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BIOMIMICRY IN ARCHITECTURE

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ABSTRACT

Influence of Biomimicry on architecture design. These dissertation intents to demonstrate the significance of creating an architecture that is considerate of nature and its ability to transform a dwelling into an enlived space. In today's increasingly urban world, where power and money have become the ultimate objective, it is hard to find the place where we can have peace with nature Biomimicry is an idea to achieve nature peace within Architecture. The purpose of this to introduce and create an interest in ideas of Biomimicry so, that we can experience nature in our everyday life and how can Biomimicry help us to build sustainable environment. The impact of our construction techniques on ecology.

KEYWORDS: Trend of Biomimicry, Reduce Carbon Emission Waste Through Biomimicry, Relevance of Biomimicry As Nature, Sustainable

This research intents to demonstrate the significance of creating an architecture that is considerate of nature and its ability to transform a dwelling into an unlived space. In today's increasingly urban world, where power and money have become the ultimate objective, it is hard to find the place where we can have peace with nature Biomimicry is an idea to achieve nature peace within Architecture.

The purpose of this to introduce and create an interest in ideas of Biomimicry so, that we can experience nature in our everyday life and how can Biomimicry help us to build sustainable environment.

The impact of our construction techniques on ecology. How nature responds to its environment and how we can incorporate. To understand the emerging trend of Biomimicry. It's evolution as a response to a design problem applying biological solution in an attempt to explore the potential of both emerging sciences in developing a more sustainable and regeneration architecture.

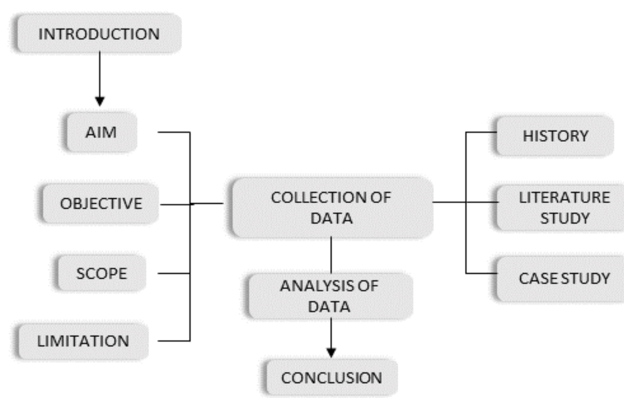
OBJECTIVE-

- Influence of Biomimicry on architecture design.
- Explore the relevance of Biomimicry as nature inspired innovation.
- How Biomimicry can help to build sustainable future.
- What we can learn and emulate from nature.
- How can we reduce carbon emission waste through Biomimicry?
- How Biomimicry could be applied to climate change.

SCOPE

The scope of this dissertation is the study and analysis of Biomimicry focusing on how Biomimicry can help to make building self sustainable like nature.

METHODOLOGY



BACKGROUND

Nature has a lot to teach us, particularly when it comes to architecture, so when it comes to buildings our best teacher is often the natural environment. The Nature is one of the best examples of something that is always changing. Our environment's ever shifting nature has permissible both plant and animal life to grow and adapt to be able to survive. The living things on this planet have gone through 3.8 billion years of research and development, refining them into the perfectly appropriate and adapted solutions we see functioning around us today. So, in our mission to create a more sustainable built world, it makes

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sense to use the similar concepts to create a more sustainable and energy efficient buildings.

With this beginning of the contemporary architecture and a significant shift on the emphasis of concern about the environment. A return to acceptance nature as an architectural driver has been observed in order to bring back a coherent understanding and a spiritual compatibility between both man and his surroundings that cannot be realized with each as opposing element. The architects have finally realized that the solution can be established by emulating nature's time-tested patterns and stmtegies, e.g., a solar cell inspired by a leaf. The core idea is that Nature, creative by necessity, has now solved many of the problems we are grappling with: energy, food production, climate control, non-toxic chemistry, transportation, packaging, and a entire lot more. Hence, taking motivation from these solutions we see around us every day we have now turned to a new stratum of designing called Biomimicry.

Biomimicry Definition

The word biomimicry originates from Greek word bios, meaning life, and mimesis, meaning to imitate. In simpler terms, biomimicry is the conscious emulation of nature's genius. It is a way to observe nature action and use that knowledge to inspire new ideas.Biomimicry is an inspiration from nature to solve human problems through the study of natural designs, systems and processes. Through this we can learn about systems, materials, structure and how nature is self-sustaining - Nature has already solved many of mechanical and structural problems without generating any wastage. Janine Benyus author of the book "biomimicry: innovation inspired by nature" explains about the science of biomimicry in her book how mimicking designs and strategies found in nature and how they can help in the way human think in every field and architecture.

She explains that living organisms and engineers have similar goals for creating any structure in terms of energy. As she explains we can incorporate what living organisms have and we can use that in our designs.

- How we can make material stronger and self-healing
- For building how we can use natural process and forces.

Concept

Biomimicry is an old concept as we can look in history from making shelter to making equipment's we are being depend on nature. The nature is self-developing from ancient period we are using biomimicry for our development/evolution as nature is evolving for itself and for us, we are trying to create new technology for mankind. This is the basic idea of combing biology and engineering to help humanity treat nature better and in more harmonious way, so anyone from largest enterprise to single individual can create better products, and work in harmony with nature for betterment of our future.

Historical origins

Master builders and Architects have been using as the source of inspiration from longest time even before the terms Bio inspiration or Biomimetics/Biomimicry were introduced. Biomimicry is applying nature's solutions to human problems. It has observed humans have mimicked their hunting, shelter and survival behaviours from animals.

In the earliest prehistoric era, before Man knew how to build shelters, they made use of the nature to provide them with shelter. The earliest forms of shelter were trees, where there is minimal protection against the heat of the sun and the cold of the rain. The first shelter was believed to made up of tree branches and stone. Stone were placed to hold the base of branches in place. Human slowly learned to make simple tools that would help them to make better structures, and later these structures gradually evolved in shape and form. Other materials then trees were bones, huge stone slabs, and even animal skin were used to build the structures. Caves are another natural form of shelter, which provide great protection from inclement weather. After building shelter when it's time to make it more aesthetically pleasing, we again took help from nature. For example, in building column they were the most communal imitators of nature, they often take inspiration from palms, lotus and papyrus plants. According to Egyptians hieroglyphs the nature shapes imitated from a bird's feather or whole animal's silhouette. Egyptians also associated animals and plants with their functions and characters, therefore they often imitated them as to transmit information across time. Shafts of column resemble like a bunch of lotus flower, stood upon circular stone bases, their bud shaped capitals creating a silhouette with inverted bell form of an open papyrus flower. The idea of imitating plants and animals is not alone. The imitation was not limited to a single example but it has conveyed universal principles of nature that were shared across all life. "The creation of sacred buildings echoes the creation of the universe, and both seek to follow similar mathematical laws". Biomimicry isn't itself a product but a process, drawing on natural organisms and processes in order to spark innovation. Organizations and even cities can look to ecosystems for inspiration, says Tim McGee, a biologist and member of Biomimicry 3.8, a Montana-based consultancy. In Lavasa—described as "India's first planned hill city" by its developers, who hope to eventually build homes for more than 300,000 people there—the guild consulted with landscape architects. Thus, the planting strategy included deciduous trees, forming a canopy to catch, and then reflect, through evaporation, nearly a third of the monsoon rain that hits it. That effect acts "like an engine that drives the monsoon inland," says McGee, which helps prevent drought there. The hydro dynamically efficient shape of banyan tree leaves influenced the design of a better water-dispatching roof shingle, while water divestment systems were inspired by the ways harvester ants' direct water away from their nests. The first Lavasa "town" has been completed, with four more projected to follow by 2020.

