International Journal of Engineering Research ISSN:2319-6890 (online),2347-5013(print)
Volume No.7, Issue Special 3, pp : 231-234 11-12 Jan. 2018

Natural Analogues as Emerging Nature-Based Parameter for Built Environment

Prof. Sushama Parashar[1], Prof. Pashmeena Ghom[2]
[1]BKPS College of Architecture, Pune, India
[2]MIT School of Architecture, Rajbaug, Pune India
sushamaparashar@gmail.com, pashmeenaghom@gmail.com

Abstract: ***The space, structure and shape of living organisms found in nature have been providing a wealth of inspiration for designers. It does not entail emulating nature, but allows innovation and problem solving, to craft more intelligent and sustainable solutions. Nature of the Space addresses spatial configurations in nature. It can be achieved through the creation of natural analogues. Natural Analogues are objects, materials, colours, shapes, patterns and algorithms that evoke nature. Broadly speaking, analogues can be considered in architecture and as representational artwork, ornamentation, biomorphic forms and natural materials.The purpose of this paper is to consider how Natural analogues complements and potentially enhances design approaches for the built environment***

Keywords: **Nature, Analogues, Biomorphic, Biomimicry, Complexity**

I. Introduction

An analogy, in its simplest form, involves making a statement about the similarity, or relationship, linking two objects. Use of Natural analogues in architecture lays a foundation for creative thought across a wide range of endeavours. Sometimes it's impossible to create new ideas out of air, the basis for new ideas can be a nature. Natural Analogue patterns applied to space have been identified as biomorphic forms and patterns, Material connection with nature and Complexity and order. Study of nature can be an important and interesting design sourcebook

*"**In every walk of nature, one receives far more than one seeks**."* (John Muir, 19 July 1877)

"The enjoyment of scenery employs the mind without fatigue and yet exercises it, tranquilizes it and yet enlivens it; and thus, through the influence of the mind over the body, gives the effect of refreshing rest & reinvigoration to the whole system." (Frederick Law Olmsted 1865)

Function and forms in nature are intimately related to each other and have co-existed in harmony since historical times.

Forms seen in nature have precise design characteristics and a definite function to fulfil.

The Golden Angle, which measures approximately 137.5 degrees, is the angle between successive florets in some flowers, while curves and angles of 120 degrees are frequently exhibited in other elements of nature (e.g., Thompson, 1917).

The Fibonacci series (0, 1, 1, 2, 3, 5, 8, 13, 21, 34...) is a numeric sequence that occurs in many living things, plants especially. Phyllotaxy, or the spacing of plant leaves, branches and flower petals (so that new growth doesn't block the sun or rain from older growth) often follows in the Fibonacci series. Related to the Fibonacci series is the Golden Mean (or Golden Section), a ratio of 1:1.618 that surfaces time and again among living forms that grow and unfold in steps or rotations, such as with the arrangement of seeds in sunflowers or the spiral of seashells.

II Biomorphic Forms and Patterns

Biomorphic Forms and Patterns are symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature.

Biomorphic forms and patterns have been artistically expressed for millennia, from adorning ancient temples to other examples like Hotel Tassel in Brussels (Victor Horta, 1893) and the structures of Gare do Oriente in Lisbon (Santiago Calatrava, 1998). More intriguing still is the architectural expression of mathematical proportions or arrangements that occur in nature, the meaning of which has been fodder for philosophical prose since Aristotle and Euclid. Many cultures have used these mathematical relationships in the construction of buildings and sacred spaces. The Egyptian Pyramids, the Parthenon (447-438 BC), Notre Dame in Paris (beginning in1163), the Taj Mahal in India (1632–1653), the CN Tower in Toronto (1976), and the Eden Project Education Centre in Corwall, UK (2000) are all alleged to exhibit the Golden Mean.

The objective of Biomorphic Forms & Patterns is to provide representational design elements within the built environment that allow users to make connections to nature. The intent is to use biomorphic forms and patterns in a way that creates a more visually preferred environment that enhances cognitive performance while helping reduce stress.

Humans have been decorating living spaces with representations of nature since time immemorial, and architects have long created spaces using elements inspired by trees, bones, wings and seashells. Many classic building ornaments are derived from natural forms, and countless fabric patterns are based on leaves, flowers, and animal skins. Contemporary architecture and design have introduced more organic building forms with softer edges or even biomimetic qualities.

Some of the natural forms that have inspired architects are the molluscs. A harmonious achieved by contrast in shapes, but addressing the design principles, rhythm, contrast, volume, colour, scale, proportion character and equilibrium. Molluscs have been inspiration for Meso-America, Greece, India and Africa. The curved structure has been adopted in the vaults and domes of the structures of Romans, Byzantine, Romanesque and Gothic.

ISSN:2319-6890 (online),2347-5013(print)
11-12 Jan. 2018

Leonardo da Vinci drafted the first spiral staircase plans from studying the simple snail shell with its interior whorls.
Château de Chambord holds one of Leonardo da Vinci's masterworks of engineering and design — a double helix "DNA" staircase.

