

use. After research into the subject of how organisms “manufacture” themselves, the results show the underlying factor for an organism’s structure is due to proteins and amino acids. Proteins allow for crystal structures to be densely structured, and they even work their magic in our bodies by creating strong, yet flexible tendons. Benyus mentions that in order for us to use biomimicry to the fullest extent, we must become experts on how proteins build structures and code for the natural processes and balances among species and the environment. Because of the natural structures of organisms, energy is not a concern. In fact, “energy is the controlling factor in only 5 percent of all problems in biology” (Vincent). From this statistic, it is apparent that organisms are naturally energy conserving, and therefore, a valuable inspiration.

Although biomimicry is a new concept, there have been many studies and there are many examples of biomimicry at work. These illustrate the potential biomimicry holds for the future sustainability initiative that the world is responsible for. Benyus lists several broad inspirations for biomimicry that cover various types of uses. For instance, she suggests farming similar to how a prairie grows, collecting energy like a leaf, weaving fibers and strengthening structures like a spider, storing what we learn like how a cell stores information and closing loops in commerce by running a business akin to how a redwood forest works.

One example of a completed product based off of biomimicry is the product called “Kinetic Glass.” The glass is “based on animal respiratory systems and made with a slit silicone surface that lets air

pass through” and uses “gills” to let out polluted air (Muntaneau). Another company, “Kyosemi,” developed a “a power-harvesting solar cell that imitates the way trees collect sunlight” called Sphelar (Munatneau). Unlike traditional photovoltaic panels, these spherical cells that are incorporated into windows can absorb the sun’s rays from multiple directions. This enables a more consistent energy consumption as the sun relatively changes its position in the sky. There is also a promise to stop air pollution with the product called “SuperAbsorber” (Munatneau). This is a highway barrier that uses a process called “photocatalyzation” (Munatneau). It is claimed “that the airborne pollution of a large city could be cut in half if pollution-reducing cement were to cover just 15 percent of urban surfaces” (Munatneau). Even automobiles are starting to see a biomimetic presence. For example, airplane engineers are looking to birds for innovative aerodynamics, and the car company, Daimler Chrysler, is looking to a fish. The design Chrysler is using mimics a box-fish (*ostracion meleagris*), which “a uniquely aerodynamic fish despite its box-like shape” (Okonsky; Zari). In addition to this, the structure of the car is also biomimetic. The structure is based on how trees grow, which minimizes stress concentrations, and there are gaps of structure because the material needed is minimized (Zari).

Much of biomimicry’s inspiration and success is based off of materials that mimic the skins and membranes of organisms. There are a few guidelines based off of nature that we can learn from, as stated by Benyus. The first is a “life friendly manufacturing process,” which means, no harsh chemicals, or high pressures and a strong reliance on water

and room temperature (Benyus 88). Benyus also suggests self-assembling. Whereas we rely on a top-down approach to manufacture materials, organisms do the opposite and self-assemble the materials they need (Benyus 91). The last guideline is a hierarchy of structures, organized by the structure of proteins to make crystal (Benyus 92). Controlling proteins is critical, and to gain that control would most likely be through the use of genetic engineering—used responsibly, of course (Benyus 93). A good example of how biomimicry is used in materials is a new swim suit material inspired by shark skin. Although sharks have very rough skin, the swim suit material based off the texture worked so well that they were banned by the FINA—the governing body for world swimming (Pawlyn 8).

Architecture also has a strong potential use for biomimicry. Right now, buildings are a huge consumer of energy. In fact, “in 2001, new building accounted for about 40% of annual energy and raw material consumption, 25% of wood harvest, 16% of fresh water supplies, 44% of landfill, 45% of carbon dioxide production” and were responsible for half of the greenhouse emissions in industrialized countries (Deolankar). The key to biomimicry in architecture is to consume the least amount of energy as possible. Biomimicry is still a new concept in architecture circles, but they are making ground as colleges start to introduce the concept.

One architect, Mick Pearce has been the ground-breaking key person for biomimicry in architecture because of his building, the CH2 and Eastgate Centre. His inspiration is termites. Termite mounds must maintain the temperature in their

mounds to 87 degrees Fahrenheit, even though their native Zimbabwe has temperatures ranging from 35 to 100 degrees in a single day (Lefaivre). Yet, termites are able to maintain this temperature because of their natural ventilation process of opening and closing spaces throughout the day (Lefaivre). They also control moisture through ventilation, their own respiratory systems, and even re-eating the mound material (French).

Mick Pearce attempts to mimic this system in his buildings, the Eastgate Centre in Harare, Zimbabwe, and the Council House 2 building (CH2) in Melbourne, Australia. Eastgate Centre uses the “mass of the building for heat and the temperature changes to keep the building uniformly cool” (Lefaivre). This natural ventilation system is very successful, to the point that it “costs 1/10<sup>th</sup> of a comparable air conditioned building” and uses 35 percent less energy than six comparable Harare buildings combined (Lefaivre). In the CH2 building, he uses vertical frames for plants to grow to act as a “living sun screen” (qtd. in Morris-Nunn). Both buildings use a “rock store” that is cooled at night by the outside temperatures, and the hot air coming in during the day is cooled by the rocks (Lefaivre). Pearce now aspires to apply the termite model to the whole town. These two buildings stand as biomimetic icons which show that sustainability in architecture does not just have to be boxes with eco-tech doodads. They show that sustainability, and more specifically, biomimicry can be aesthetically pleasing as well as incredibly efficient.

Biomimicry can change the way we see technology and the built environment.

Nature's systems work efficiently for a reason. The ecosystem services our earth provides give us exactly what we need. We, as a race, just need to change the way we see nature. Instead of trying to control it, we should look to it for guidance and wisdom. In our current predicament of dire environmental issues, we need innovative solutions to combating climate change and ecosystem destruction. With biomimicry, we can appease our desires for faster, bigger, and cooler things, without destroying the planet we are given. Biomimicry can change the way we approach technology and invention. It can change the way we live.

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