Figure 1: Cave made up with animal bone's (shelter , n.d.)

Figure 2: A cave formed within mountainous rock (shelter, n.d.)

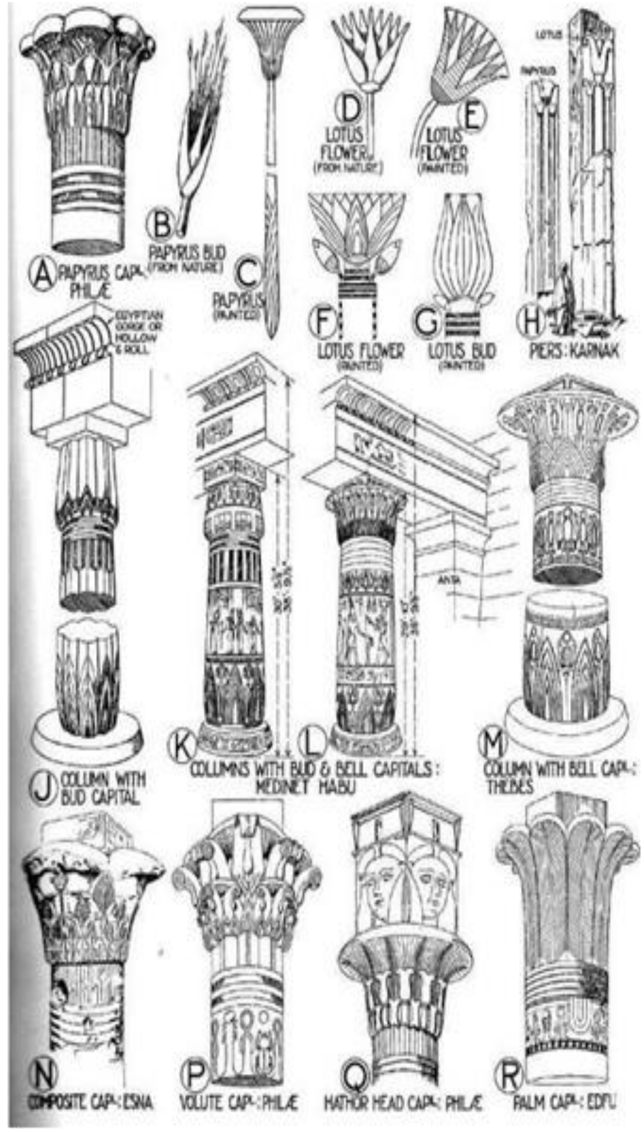

Figure 3: Egyptian column's (virmani, 2014)

Figure 4: Velcro plant

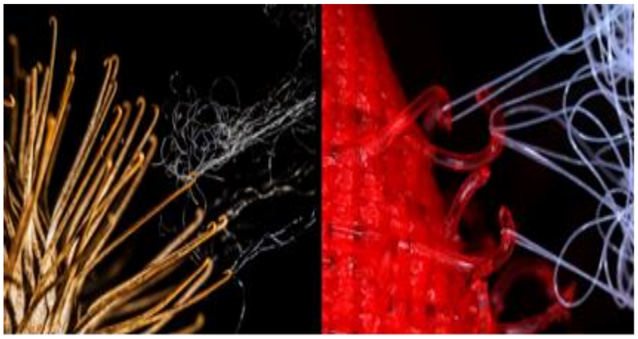

Figure 5: Prosses of Sucking Velcro and Velcro plant

This is as a outcome of its over 3.8 billion years of evolution, making nature an extraordinary role model for harmonious balance and proportion, encompassing efficiency, collaboration, resource utilisation, and longevity. While, their sustainability cannot be determined, the following are early records of iconic nature-inspired innovations, amongst many others:

- Proposed design of flying machines also known as the ornithopter by Leonardo da Vinci (1452-1519), where he mentioned bats, kites, and birds as his inspiration sources. Even though, Leonardo da Vinci only drew the sketches of the ornithopter and never built one, the first successful flight of a manned ornithopter was recorded in 1942. Since then, there have been records of successful free-flight, manned, robotic and electrically powered ornithopters.
- The invention of velcro, by Georges de Mestral, a Swiss engineer, as inspired by the removable yet easily reattachable attribute of the prickly seed burrs from the burdock plant. This idea is what led to the invention of hook and loop fastener, a commercial product developed after 25 years of discovering Velcro.
- Sir Joseph Paxton's design of the London's Crystal Palace at Chatsworth in England, inspired by the huge leaves of the giant Amazonian water lily and subsequently erected in the year 1851.

Nature Inspired Invention

In the 15th century, Leonardo DaVinci took this this type of imitation further when he was influenced by birds and created drawings that portrayed flying machines. Leonardo Da Vinci borrowed ideas from nature. Most of Leonardo da Vinci's Discoveries were relatively sustainable in nature they were later adapted and evolved into energy consuming ideas. Today these ideas machines have conquered the lands, seas, sky, and even space but it is unfortunate that they all consume vast amounts of natural resources for its production, lifetime usage and demolition. At the price of Johnson Wax building, column natural resources these machines enable humans to explore space but they are still unable to replant, re-grow and rehabilitate the many ecosystems that inspired their formation and sustain their existence. These lifeless creatures that man remains giving birth to are alien to the planet because they are still far from sustainable integration with the ecosystem. Technology is the tool with which man is gradually taking away the foundations that helped sustain life on the planet for billions of years and from a moral standpoint this selfish human act puts man and all life on Earth in danger. Buildings such as Frank Lloyd Wright's Johnson Wax building (1936-1939) in which the thin shell concrete and steel-mesh columns inspired by the anatomy of the Staghorn cholla cactus begin to examine the potentials of the architectural product of biomimicry. Another example is the Biosphére Montréal, designed by Buckminster Full. Buckminster Fuller perfected the mathematics to create a large geodesic dome, you can 't help but look at it and think of the structure in honeycombs. Figure 6 Giant saguaro cacti.

Figure 4: Leonardo Da Vinci

We can look at history to find examples of eras that biomimicry emerged in the culture, usually in the form of a single inventor, like Leonardo da Vinci, Frank Lloyd Wright, Antonio Gaudi, Frei Otto or Buckminster Fuller. Unfortunately, these were isolated instances, but not the start of a series. There was no body of work, no scholarship, no cohorts of students trained to be nature's protégés. And so biomimicry went dormant again. Some of his inventions:

Flying Machine

Leonardo da Vinci's many areas of study. Da Vinci seemed truly eager by the possibility of people soaring through the skies like birds. One of da Vinci's most famous inventions is the flying machine (also known as the "ornithopter") ideally displays his powers of observation and imagination, as well as his enthusiasm for the potential of flight. The design for this invention is clearly inspired by the flight of winged animals, which da Vinci hoped to replicate. In fact, in his notes, he mentions bats, kites and birds as sources of inspiration.

