

Use of metaphors in architecture, to build sustainable buildings which are ecosensitive and have adapted to the natural environment of that place.

AR. Archana Anand Deshpande

Assistant Professor,

*Research scholar : Department of Architecture , AFFILIATION DR. D. Y. PATIL COLLEGE,
KASBA BAWDA, KOLHAPUR.*

AR. GOURAV VINCHU

Assistant Professor,

Department of Architecture

AR. GAYATRI JADHAV

Assistant Professor,

Department of Architecture

Abstract: The study is an attempt to understand the relationship of organisms in their ecosystem. An ecosystem is self-balanced and adapts to the natural surroundings. If buildings are built using ecological principles, they will become sustainable, will merge into the surroundings. This they will do by imitating or mimicking nature.

Keywords: Biomimetic, mimicry, bioclimatic, ecology, adaptive, design paradigm.

Introduction: The Ecological cycles existent in nature are self-balanced and independent on their elements. The environmental policies by Australian Institute of Architects or American Institute of Architects suggest to reduce the negative impacts of human activities to the natural environment. In an ecosystem, every byproduct of an organism becomes food for another. In 1950's American biophysicist and polymath Otto Smitt, came up with the concept of Biomimetic. It means imitating biological principles of nature, to build buildings. This makes them sustainable in a particular environment. Thus Biomimetic Architecture seeks solutions, not by replicating the natural forms, but by understanding the rules governing such forms.

The buildings contribute to nearly half of the greenhouse emissions and energy consumption. AIA, RIBA, plan to achieve 80% of carbon reduction by 2050 and this can be done by building sustainable structures.

Since the buildings consume energy, materials and water that emit gas, liquid, solid contaminants as waste as 0.4 – 0.5 tons per capita per year ; the need to build structures, which

would reduce the above arises.. Biomimetic Architecture uses examples from nature like learning from termites mound, how to create sustainable buildings. As cacti sustain themselves in dry climate, so would a building in hot arid environment.

Methods :- Biomimicry or Biomimetic Architecture asks Architects to think of a building as a living thing. Three levels of mimicry: The organism level, behavioral level and the ecosystem. Buildings on organism level. Mimic a specific organism. On behavioral level the buildings mimic how an organism behaves or relates to a larger context. On the level of ecosystem, a building mimics the natural process and cycle of the greater environment.

Examples : On organism level : Norman Foster's Gherkin Tower (2003) has hexagonal skin inspired by the Venus Flower Basket sponge.

Behavioral level: The East Gate Centre designed by Architect Mick Pearce, in an office and shopping complex in Zimbabwe. To regulate inner temperature, it behaves like self-cooling termite mounds.

Ecosystem level : The cardboard to Cavier Project founded by Graham Wiles, in Wakefield UK, is a cyclical close loop system using waste as a nutrient .

As per the Ecological Approach :

- 1) The processes that operate within the domain of ecology.
- 2) The spatial and temporal patterns that exist in nature. Odum's model illustrates relationship between energy and materials.

Use of climatology, Architecture, Technology and Biology are adhered to in the bioclimatic approach.

The complex adaptive, self-organizing, hierarchical open systems are explained in the SOHO System Model.

Analogical Translations	Nature Studies Analysis (NSA)	Typological Analysis (TA)	Design Spiral (DS)	Bio-Triz (BT)
Scale of Application	Ecosystem, Process, Form	Organism, Behavioral Ecosystem	Form, Process, Ecosystem	System, Sub-system, Super-system
Design Process	Categorization, Scientific Reasoning, Functional Adaptation, Contextual Adaptation, Aesthetic formation	Form, Process, Material, Construction, Function	Identify, Interpret, Discover, Abstract, Emulate, Evaluate	Problem Identification, Problem Understanding, Logical Solutions, Biomimetic Solutions
Biomimicry Design	Natural System to Built Systems & Built Systems to Natural	Biology Influencing Design & Design looking to Biology	Biology Investing Design and Design Investing Biology	Solution Driven Approach, Problem Driven Approach

As per the Architectural Science Association ANZASCA, a systematic method of inventive problem solving is explained in BIO-TRIZ.

BIOMIMICRY THEORETICAL FRAMEWORK (BTE)

SCALE OF APPLICATION	DESIGN PROCESS	DIRECT APPROACH SPECIFIC MIMICRY	INDIRECT APPROACH
Ecosystem:- How does it fit with the whole	1) Categorization What is the type of classification	Type of species – Physical characteristic, climatic zones, relationship between species, size variations, form variations	Identification of building type, type of users, size variations, form variations, relationship between users and organisms, climatic zones

