



APPLICATION OF BIOMIMICRY PRINCIPLE AS A MODEL IN
MODIFYING BUILDING SKIN TO ACHIEVE THERMAL
ADAPTATION IN BUILDING.

HANIF MUSA ALIYU,¹ ZAKARI ABDULLAHI TIJJANI,²

Department of Architecture, Kano University of Science and Technology

Abstract

Architecture is a practice that provides technical and spatial responses to human needs, functions and activities in open and enclosed physical spaces. These needs, functions and activities manifest in a variety of forms according to ages, gender, income and social status among others. They are also expressed in the connecting build environment with nature. Youngsters stress from clinic visits can be additionally compounded by issues of design, colors, textures, materials and so on. Notwithstanding, this postulation targets fostering a structure for the coordination of Biomimicry application and examples in the plan of pediatrics hospital, along these lines making an association between life, nature and the built environment which evolve architecture that can positively contribute to the healing and psychological recovery of patients. In view of existing writing corresponding Biomimicry plan application and building skin, procedures for the joining of Biomimicry configuration designs were created dependent on three expansive examples of Biomimicry plan in particular; Nature in the space, Natural analogs and Nature of the space. The research type is exploratory and encompasses both the qualitative and quantitative tradition in methods of data collection through case studies and interviews, in order to check how these strategies were adopted in the design of pediatrics hospital and apply in the new design of pediatrics hospital katsina, katsina state Nigeria.

Keywords; Biomimicry, building skin, Biomimetic, Complexity/order and Natural Analogues.

Research Background

Biomimicry is an applied science that offers answers for human issues through the investigation of organic systems and processes (Michael, 2011). It is motivating to know that a lot of the design challenges we face today within our built environment, have already being addressed in the natural world (Benyus, 2011). Introducing natural solutions in building facades is essential considering the sustainability and energy efficiency of natural skins (Elghawaby, 2012). Biomimicry is a way to deal with advancement that looks for supportable answers for human difficulties by imitating nature's dependable examples and methodologies. The target of this task is to utilize such survey to give a way to deal with the utilization of regular provisions for

accomplishing warm transformation in the structures of blistering and dry environments. In this review, the successful examples are analyzed to identify and examine the principles that influence the thermal comfort in both building and urban levels. Biomimicry Definitions There have been many researchers who have defined Biomimicry. For example, Benyus, characterized Biomimicry as another discipline that reviews qualities best thoughts and afterward mirrors the plans and interaction to tackle human issues. While Pederson Zari noticed that an impediment looked by modelers is the absence of an unmistakable definition from the assorted choices that engineers can apply in their task. That is the reason breaks down the suitable way to deal with completely apply the best technique to completely use the benefits. Then again, Biomimicry is the investigation of covering areas of science and planners that show inventive potential for engineering issues (Gruber, P. 2008).

Biomimicry in Architecture:

There are many examples of Biomimicry in architecture. One model can be dated to 1851 when James Paxton planned the primary arrangement of the gem castle from his perception of goliath water lilies. In these lilies likewise motivated him in the lily house in Strasbourg. During the twentieth century, Robert Le Ricolais, a French educator at the College of Pennsylvania additionally created underlying models by emulating organic construction models that were drawn by Haeckel, a German scientist, in the nineteenth century During that very century; numerous architects, for example, Le Corbusier and Straightforward Lloyd Wright were roused essentially. Blunt Lloyd Wright joined natural engineering into his plans, and yet didn't have nature as an overwhelming component. (Asian building and construction, 2001)



Plate I: falling water by Le Corbusier, mage used in study.