Leonardo Da Vinci's flying machine has the pilot lying face down in a winged device that is obviously inspired by animals capable of flight. It is items such as this which really sets da Vinci apart from Michelangelo's inventions. The two wings on da Vinci's flying machine actually have pointed ends which suggest he had studied the various forms of flight taken by animals and discovered that bats are one of the most efficient at using their wingspan. To power the wings the pilot would use pedals to crank a rod and pulley system that was attached to the wings. He also imagined a separate crank for increased power and a head piece which served as a steering wheel. Unfortunately, the invention could not be made in practical application as the single pilot would not be able to create enough power to keep it in the air.

Figure 5: Leonardo Da Vinci Flying machine

Armoured Car

The precursor to the modern tank, Leonardo da Vinci's armoured car invention was capable of moving in any direction and was equipped with a large number of weapons. The most famous of da Vinci's war machines, the armoured car was designed to intimidate and scatter an opposing army.

Da Vinci's vehicle has a number of light cannons arranged on a circular platform with wheels that allow for 360-degree range. The platform is covered by a large protective cover (much like a turtle's shell), reinforced with metal plates, which was to be slanted to better deflect enemy fire. There is a sighting turret on top to coordinate the firing of the canons and the steering of the vehicle.

The motion of the machine was to be powered by eight men inside of the tank who would constantly turn cranks to spin the wheels. Leonardo suggested in his notes that the thought of using horses for power crossed his mind, but he dismissed it because he feared the animals would become too unpredictable in the confines of the tank.

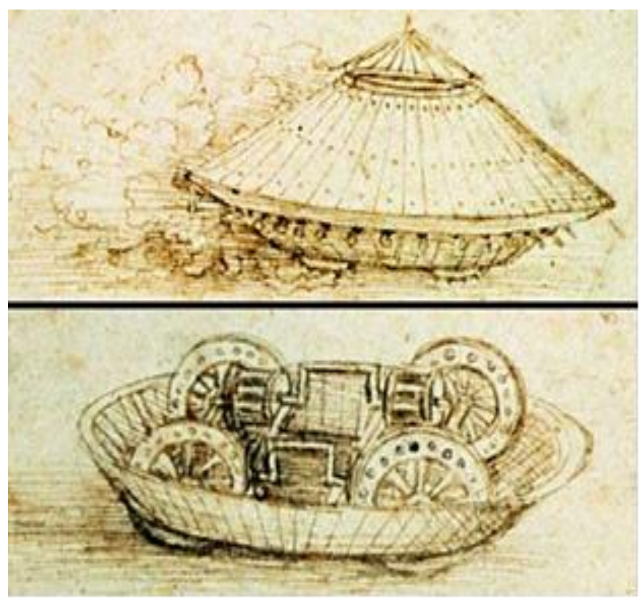

Figure 6: Leonardo Da Vinci's Armoured car

Influence of Biomimicry on Architecture

As we have learned from history that we are taking nature's inspiration so we should incorporate in our architectural design too. We have to take nature as a model, measure, and mentor. (Figure 9)

Nature as Model

Biomimicry is a new science that studies nature's models and then mimic these forms, process, systems, and strategies to solve human problems. The Biomimicry association and its collaborators they have developed a practical design tool, called the Biomimicry Design Spiral, for taking nature as model.

Nature as Measure

Biomimicry uses an ecological standard for judging the sustainability of our innovations. After 3. Billion years of evolution, nature has learned what lasts and what will work. Nature as measure has been captured in life principles and is embedded in the evaluate step of the biomimicry design spiral.

Nature as Mentor

It's a new way of viewing and valuing nature and it's form. It introduces an era based not on what we can extract from the natural world, but what we can learn from it.

Figure 7: Biomimicry design spiral

Principles of Biomimicry

Biomimicry Innovation Inspired by Nature by Janine Benyus sets out that there are nine basic laws underpinning the concept of biomimicry. The biomimicry principles focus exclusively on nature's attributes; thereby implying that humans have much to learn from the billions of years of the natural world's evolutionary experience. They are:

1) Nature runs on sunlight
2) Nature uses only the energy it needs
3) Nature fits form to function
4) Nature recycles everything
5) Nature rewards cooperation
6) Nature banks on diversity
7) Nature demands local expertise
8) Nature curbs excess form within
9) Nature taps the power of limits.

Approaches to Biomimicry

Approaches of biomimicry as a design process gernally fall into two categories- defining a human need (design problem) and examining the ways that how other organism's ecosystem work, examine to biology, or identifying a particular characteristic of organism and translating it into human design, referred as the biology influencing design.

Each of these phases is comprehensive, "non-product specific" and is arranged around an "outward spiral". Each time one makes a complete revolution around the spiral it solves some aspect of the problem. Subsequent revolutions refine the results to resolve deeper aspects of the challenge. Utilizing the biomimetic method with its "small feedback loops" and applying Life's Principles to the results can help the designer discover truly sustainable solutions to design challenges in a unique manner that is unimpeded by linear classic methodologies Because this is a reiterative process, after it resolves one challenge and evaluates how it compares to Life's Principles, most likely another problem appears, and the process begins again.

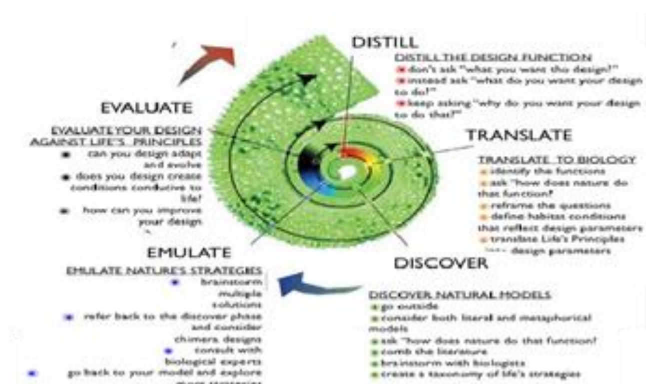

Figure 8: Design spiral: design to biology approach (virmani, 2014)

Table 1: A Framework for the Application of Biomimicry (adapted from Pedersen Zari)

Level of Biomimicry		Example - A building that mimics termites:
Organism level (Mimicry of a specific organism)		The building looks like a termite.
	material	The building is made from the same material as a termite; a material that mimics termite exoskeleton / skin for exam le.
	construction	The building is made in the same way as a termite; it goes through various growth c clues for exam le.
	process	The building works in the same way as an individual termite; it produces drop an efficient through meta- enomics for exam le.
	function	The building functions like a termite in a larger context; it recycles cellulose waste and creates soil for exam le.
Behaviour level (Mimicry of how an organism behaves or relates to its larger context)	Form	The building looks like it was made by a termite; a replica of a termite mound for exam lee
	material	The building is made from the same materials that a termite builds with; using diested fine soil as the rima material for exam le.
	constitution	The building is made in the same way that a termite would build in; piling earth in certain laces at certain times for exam le.
	process	The building works in the same way as a termite mound would; by careful orientation, shape, materials selection and natural ventilation for example, or it mimics how termites work to ether.
	function	The building functions in the same way that it would if made by termites; internal conditions are regulated to be optimal and thermally stable for example (fig. 6). It may also function in the same way that a termite mound does in a lar er context.
Ecosystem level (Mimicry of an ecosystem)	Form	The buildin looks like an ecos stem (a termite would live in).
	material	The building is made from the same kind of materials that (a termite) ecosystem is made of; it uses naturally occurring common compounds, and water as the chemical medium for exam le.
	construction	The building is assembled in the same way as a (termite) ecosystem; principles of succession and increasing complexity over time are used for exam le.
	process	The building works in the same way as a (termite) ecosystem; it captures and converts en from the sun and stores water for exam le.
	function	The building is able to function in the same way that a (termite) ecosystem would and forms part of a complex system by utilising the relationships between processes; it is able to participate in the hydrological, carbon, nitro eles etc in a similar wa toan ecos tem for le

