Biomimicry: Nature in Design and Architecture

Biomimicry is a branch of science that studies the imitation of nature’s functions and systems. It is a fast growing and exciting field of study that seeks to understand how to integrate living and breathing organisms into a design process.

In nature, all surfaces are organic, flowing forms; materials and textures merge together seamlessly. Through the application of nature into architectural design, architects can design buildings for environments that are closer to nature rather than invasive.

Architects have often turned to nature for inspiration in solving design problems or confronting new design issues. They have used nature’s ideas to foster innovations in design and engineering. Biomimicry can be applied at various levels. In architecture, buildings seek to mimic nature’s forms. Frank Gehry’s fish-like shapes, the spiny spires of Gaudi, and the structural vertebrae of Calatrava exemplify the architect’s fascination with nature.

Shells like that in Image_02 have housed marine creatures for millions of years. Biomimicry does not just look at the shape and form of nature, but asks a much bigger question: what function does that form provide?
Contemporary architects are turning to ecosystems and microclimates for clues and solutions regarding the efficient use of natural resources. How they can adapt the design of their buildings to function as effectively? Nature may have the answer to every design problem. One just needs to know where to look.

Look at the illustration of the Crustacean above. While retaining some of its core characteristics, what aspects of its design could be applied to the design of a building?
Through Biomimicry, architects are able to observe how sustainability works in nature, and incorporate solutions into structures in the built environment. It is important that buildings be eco-efficient, so integrating aspects of nature into the design is essential.

Architects today are studying turtle shells. Not just the features, but how an efficient organic structure, which houses and sustains the turtle can be applied to a building's design. An atrium is a central court in a building that rises several floors, with galleries and rooms opening off of each level. Atriums might provide a sustainable way of collecting water, as well as letting in natural ventilation and light. Turtle shells regulate heat. How can that process be applied to a building? These are the questions that drive architects to push the boundaries of structure and sustainability.

The following images illustrate how the design of a turtle shell can be turned into an atrium.

An initial sketch of a turtle enables architects to understand its form.
A few loose sketches of the turtle shell atrium provide an overall idea of the structure. Drawing several views enables a better understanding of a design.

With the form of a turtle shell in mind, compose a sketch. The sketching stage is the most important, and inspiration can be drawn from the natural world. Designs are still informal, so explore a multitude of ideas to make a design work.
These sketches are based upon the body shape of various insects. Begin to apply these ideas to an architectural design.

**Note:**


True Biomimicry is difficult to achieve. Biological systems work and solve problems differently than engineering systems. In order to formulate the right questions and know which areas in nature to emulate, architects work with biologists throughout the design phase. Contemporary architects use the sculptural designs of nature to create beautiful, organic, sustainable, and eco-friendly structures. In a world where survival of the fittest rules, nature has won many evolutionary battles. Architects look to nature when determining how size, weight and material choices can result in ultimate performance and durability of design. Millions of years of evolution have optimized these natural forms. They have survived and been shaped by water, wind and other elements in their environment. It is these survival traits that hold the key to enabling architects to implement sustainable design solutions.
By looking to nature for inspiration, architects strive to identify features that can be incorporated into a design, including form and structure, long life, superior function, and adaptability. Architects turn to Biomimicry for new building designs, and as a source of inspiration for aesthetic expression. In many cases, the results are buildings that are highly efficient, more durable and require less energy and construction materials.

Consider Image_11. Take the atrium design a step further by sketching a different point of view.

One of the main reasons architects look toward nature is to find sustainable solutions in design. Biomimicry seeks to extract sustainable design solutions by emulating nature’s time-tested strategies and patterns. Can a solar cell be developed based on the behavior of a leaf?

Nature has been imaginative and solved many problems humans are still grappling with: energy, food production, climate control, and packaging. Biomimicry is unlike any other “bio” approach. It studies the design principles of organisms and ecosystems in order to apply them to architectural ideas.

Biomimicry regards nature as model, mentor, and measure. Biomimicry is a science that studies nature’s models and then emulates these forms, processes, systems, and strategies to solve key human problems like energy conservation and recycling.
Looking at some of Santiago Calatrava’s works http://www.calatrava.com/, it is easy to see how he is inspired by birds. This is evident in designs such as the Milwaukee Museum of Art.


The foremost Biomimetic buildings are those that utilize functional properties derived from nature. There are many examples of nature in human innovations. Just as a sunflower can track the sun, so can man-made solar panels. Consider the example of a leaf as it unfolds and develops. It assembles itself into a photosynthesizing, water repelling, thermal regulating surface. It can distribute water to all parts of its structure through veins in its architecture. A roof can be designed in such a way that all rain water is distributed to a central downspout for collection and re-distribution.

Look at the photo of the leaf. Notice the detail of the veins and look how they serve each part of the structure all the way to the tips. The surface is water and pest repellent, yet sustainable in the sense that it uses these veins to feed itself.
The most inspiring examples of Biomimicry combine the functional properties of nature with aesthetic expressions. Take a look at the Johnson Wax building by Frank Lloyd Wright [link](http://www.greatbuildings.com/buildings/Johnson_Wax_Building.html). It is a beautifully lit hall with columns that expand as they rise, evoking lily pads floating on the surface of water. These columns were the first thin-shell concrete structures in the world. They were designed with an innovative use of steel-mesh reinforcement, inspired by the natural structure of a cactus plant.

Image_14 shows a quick sketch of the front of the Johnson Wax building by Frank Lloyd Wright.

Image_15 shows a quick perspective sketch of the interior of the Johnson Wax building by Frank Lloyd Wright. Nature relies heavily on self-assembly. This method has been streamlined through millions of years of evolution, and uses friendly processes of manufacturing. It incorporates an ordered hierarchy of structures to fit form to function.

Image_14

Image_15
Look at the photo and consider the streamlined design of a whale shark. Could this form be utilized in a building for a new public aquarium?
The most exciting stage for most designers is sketching to develop new ideas.

Sketching is the start of any creative design process where ideas go from the mind onto paper. Clarifying an idea makes anything possible. The design in Image_17 will house an underground aquarium. This structure will serve as the entrance and exit, as well as the main foyer and reception of the building. The design was inspired by the whale shark.
A 3D model based on the drawing's design concepts can now be initiated. Complex repetitive patterns can be created with digital software, and changed at will throughout the design process.

Breaking down the parts of a design makes it easier to understand and construct the model. The 3D process will often be used to create shapes and block out designs. However new a design idea might seem, chances are nature has already perfected it. The first airplanes attempted to mimic the wings of birds. The idea for Velcro was developed by a Scottish inventor who studied the burs stuck to his dog's coat. What is new, is that Biomimicry is being actively studied and promoted by a new generation of designers and architects, enabling them to create sustainable and eco and environmentally friendly buildings and products.