Source: Google search (2021)

It shows how he utilized the normal component of water in the falling water. His entire way of thinking was that engineering invites nature and nature welcomes architecture. As Le Corbusier affirmed as biology to be "the great new word in architecture and planning"

PRINCIPLES OF BIOMIMETIC DESIGN

Biomimetic design, in addition to mimicking specific creatures, can also be the mimicry of general patterns and processes found in nature. These general patterns and processes are referred to as Life’s Principles, (Benyus 2007), this principles are: Nature in the Space(Visual connection with nature, Non-visual connection with nature, Non-rhythmic sensory stimuli, Thermal airflow and variability, Presence of water, Dynamic & diffuse light and connection with natural systems), Natural Analogues(Material connection with nature and Complexity/order), Nature of the Space (Prospect, Refuge and Mystery)

Approach Model

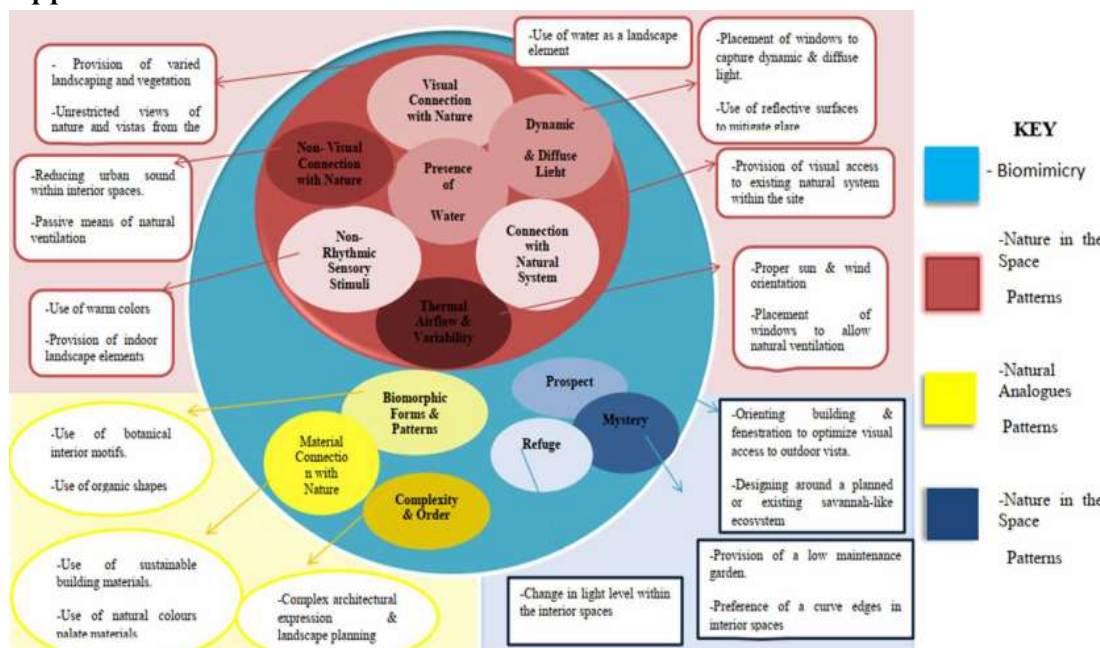


Figure 1: A framework for the integration of Biomimicry design patterns.

Source: Researcher’s sketch (2021).

Building Skin as a Tool for Energy Management:

There are many researchers who have defined building skin. For example, according to Rankouhi, it is the "boundary through which the buildings interaction with the environment occurs" It forms layers and filters that react to light, air, moisture, sound and heat. "The most well-known component is the capacity to keep up with the ideal inner conditions that react to the capacities they convey." While, notwithstanding, characterized the structure envelope as

the structure shell, texture or nook as, it is the limit between the inside of a structure and the outside. Then again, Kieran characterized the structure skin as where most energy and material trade happens. It is the view of a structure character. The structure skin comprises of the veneer and rooftop. It incorporates the outer dividers, floors, rooftops, roofs, windows and entryways (El-Zeiny, R.M.A 2012)