Biomimicry in Architecture

The need for analysing process of biomimicry is multiple because it is being applied in almost every scientific and social field of work and research. Since architectural design is primarily done to satisfy basic human need for shelter, the manner in which it is done has a great social impact and vice versa. But manner in which biomimicry architectural approach will influence life of inhabitants of such architecture is still unknown. Trend of returning back to the nature in the sense of creating more nature friendly buildings is gaining momentum, with biomimicry being the most advanced in the line of holistic approaches to design. It is important for architectural design to consider social aspects for it will ultimately influence

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people and behaviour, relationships and influences between entities and its environment. It is crucial for architects to follow biomimicry approach, in order to evaluate if this kind of design satisfies its basic function – to be used by the inhabitants. As itreflects the challenge of creating more equitable life on earth, our focus is shifting; from artefacts to systems, from transactions to relationships, from design as craft to design as thinking, from habits of destruction to awareness of the need for resilience.

Sustainable Development and green design concepts are the foundation of biomimicry**.** Architectural professional accepted the fact that as a society's economic status improves, its demand for architectural resources — land, buildings or building products, energy, and other resources — will increase. This in turn increases the combined impact of architecture on the global ecosystem, which is made up of inorganic elements, living organisms, and humans. The goal of sustainable design is to find architectural solutions that guarantee the well-being and coexistence of these three constituent groups. (Kim, 1998)

Theory of Natural Capitalism is a new business model that involves four major and synergistic elements (P., Lovins, & Hunter Lovins, 2000) Radical resource productivity **-** Radically increased resource productivity is the cornerstone of natural capitalism because using resources more effectively has three significant benefits: It slows resource depletion at one end of the value chain, lowers pollution at the other end, and provides a basis to increase worldwide employment with meaningful jobs. Ecological redesign Reducing the wasteful throughput of materials—indeed, eliminating the very idea of waste—can be accomplished by redesigning industrial systems on biological lines that change the nature of industrial processes and materials, enabling the constant reuse of materials in continuous closed cycles, and often the elimination of toxicity. Service and flow. This calls for a fundamental change in the relationship between producer and consumer, a shift from an economy of goods and purchases to one of service and flow. In essence, an economy that is based on a flow of economic services can better protect the ecosystem services upon which it depends. Reinvestment in natural capital. This works toward reversing worldwide planetary destruction through reinvestments in sustaining, restoring, and expanding stocks of natural capital, so that the biosphere can produce more abundant ecosystem services and natural resources.

Cradle to Cradle or Regenerative Design is a holistic economic, industrial and social framework that seeks to create systems that are efficient and essentially waste free. It promoted the idea of industry protecting and enriching ecosystems and nature's biological metabolism while also maintaining a safe, productive technical metabolism. It is based on three fundamental ideas Waste Equals Food, Use Current Solar Income and Celebrate Diversity. (Strandesen & Bjorn)

Biomimicry theory differs from other theories which are bio-oriented. Very often design approaches that are bio-assisted are classified under the theory of biomimicry. Biomimicry in design is in many ways different from what it is in other theories. What makes biomimicry different from other theories is quest for solutions in nature. Biomimicry is natural symbiosis of form and process where nature is not only a source of aesthetic value.

Structuring Biomimicry, Improving Building's Resiliency

The major earthquakes throughout the world have verified the inefficiency of the current building architype and have warned building architects to adapt structures in order to withstand future seismic events. Heavy materials for construction such as concrete and masonry, some unsustainable approach for structure's construction and its dangerous vulnerability due to the existence of great percentage of structures designed and constructed following poor seismic regulations or even built without professional assistance. Imitating nature has become a meaningful approach for contemporary architects and design futurists to the built environment, especially for those who foster a future that doesn't compete with nature but coexist with it. At the light of recent natural disasters around the world, especially those geologically associated such as tsunamis and earthquakes, which have proven its destruction power over the current built environment; architects and structural engineers have found in biomimicry an ecological approach in order to improve future building's disaster resilience.

Bio-Structural Analogues in Architecture, by the Singaporean architect Joseph Lim (2009) emphasize that "central to the idea of a design strategy in developing the architectural concept, is a form of technological thinking which drew inspiration from other forms of knowledge". Scientific thinking on architecture has leaded a bottom-up approach for resilient structure's design. As wrote by the biologist D'Arcy W. Thompson, every form in Nature is essentially the product of the diagram of forces acting on it or which have acted on it. That technological feature of the living structures proves to be a resilient parameter of its morphology, basically because its tessellation grows in intrinsic relationship with the ecosystem and its natural flows.

Present built structures are unresponsive to the Earth dynamics and aren't completely adapted to the ecosystem flows of forces. This fact leads to an important concern of the global building industry about its resiliency capacity toward the future and its potential dangers by natural hazards. Geological associated hazards have caught great attention by the design community at important forums throughout the world. Recent major earthquakes throughout the world have proven the inefficiency of the current building paradigm and have warned building professionals to adapt structures in order to withstand future seismic events. Principles of a Bio Tectonic Culture master degree thesis takes Puerto Rico as a laboratory for the design of biomimicry-driven structures made of reinforced concrete in order to improve its resilient output.

As a matter of fact, reinforced concrete was conceived emulating a bone structural property where the collagen provides tension resistance such as steel bars, and mineral provides resistance to compression such as concrete. The type of loads which experiments the femur are very similar to those in typical beams and columns: tension, compression and bending. Then, the bio-structural parameters selected from the femur includes the mid-diaphysis (middle-cross section) geometrical properties associated with its maximum stress resistance value (about 4,000 pounds per square inch); and its response to mechanical stress, according to the Wolff's law, which implies that a bone's anatomy reflects the common stresses it encounters. The proposal undertakes those biological features of the femur bone to extrapolate morphogenetic parameters to the building structure in order to improve contextual integration and encourage better use of concrete.

Based in the bio-tectonic technological features extrapolated from the femur, the product achieved was a non-prismatic lightweight component deeply related to the bending-moment diagram of the typical frames which is normally generated by the effect of the lateral loads. Hence, the earthquake typical effect on the frame becomes a key parameter to its morphology design. Furthermore, due to the same principles, a lighter frame was obtained which also represents an achievement because implies the decline of the earthquake general intensity on the building. The structure proposal achieves a force-driven morphology implying some grade of mechanical resilience, and ecological adaptation.