Double helix "DNA" staircase
Source: (Lambert, 2016)

Egyptian and ancient Greek civilisations studied natural forms and the human body and abstracted them as geometry. They used the circle, ellipse, triangle, and rectangle to derive harmonious proportions for their shrines and temples as typified in Pyramid of Giza and so promote harmony between themselves and their elemental gods and spirit of the earth and cosmos

Source: Researcher

There are essentially two approaches to applying Biomorphic Forms & Patterns, as either a cosmetic decorative component of a larger design, or as integral to the structural or functional design.

The Art Nouveau Hotel Tassel in Brussels (Victor Horta, architect, 1893) is a example of cosmetic decorative component of Biomorphic Forms & Patterns. The interior space in particular is rife with natural analogues, with graphic vine-like tendrils painted on the wall and designed into the banisters and railings, floor mosaics, window details, furniture, and columns. The curvaceous tiered steps seem to make distant reference to shells or flower petals.

The Art Nouveau Hotel Tassel in Brussels by Victor Horta 1893
Source:

The pioneers of biomorphic architecture include Antonio Gaudi, Calatrava Santiago, and Rudolf Steiner while those of organic architecture include Louis Sullivan, Frank Lloyd Wright.

Mainstream architecture is also adopting outward biomorphic forms. The stronghold of rectilinear design is under siege, free form design is on the attack. More liberated and imaginative forms which were unacceptable to major corporate clients a few years ago are now actively sought. Notable examples include the Bordeaux Law courts and London's Millennium Dome designed by Sir Richard Rogers, the curvaceous London mayoral headquarters (sir Norman foster), the competition-winning elliptical dome for the Chinese national opera house and concert hall, Beijing (Paul Ardeau), The Media Center, Lord's Cricket Ground, London, and the Earth Centre Ark, England.

III Notable Examples Biomorphic forms and Patterns

According to Antonio Gaudi, Nature abhors right angles and straight lines. His designs were direct inspiration from nature. One of the example of his work is La Sagrada Barcelona in Spain

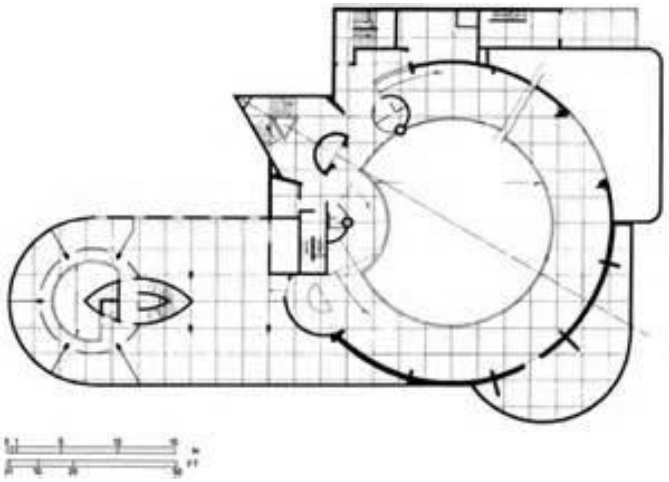
ISSN:2319-6890 (online),2347-5013(print)
11-12 Jan. 2018

La Sagrada Familia Barcelona Spain.
Source: (La Sagrada Familia, The Church Nuanced "Art Deco" in The Heart of Barcelona, 2016)

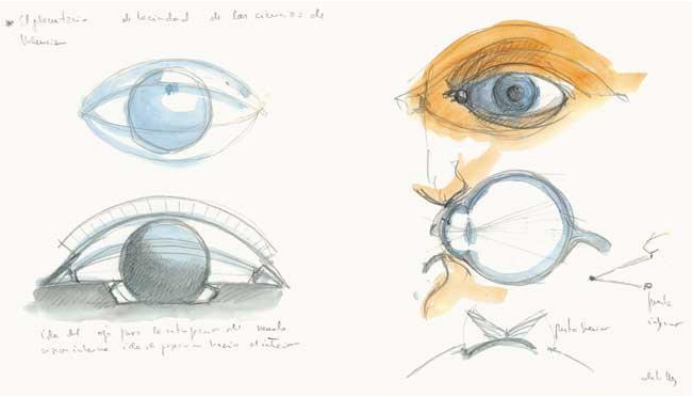
Detail of the roof in the nave. Gaudi designed the columns to mirror trees and branches
Source: (La Sagrada Familia, The Church Nuanced "Art Deco" in The Heart of Barcelona, 2016)

Frank Lloyd Wright described Organic Architecture as increasing desire to integrate the manmade and natural environment.
Frank Lloyd Wright's Guggenheim Museum in New York built in 1959 is inspired from nautilus shell.