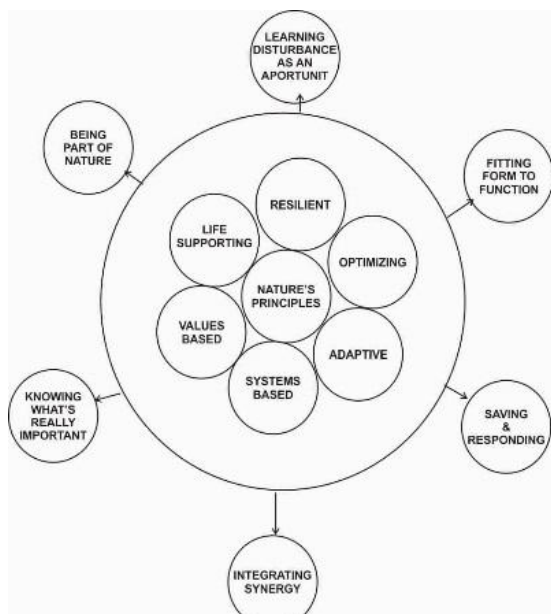
Process :- How does it perform and how is it made?	2) Functional integration - What are the innovative strategies?	Hierarchy of functions - primary, secondary, techniques, physical characteristics, patterns, mechanism, behavioral patterns, needs, communication organization	Users and user needs : Hierarchy of functions - primary, secondary, techniques, physical characteristics, mechanism, behavioral patterns, needs,
E	3) Environmental Adaptation :- What are the innovative strategies ?	Macro and Micro environment, physical characteristics habitat, topography, macro and micro climate, wind, sunpath, humidity, temperature, rainfall	Macro and Micro environment, physical characteristics, habitat, topography, macro and micro climate, wind, sunpath, humidity, temperature, rainfall
Form : What is shape?	4) Innovative form : What is the expression ?	Design fundamentals : Line shape, texture, color, patterns, genetic progression, module unit to whole, scale and proportion	Design fundamentals : Line shape, texture, color, patterns, genetic progression, module unit to whole, scale and proportion

Results:

Ecological design integrates human purpose with nature's own flows, cycles and patterns. They tend to lessen the negative impact of buildings on natural environment. We can draw deep patterns and mechanisms found in natural systems, so that we can design our buildings and cities to buffer storms such as tidal wetland, store water like an aquifer does, reduce heat the way a forest, prairie or desert oasis does.

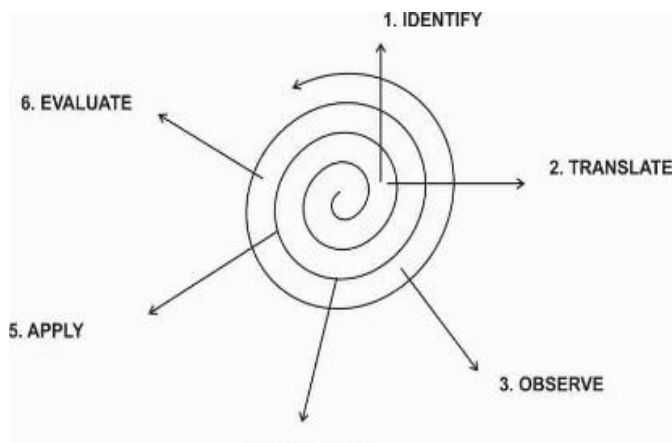
Examples: By studying and mimicking the mechanism of coral reefs, Calera developed a process to manufacture a stable form of cement, by using salt water in the presence of calcium ions and carbon dioxide. This process removes carbon dioxide from atmosphere instead of emitting it.

Guild (2007) said that ecosystem principles can be applied to design process and to be applied to every stage in design by transforming them into a set of design principles that are required in a project.



A design spiral helps imitate the principles of ecosystem into designing of buildings.

Design spiral :



DISCUSSION :

The above studies state certain principles of biomimicry in design. They are :

Adaptation : Ecosystem best suited to habitat.

Material as system : Optimize the system than components biological materials are weak, but make strong structure.

Evolution : Adapt and evolve continuously.

Emergence : Material emerges into a continuous form.

Form and behavior : Maintains structural form or behavior of organism / ecosystem, thus mimicking nature. e.g. In daily ecosystem a natural foam or soap bubbles will demonstrate the differentiation of the cells inside in an intricate geometry of form architecture. When seen in a micrograph the cells produce a porous structure inspires to be adapted in architecture to form a structure, material an construction of design.

eg. as per the materials :

- 1) The example for material systems in biomimicry can be seen in Water cube National Swimming Centre, Beijing.
- 2) Eiffel Tower : The internal wrought iron braces resembles thigh bone. It's unique structure controls the amount of sunlight entering the steel.

Other examples include Waterloo National Stadium, ETFE, replication of a snails shell in spiral staircases.

In India : Bahai temple, Delhi, T₂ Terminal columns at Mumbai International Airport, Lavasa City by HCC group.

Conclusion : The greatest contribution of biomimicry lies in problem solving process rather than just imitating of biological shapes and form. It is a guide that helps mimics natural strategies like camouflaging, defense technique, locomotion, forces of gravity, use of local resources, behavioral patterns and mechanisms of integration and adaptation.

The procedure offers a design thinking which draws taking ecology as an analogical model, which follows conventional design process. This process can integrate and adapt ecotechnologies as a part of whole system design. This would lead to a less waste initiative process, making buildings sustainable.

References :

1. www.academia.edu
2. www.slideshare.net
3. www.greatecology.com
4. www.tandfonline.com
5. www.inhabitat.com
6. www.Wikipedia.com
7. www.biomimicry.org-india
8. www.zingyhomes.com-india
9. www.isrjournals.org
10. www.quora.com
11. www.ecoideas.com
12. www.livemint.com