CASE STUDY

As architects, we can take advantage from biomimicry to make our buildings better by pushing for more natural, combined, efficient and healthy solutions. We also need to take a look at the role aesthetics plays in nature with the way function and form so synergistically merge. Perhaps this is a way for buildings to harmonize with nature in renewed waysmaking built environments more environmentally sound and healthy for occupants Nature can teach us about systems, materials, processes, structures and aesthetics (just to name a few). By delving more deeply into how nature solves problems that we experience today, we can extract timely solutions and find new directions for our built environments.

Study on Lotus Temple

Location-New Delhi, India

Architect-Fariborz sahba

ArchitecturalStyle- Expressionist

Construction Period-13 November 1980 – 24 December 1986

Height- 34.27 meters (112.4 ft.)

Capacity- 1,300

Figure 9: Lotus temple

Introduction

It's Baha'i house of worship which is dedicated to public worship, so their doors are open for all types of religions and faiths. Each component is repeated nine times. The temple looks like ahalf-opened lotus flower, afloat surrounded by its leaves.The main temple is consisting of the worship house,the ancillary block- reception centre, administrative block and library. It's also consisted of basement to accommodate the electrical and plumbing service for assembly area there is lotus shaped superstructure. All around the lotus there are walkways with balustrades, bridges and stairs which is all surrounded by nine pools which represent the floating leaves of the lotus. The pool also helps for cooling process of the building. The temple is surrounded by gardens and its location in the centre of the ponds creates the impression of a giant lotus flower floating on the water. The external covering of white marble ensures the building is visible from a distance and shines with the rays of the sun.

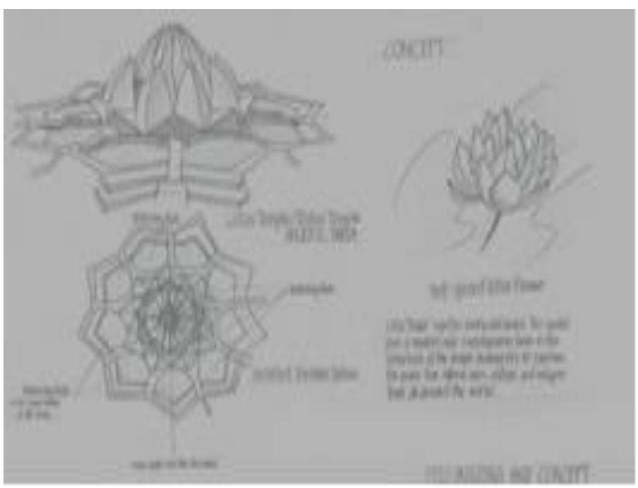

Figure 10: Concept of Lotus temple (S.naharoy)

Concept

The concept is developed from flower which symbolises purity. The site was located in Delhi which was known for its rich tradition. Before starting the project, the architect Fariborz sahba had travelled around the India to study the country architecture, in that he realised the lotus flower played an important role. The objective of representing concept of purity and freshness design of the Delhi temple in the form of lotus flower. The temple looks like a semi-opened lotus flower floating and surrounded by its leaves.

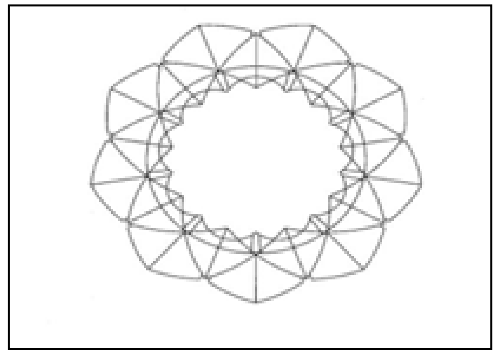

Figure 13: Basic Shape (S.naharoy)

Geometry

The concept of the lotus flower, has conceived by the architect, the geometry had to be converted into definable geometrical shapes such as spheres, cylinders, toroid and cones. The basic shape of lotus flower is used which is converted into definable form and then these shapes were used for making basic structural analysis and engineering drawings.

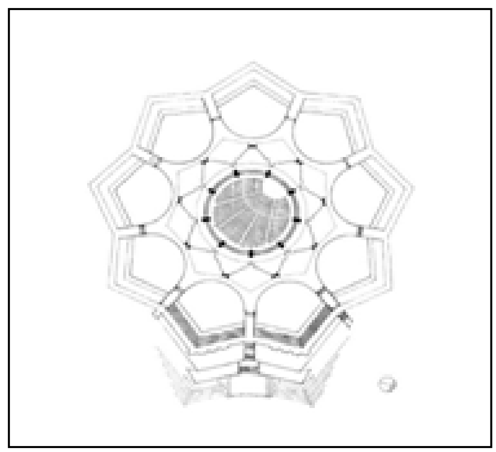

Figure 14: Terrace plan (S.naharoy)

Structure

The building is in reinforced concrete twenty-seven structure in the shape of petals, are clad in marble, all are arranged in group of three which are repeated to create the nine faces. All the Baha'I house share similar architectural elements such as circular in shape with nine sides specified in Bahá'í's scriptures. It also state that no painting, statue, image, pulpit or altar can be added to it's architectural element. Petals of the entrance and outer leaves are created by the shell on each side to the entrance-ways and outer leaves are formed by spheres which have different radii. In interior there is group of spheres which are fixed for structural consideration. Inner leaves are composed of an edge and valley, the inner leaves have q thickness of two metres, and a height of 34.4 metres over the platform. Lower level leaf, is maximum 14 metres. The arches have almost the entire structural load temple the interior space is being supported by nine arches which spread outwards of the central hall, the form of these arches is flat, conical and cylindrical.

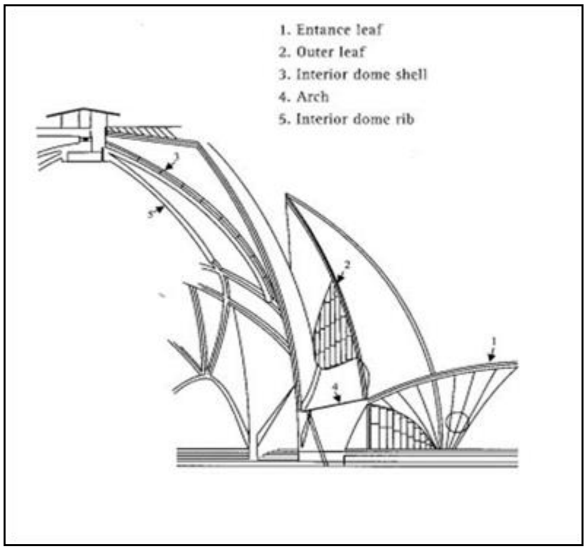

Figure 11- section (S.naharoy)

Material

The temple is constructed in marble and concrete so that it can be visible from distance. All 27 petals are clad in Rajasthani Macrana, the dolomit clay which is from Alwar, and white silica sand from Jaipur. The structure is made up of cement which is pre-fabricated.