Biomimicry and Building Skin

In request to have the option to draw the analogs of building skin and examine the shared characteristics of each. This incorporates assessing the principle similitudes and the main thrusts that influence nature and the structural plan measure. The structure skin is a slender film that covers the skeleton (structure), manages the organs (mechanical, plumbing and electrical) and characterizes its inside spaces (Bar-Cohen Y., 2005). The structure skin is like regular skin as it comprises of various layers and channels that respond to light, air, dampness, sound and warmth. The successive quality among normal skin is for its capacity to keep up with inner conditions while be receptive to its capacity. The structure skin like normal skin is the limit the controlled and uncontrolled climate. It is the arrangement of the aftereffects of both inward and outer powers. The two of them go about as a filtration during the time spent permitting what is permitted to enter and exit (Ibrahim, M., 2011). A structure's skin is the main layer that defies us when we assess a plan stylishly and furthermore a pivotal component in the in general innovative usefulness of a structure. At the point when we distinguish the characterizing attributes of a structure we are normally portraying its skin. Its structure and piece have both tasteful and per developmental repercussions. It is surely a plan component, yet it is indispensable to dampness assurance, warm solace, the in general underlying framework, and the specialized creation of a structure. (The China National Aquatic Center, 2007).

Boundaries a rundown of ten boundaries that ought to be examined when planning building skins is displayed underneath.

Each can possibly characterize the person and influence the general impression of a structure. Sun Control, Natural Ventilation, Day Lighting, Connection to Outdoors, Thermal Insulation, Moisture Control, Micro-Climate Zones, Structural Efficiency, Material Choices, Potential for Energy Generation.

Biomimicry and Adaptive Building Skins

Noticing and gaining from personal conduct standards of living beings give a chance to work on versatile techniques of building skins. These versatile procedures and fundamental standards can be gained from nature. For sure, living organic entities have created through advancement, a wide scope of methodologies to adjust to various climatic and natural conditions. Examination and investigation of these procedures and their key standards is a fundamental initial step to

move these systems to versatile structure skins plan. The way that nature gives an incredible wellspring of versatile techniques requires a designated system plan that meets the necessities of versatile structure skins (The China National Aquatic Center,2007)

Case Study One: Pediatrics Department, General Hospital, Katsina.

Highlighting Nature in the Space patterns in general Hospital, katsina.

Table 1: Nature in the space description – pediatrics department, general Hospital, katsina, Nigeria

Biomimicry application/patterns	ATTRIBUTES	LEVEL OF REFLECTION				AVERAGE
		Abs (1)	Low (2)	Med (3)	High (4)	
Visual Connection With Nature	- Provision of varied landscaping and vegetation	X				1
	-Unrestricted views of nature and vistas from the interior	X				
Non-Visual Connection With Nature	Access to nature over sound urban sounds			X		3
Non-Rhythmic Sensory Stimuli	-Use of warm colors for sensory stimulations		X			2.5
	-Provision of indoor landscape					
Thermal Airflow & Variability	-Design with respect to sun and wind orientation			X		3.5
Presence of Water	-Placement of windows to allow natural ventilation	X				1

	Use of water as a landscape element			
Dynamic & Diffuse Light	Placement of windows to capture dynamic and diffuse light within the interior of the building		X	3
Connection With Natural System	-Provision of visual to existing natural system within the site	X		1
TOTAL				15
AVERAGE				2.5

Source: Author's fieldwork, (2021)

Highlighting Natural analogues description in general Hospital, katsina.

Table 2. Natural analogues description – Pediatrics Department, general Hospital, katsina, Nigeria

Biomimicry application/patterns	ATTRIBUTE S	LEVEL REFLECTION	OF AVERAGE				
			Abs (1)	Low (2)	Med (3)	High (4)	
1. Biomimicry application& patterns	- Use of botanical interior motifs -Applications of organic shapes in building exterior	X		X			1.5
2. Material Connection With Nature	-Use of sustainable building materials.	X					1

-Use of natural color pallet like green within the interior spaces

3. Complexity & Order	-Complex architectural expression and landscape planning -Integration of buildings parts into whole	X	X	1.5
TOTAL				4
AVERAGE				2.5

Source: Author's fieldwork (2021)

Highlighting Nature in the Space patterns in pediatrics department general Hospital, katsina.