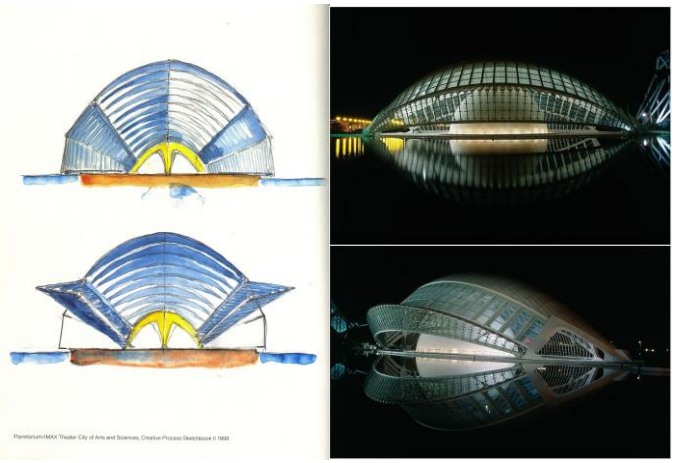
Sky light in Guggenheim Museum in New York design by Frank Lloyd Wright 1959
Source: Researcher



Santiago Calatravas structures created were inspired by the observation of human and animal anatomy. The first buildings he created in the United States were very much influenced by nature and plants.



Conceptual sketch of City of Art and Science done by Santiago Calatrava
Source: (Ramos, 2010)



Form is derived from the human eye and functions as an IMAX theatre and planetarium. Each side of the eye-shaped building opens and closes like the eyelids of an eye
Source: (Ramos, 2010)

ISSN:2319-6890 (online),2347-5013(print)
11-12 Jan. 2018

IV Material Connection with Nature

Everything seen in nature contains a structure in itself. The structural purpose is to transmit forces to the solid base. Structure that undergo compression are short and thick like trees and structure that use tension are slim and fragile like cobwebs.

One of the greatest achievement of architects and engineers is the development of light weight structures. These structures derived from natural models can be categorized.

Pneumatics – inspired from Bubbles

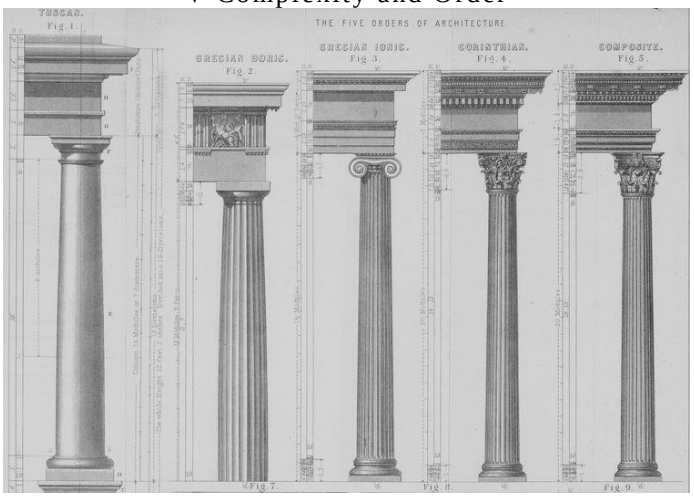
Vaults and domes – inspired from shells and eggs

Geodesics – inspired from radiolarians

These structures inspired by nature, are characterised by low cost material, low dead weight, large spans, uncomplicated construction details and reduced construction time.

Few Architects find inspiration in fluid, organic forms, e.g. Frank Gehry, Jeanne Garg Herzog, De Mueron and Zaha Hadid. These architects were able to create structures with more biomorphic forms due to computer aided design and construction technologies.

V Complexity and Order



Golden Section in Parthenon

Le Corbusier‘s modular architecture which was derived from the human body

VI Conclusion

Natural form brings the geometries of the natural world into our architectural landscape.

Learning from Nature makes Architecture universal, but the buildings should also maintain a stamp of the culture followed by the natives and the influence of place of origin of the inhabitants. In short, it involves socio-cultural validation

References

i. *(Terrapin Bright Green, LLC, William Browning, Hon. AIA, Catherine Ryan, Joseph Clancy, October 16, 2014)*

ii. *https://www.goodreads.com/quotes/23638-in-every-walk-with-nature-one-receives-far-more-than*

iii. *https://www.nps.gov/articles/cultural-landscapes-community-well-being-parkrx-anne-o-neill.htm*

iv. *Lambert, B. (2016, September 22). Leonardo da Vinci’s French Castle “DNA Staircase” & The Secret Tunnel To The Château Where He Died. Retrieved from https://www.feelguide.com/2016/09/22/leonardo-da-vincis-french-castle-dna-staircase-the-secret-tunnel-to-the-chateau-where-he-died/*

v. *La Sagrada Familia, The Church Nuanced “Art Deco” in The Heart of Barcelona. (2016, june 02). Retrieved from https://traveldigg.com/la-sagrada-familia-the-church-nuanced-art-deco-in-the-heart-of-barcelona/*

vi. *Benyus, J. (1998). Biomimicry: Innovation Inspired by Nature. New York: Perennial.*