Figure 12- side view of temple

Influence of Biomimicry on Sustainable Future

With the population growth and the lack of land in the inner cities, the average building height is increasing. Unravelling living or working places from the ground and placing them in height, solves the scarcity of land in the big cities but it also splits people from nature and ground. On the other hand, high-rise buildings have critical environmental impacts such as carbon dioxide emission and high-energy consumption. One advanced approach to achieve harmonious coexistence between human society and nature is biomimicry. Architects have considered nature as a great source of inspiration for centuries. Nature provides creative solutions for human problems. Biomimicry claims that nature is the most effective source of innovation for designers. Biomimicry is a motivation for intelligent and innovative engineering for minimalizing or eliminating the negative impact of the construction industry on the environment and attainment overall sustainability of the buildings. In this regard, this paper studies different approaches and levels of biomimicry that have evolved during recent years, exemplifies, and discusses three tall buildings that biomimicry principles are applied in their design.

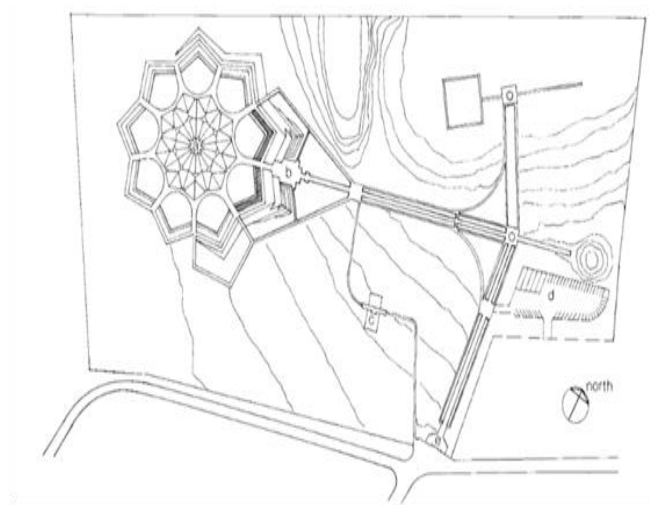

Figure 13- Site plan (S.naharoy)

Sustainable Architecture

Sustainable buildings are causing environmental interference as possible, such as, the use of friendly environmental materials that do not create- a health hazard, renewable energy use, low energy requirements, high-quality and longevity as a recommendation for construction, and last, an economical operation". In sustainable architecture, the building relates with the environment and adapts itself to the climate conditions. According to Richard Rogers, the buildings are similar to the birds that they dress their feathers in winter to adapt to the new condition and to regulate their metabolism. The benefit of sustainable construction to the natural environment and human health is irrefutable. As Kim JJ, Rigdon B definite there are three fundamental levels of sustainability in architecture: reducing resource consumption that deals with reusing and recycling natural resources used in construction, designing based on life cycle which presents a way to analyse construction process and its impact on environment, and human design that focuses on the interaction between human and the natural world.

Figure 18- Sustainable future

The Basic Principles of Sustainable Architecture

- Locational, functional, and structural solutions need to be selected in harmony with the local conditions, such as topography, water surfaces, microclimate, soil composition, flora etc.
- Size must be limited, with the footprint, i.e. the reduction of used green areas.
- Natural features must be improved and it is advisable to use renewable energy resources such as solar energy, wind, biomass etc.
- The daily use must be carefully planned, otherwise the building cannot be considered biological.
- Building structures, hygienic systems, substitute ways of construction are to employ environment-friendly building material and consider biological construction theories.
- Environment-conscious ventilation,material, energy consumption must be observed in the effective of the building as well.
- Recycling materials, protecting water in different ways such as harvesting rainwater, and recycling grey water.

Biomimicry Principles

In the book by Janine M. Benyus titled Biomimicry: Innovation Inspired by Nature, nine principles of nature were enumerated, which are also the basic principles supporting concept of biomimicry. They are the following: nature uses only the energy it needs, nature runs on sunlight, nature recycles everything, nature fits form to function, nature banks on diversity, nature rewards cooperation, nature demands local expertise, nature taps the power of limits, and nature curbs excesses from within. These principles are abstracted biological approaches, some of which are understandable and self-explanatory, that can be found in most of the organisms and which empower life to be successful in regenerating itself. They are creative common tools through which biomimetic designs, materials, and applications are estimated for sustainability. They are important checklists to be followed to in ensuring the application of biomimicry resulting in sustainable outcomes. According to the Biomimicry Group, the six major principles of biomimicry and their constituting twenty-three principles are:

Resource (Material and Energy) Efficient

This is skilfully and conservatively taking advantage of resources and opportunities. It consists of four principles, namely using multifunctional design (meet multiple needs with one elegant solution); using low energy processes (minimise energy consumption by reducing requisite temperatures, pressures, and/or time for reactions); recycling all materials (keep all materials in a closed loop); and fitting form to function (select shape or pattern based on need).

Evolve to Survive

This is the continuous incorporation and embodying of information to ensure enduring performance. It consists of three principles, namely replicating strategies that work (repeat successful approaches); integrating the unexpected (incorporate mistakes in ways that can lead to new forms and functions); and information reshuffling (exchange and alter information to create new options).

Adapt to Changing Conditions

This is appropriately responding to dynamic contexts. It consists of five principles, namely maintaining integrity through self-renewal (persist by constantly adding energy and matter to heal and improve the system); embodying resilience through variation, redundancy, and decentralisation (maintain function following disturbance by incorporating a variety of duplicate forms, processes, or systems that are not located exclusively together); and incorporating diversity (include multiple forms, processes, or systems to meet a functional need).

Integrate Development with Growth

This entails optimally investing and engaging in strategies that promote both development and growth. It also consists of three principles, namely combining modular and nested components (fit multiple units within each other progressively from simple to complex); building from the bottom up (assemble components one unit at a time); and self-organising (create conditions to allow components to interact in concert to move toward an enriched system).

Been Locally Attuned and Responsive

This is fitting into and integrating with the surrounding environment. It consists of five principles, namely using readily available materials (build with abundant, accessible materials); harnessing freely available energy (use of solar/renewable energy); cultivating cooperative relationships (find value through win-win interactions); leveraging cyclic processes (take advantage of phenomena that repeat themselves); and using feedback loops (engage in cyclic information flows to modify a reaction appropriately).

Using Life-Friendly Chemistry

This entails the use of chemistry that supports life processes. It also consists of three principles, namely building selectively with a small subset of elements (assemble relatively few elements in elegant ways); breaking down products into benign constituents (use chemistry in which decomposition results in no harmful by-products); and doing chemistry in water (use water as solvent).

Biomimicry to Increase Sustainability

Built environment is held responsible for environmental and social problems like excessive waste production,energy, and material use, and greenhouse gas emission attributed to the habitat’s humans have created for themselves. With this rapid development of urban construction, a mechanism should be applied to reduce these harmful effects. Biomimicry suggests innovative and eco-friendly approaches that can provide compatible and flexible solutions. Any organism in nature avoids excesses and overbuilding, attains maximum efficiency with minimum material and energy. Nature recycles everything and finds a use for everything, adapts itself to local conditions, runs on the sun and other natural sources of energy, and uses only the energy and resources that it needs. Biomimicry provides a wide range of solutions for structural efficiency, water efficiency, zero-waste systems, thermal environment, and energy supply, which are essential for any sustainable building design. Nature itself is a great mentor for living in harmony with it, for instance, we can learn from plants that how they make use of air pollution and convert carbon dioxide into oxygen. Considering biomimicry levels (organism, behaviour and ecosystem), mimicking an organism alone without mimicking how it is able to take part in the larger context of the ecosystem it is in, has the possibility to produce designs without environmental impact. Because mimicking organisms is just a specific feature, for instance, designing a building in the form of cacti (simple shape imitation) may not increase building overall sustainability. In behaviour level biomimicry, the behaviour of the organism is mimicked. In this level, designers have to figure out if the organism behaviour is suitable for human beings to imitate, and which part its behaviour will increase building sustainability.