Biomimicry application/patterns	ATTRIBUTES	LEVEL REFLECTION				DF	AVERAGE
		Abs (1)	Low (2)	Med (3)	High (4)		
1. Prospect	-Orienting building, fenestration or corridor to optimize visual access to outdoor vistas. -Designing around existing or planned savannah-like ecosystem		X				2.5

2. Refuge	-Change in light levels within the interior	X	2
3. Mystery	-Provision of low maintenance garden with winding path. -Preference of curve edges than sharp corners within the interior spaces.	X	3
TOTAL			7.5
AVERAGE			2.5

Source: Author's fieldwork (2021)

Analyzing application/ patterns in general Hospital, katsina.
 Taking total average scores of the patterns under each category shows that nature of the space have the score of 2.5, while natural analogues and nature in the space has the score of 2.5 each

Table 3: Summary of findings in general hospital, katsina.

Biomimicry application/ patterns	Score
Nature in the Space	2.5
Natural Analogues	2.5
Nature of the Space	2.5

Source: Author's fieldwork (2021)

This result implies that the facility has better orientation and building exterior to optimize visual access to outdoor vistas while the extensive use of glazing, differing orientation of windows allow light to penetrate at varying levels within the interior spaces of the pediatrics department which is a good demonstration of refuge.

Although the score of 'natural analogues' is 2.5, still the department doesn't incorporate the use of botanical motifs in the interiors spaces and has no application of organic shapes in its exterior spaces. Therefore, the hospital has less use of sustainable building materials.

Analyzing Biomimicry application/ patterns in maternity and children Hospital, katsina.

Taking total average scores of the patterns under each category shows that nature of the space

have the score of 8.5, while natural analogues and nature in the space has the score of 2.5 each (see Table 4)

Table 4: Summary of findings in maternity and children hospital, katsina.

Biomimicry application/patterns	Score
Nature in the Space	3.5
Natural Analogues	2.5
Nature of the Space	8.5

Source: Author's fieldwork (2021)

This result implies that the facility has better orientation and building exterior to optimize visual access to outdoor vistas while the extensive use of glazing, differing orientation of windows allow light to penetrate at varying levels within the interior spaces of the pediatrics department which is a good demonstration of refuge.

This result can be back up with adequate provision of nature in the space variables in the facility like presence of varied landscaping and vegetation, and most notably a healing garden.

Conclusions

Biomimicry design is intricate, but satisfying area of sustainable architecture by achieving thermal adaptation. To be able provide comfort and healing to patients with psychological and cognitive stress is unique opportunity. Over the course of this paper, the notion that nature's healing and restorative impact are insightful was repeated over and over again. Instead of designing without nature, this paper proved that there are numerous beneficial impacts on the patients by designing healthcare settings with nature in mind. Providing naturalistic spaces within health care settings allows the patients the opportunity to harness the healing properties of nature and surrounds themselves with one of the most basic needs, connection to life and providing thermal adaptation base on the climatic situation of the environment.

REFERENCES

- Aliyu, A. Ramli, A. (2013). Nigeria electricity crisis: Power generation capacity expansion and environmental ramifications.
- Ashraf, S. (2011). as a tool for sustainable architectural design: Towards morphogenetic architecture. Ballbriga, Angel (1991). One century of Paediatrics in Europe (section development of paediatric hospitals in Europe)
- Benyus, J. (2007). Innovation Inspired by Nature Work Book, Guild, 07(4),8-9.
- Berkebile , M., McLennan, J. (2004). The Philosophy of Sustainability Design: the Future of Architecture. New York : W.W. Norton & Company New York.
- Elghawaby, M. (2012). Breathing Facades: A new concept to create dynamic Thermal ambiance in buildings located in hot climates. HAL archives publishing.

Ibrahim, M., 2011. Biomimicry as a tool for sustainable architectural design towards morphogenetic architecture morphogenetic architecture.

Loughborough University, 14-16 May 2008. Leicester, UK: Loughborough University.

Le Corbusier, 1923. Manifesto versune architect (towards an architect) Chicago tribune article by Elizabeth Taylor of sept 21, 2003.

Mazzoleni, I., 2013. Architecture follows nature- Biomimetic Principles for Innovative Design. CRC Press.

The China National Aquatic Center, 2007. Box of bubble. Ingenia Issue 33 December.

Turner, J. S., Soar R.C., (2008). Beyond Biomimicry: What termites can tell us about realizing the living building. In First International Conference on Industrialized, Intelligent Construction(I3CON).