Influence of Biomimicry on Climate Change

Among the global problems, climate change is often cited as the most serious threat facing humanity as the impacts now affect all countries and regions around the world, albeit in different and uncertainways. In the progress towards rapid urbanisation, statistics has shown that human activities contribute heavily towards environmental degradation and pollution. The importance of plants and equipment in the delivery of infrastructural project objectives seems to be increasing on a daily basis, all in a bid to match and sustain the growth. However, the fuel and energy used to power these plants and the resulting exhausts/emissions negatively impact the environment. Today, we primarily use fossil fuels to heat and power our homes as it is convenient using oil, coal and natural gas for meeting our energy needs. These are done without a conscious consideration for the environment, the resultant effect been the rapid increase in the atmospheric concentration of pollutants. Atmospheric concentrations of greenhouse gases (GHGs) are already well above pre-industrial levels and are projected to continue rising rapidly. The increase in GHGs within the atmosphere is changing the manner in which radiation is transmitted within the atmosphere resulting in global warming. Carbon dioxide (CO2), among several others, is the primary GHG that has contributed to recent climate change and known to be directly emitted by humans. It has been discovered that buildings are major emitters of other non-CO2 GHG emissions such as halocarbons, chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) as a result of their use for cooling, refrigeration, fire suppression, and in the case of halocarbons, insulation materials. These other GHGs are known causal agents of respiratory health problems, headaches, dizziness, irritation of the eyes, nose and throat and other illness. Other impacts also include sea-level rise, changes in storm paths and frequency, more frequent floods from heavy rainfall and among others, intense droughts leading to food shortages etc. Policies and actions to combat GHG emissions must expand rapidly as the impacts of climate change bites and increases. It is, however, noteworthy that, during nature's years of evolution, it has evolved highly efficient systems and processes, which can propel solutions to many of the challenges we now grapple with today. By responding to its need and finding solutions that work, nature evolves and sustains itself over the long haul. For 3.8 billion years, 10-30 million species have learned to do everything humans want to do, without guzzling fossil fuels, polluting the planet, or mortgaging the common future of generations to come. CO2 removal from the atmosphere by the photosynthesis of plants and the absorption of CO2 for pH level reduction by the oceans are few of the highly successful strategies found in nature. This discovery has therefore birthed an era whereby humans consult nature, studying their forms, processes, systems and strategies to solve problems. Biomimicry, the term describing this practice, will be construed in this study. In light of the conclusions reached, a long-term biomimetic solution is proposed thereby utilising the synergy of strategies found in nature with respect to tackling climate change.

The United Nations Framework Convention on Climate Change (UNFCCC)

At the Rio Earth Summit in 1992, countries joined in an international treaty, the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC is a framework for international cooperation to combat climate change by limiting average global temperature increases and the resulting climate change, and adapting to the inevitable impacts. Climate change is a large-scale global and long-term issue full of uncertainties. Regardless of the stance held by individuals, societies or governments on the sorts or magnitude of change occurring, an important consideration is the changing nature of change itself: its pace is quickening; its intensity increasing; its symptoms are more obvious; the consequences and severity of change are more evident; and it is fomenting additional and more ferocious change. The primary objective of the UNFCCC, as stated in mitigation leading to stabilisation of GHG concentrations in the atmosphere but within a time frame that allows ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner''. Although, adaptation and abatement/mitigation of GHGs emissions are both set out in the UNFCCC as responses to anthropogenic climate change, a dichotomy between the two as policy approaches has emerged as one of the most striking features of the discussion on how to respond.

Adaptation and Mitigation Responses to Climate Change

The duo of mitigation and adaptation has been recognised as being responses to the issue of climate change, as most of the scientific analysis and literature to date has tended to treat them as separate domains, with very little overlap. While mitigation focuses on the source of climate change, adaptation addresses its consequences. The relationship between them is such that, in theory, the more mitigation that takes place, the less adaptation will be needed, and vice versa. The visible effect of mitigation is not usually immediate, just as the impact of climate change seen now is as a result of long years of accumulated atmospheric concentrations of GHGs and other causal agents. Mitigation is, however, the best path and response to climate change as it assures of a permanent and long-term remedy since adaptation addresses the immediate consequences of climate change. Biomimicry mitigative response to climate change in the built environment Biomimicry has the potential to tackle climate change by mitigating GHG emissions which remain the primary causal agent. Biomimicry can mitigate against the effects of climate change through the following ways: application of biomimicry for energy effectiveness and energy efficiency; biomimetic energy generation; and biomimetic sequestration and storage of carbon. Nature has been found to be a master in dealing with chaos, complexity, and unpredictability. Learning from the processes, systems, and strategies at work in nature can be adopted, providing both mitigative and adaptive responses. Successful research and development from nature's over 3.8billion years of evolution has resulted in finding what works with the results found to be sustainable, efficient, functional and aesthetically pleasing as well.

What we can Learn and Emulate from Nature?

Nature is the biggest example of self-sustaining ecosystem. Nature doesn't need help from any other source than nature for sustaining it.The key eco-services that support the situations for life on Earth and can provide stimulation for Interface's:

Food and Fiber

Ecosystems produce food products derived from plants, animals, and microbes, as well as other materials, such as wood, hemp, and silk.

Storm Protection

The presence of ecosystems like coral reefs and wetlands can greatly reduce the amount of damage caused by coastal storms. At Interface, the factory design could include constructed wetlands to mitigate flooding.

Fuel

Wood, dung and other biological materials provide energy.

Climate Regulation

Ecosystems affect local and global temperature through land cover and sequestering or emitting greenhouse gases.

Pollination

Ecosystems support pollinators, which sustain plant life. Green roofs at an Interface factory could restore native pollinator communities.

Water Regulation

Land cover plays a key role in the magnitude of flooding. At the Interface factory, swapping concrete for more permeable pavement could reduce runoff.

Disease Regulation

Ecosystem changes affect the abundance of pathogens and disease-carrying organisms like mosquitoes. Warmer temperatures push malaria cases to higher elevations, for instance.

Erosion Control

Vegetative cover helps with soil retention and the prevention of landslides.

Cultural Diversity

Ecosystems affect the unique cultural behaviours of the humans within them. Maybe one day Interface employees will want to bird-watch in the surrounding wetlands on their lunch breaks, Benyus says.

Social Relations

Societal norms depend on surroundings. Fishing villages have different social customs than nomadic herders, for instance.(McNeal, https://www.wired.com, 2018)If we integrate those things in Architecture technology then those things have greater impact on human and nature. Architecture is not possible without human and nature's help but during this process we are degrading nature which should be reduced the balance should be their while designing and constructing a building. The line between nature and the build environment is a blurred one and most of the Architects are using this concept across the world to create innovative and cutting-edge designs. Nature has learned how to achieve most efficient multifunctional structures, i.e., functional integration. The optimized biological solution should give us inspiration and design principles for the construction of multifunctional artificial materials with multiscale structures. Most of current work has still focused on the biomimetic synthesis of multiscale structures inspired by one biological materials. In the near future, the following research directions should be a growing and vigorous field.

- To extend the function of bio-inspired multiscale structures through modification with functional molecules.
- To fabricate novel multiscale materials for functional integration inspired by two or more biological materials. For example, taking advantage of layered nacre and the marine adhesive of mussels, a novel nanostructured composite film was constructed.

The fusion of two or more seemingly distinct concepts found in nature into a unique composite with excellent functions is an exciting direction for the fabrication of novel multifunctional materials. Although the biomimetic and bio-inspired research is in its infancy, it is a rapidly growing and enormously promising field, which will become the focus of international competition in the near futureBuildings are responsible for almost half (48%) of all energy consumption and GHG emissions annually; globally the percentage is even greater. (US Energy Information Administration) 76% of all power plant-generated electricity is used to operate buildings. Hence, there is an urgency for action to protect our environment urgently.

BIOMIMICRY IN INTERIOR ARCHITECTURE

Natural organisms interact with the environment in a successful and sustainable way, without depleting natural resources or polluting the environment. They designed highly efficient biological systems that can adapt themselves to the surrounding environmental conditions in order to overcome different challenges. Biomimicry has the purpose of designing to emulate and integrate with natural systems when planning for a human design with the aim of reducing: energy, weight, material, cost and pollution. Interior design tried to imitate nature to enhance and improve its capabilities. It started with imitating figures, forms and structures. It was until the end of the 20th century, when it became possible to imitate nature's process, function and ecosystems in designs.In interior designing a design is influenced by nature, then it most likely about its appearance: it has an organic shape. Nature is a good teacher in this regard, but imitating or being inspired by natural-looking forms, textures and colours alone is not biomimetics. To quote Dr Julian Vincent 'biomimetics has to have some biology in it.' By which he means that a design should in some way be informed by nature's science, not just its look to be truly biomimeticIn interior design few years ago was for minimalism trend, this design language is hardedged and machinelike but succeeds in being humane and friendly through its simplicity and careful use of materials. At present, the fashion is an organic encased in smoothly flowing forms and curvy details. For example, the curved spiral shell house which designed by Senosiain Arquitectos and was inspired by a sea shell. Inside the home, the odd forms of the exterior continue to wrap through and connect each space. Application of biomimicry in interior architecture Inspired by the random patterns of the forest floor, achieving environmental advantages not found with other carpet tiles. Because the subtly-shaded carpet tiles blend together like leaves, without strict patterning, it is easier to match the replacement tiles, less discards, easier in installation, all ultimately resulting in the reduction of waste. In this way, biomimicry can benefit facilities managers and building owners. The paint surface takes the shape of densely packed ridges or bumps, just like the bumps found on lotus leaves.

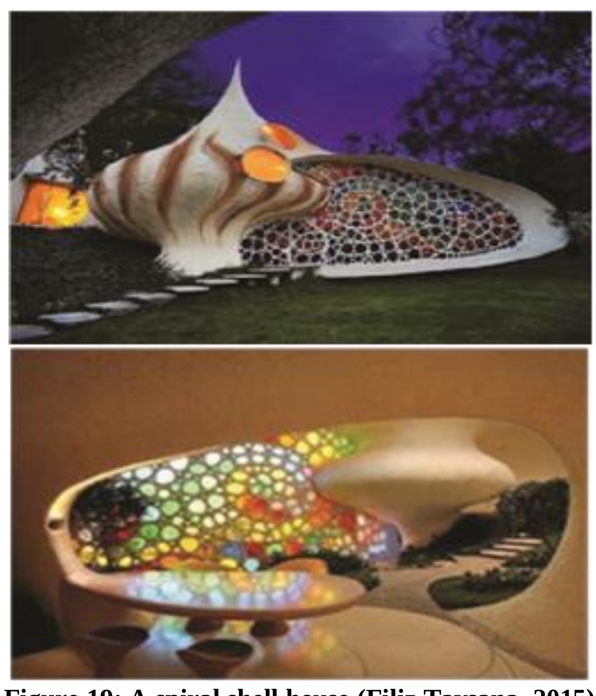

Figure 19: A spiral shell house (Filiz Tavsana, 2015)

Figure 21: Interior of a building (tree shaped column are used)

The Future of Biomimicry in the Interior Environment

Now, biomimicry is still in its infancy in the interior environment. In spite of a growing number of bio-inspired materials and products are expanding the friendly environment options available to designers; projects that incorporate biomimicry at the macro scale are few and far between. It is expected that it will continue to be applied most wildly in architecture and interior environment in the future, particularly as a tool of sustainable design in terms of day lighting, energy consumption and ecological footprint of new facilities. The architectural and interior design profession are cohesive enough to allow innovative approaches and new technologies to spread rapidly particularly when the profit is clear. As an example, the ability to effectively provide daylight into an interior space that has limited access to it reduces the need for artificial lighting. As a result, less heat is generated and less cooling is necessary, which could reduce cooling equipment’s size (a capital cost). Overall energy use is reduced (a cost of operation), and the dependence on fossil energy is lessened (an environmental cost). This is in addition to the important aesthetic and human benefits that daylight offers. The architecture and design will have inspiration, not from the machines of the 21th-century, but from the butterfly that flies in the sky or the flower that exists in the landscape that surrounds them.

CONCLUSION

1. To prove that the conscious emulation of life's genius is a survival strategy for the human race, a path to a sustainable future the more our world functions like the natural world, the more likely we are to endure on this home that is ours.
2. The Baha’I are known for their purity, so the Architect Fariborz Sahba took the concept very carefully the lotus flower which is symbol of purity in Hindu culture. The material also chosen wisely makrana marble from Rajasthan has been taken which is also used to construct Taj Mahal so that purity of marble can be seen and concrete for construction.
3. In this architect have taken lotus flower as lotus is pure and most religious flower which is needed in design so he integrated those points which he learns from it and material and construction technique plays a great role in execution.
4. Summarising the concept of this study, there are many aspects to be considered between nature and Architecture, some we have been learning since the historical times how humans started learning from nature, and the relationship between nature and build environment. Approaches to sustainability is to focus upon reducing energy and resources consumption Biomimicry provides the forum where natural system helps to produce a more positive and regenerative design.Not only is nature a readily available source of inspiration given that it is present in every molecule around us, but natural forms have also evolved within the same confines as humanity, utilizing only the material and energy resources available on Earth.
5. Following the concept of Biomimicry in every field like in design technology, interior designing, furniture designing which are not directly connected to it would make it more successful and by this we can achieve more sustainable environment.
6. These conceptsalso help is deigning so, if we introduce these in Architecture education then students would have more scope to learn about it and they have more knowledge about Biomimicry and what nature can do. Which would further help them in future design by this we can sustain our future environment and design also.As we are evolving, we must embrace our potential for future development so, that the Aim of making sustainable future can be achieved.

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