

## BIOMIMETIC APPROACHES TO SUSTAINABILITY AND ITS APPLICATION IN INTERIOR DESIGN OF THE TOURIST BUILDINGS

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### Abstract

This paper discusses that, in spite of the designers utilize the Great progress in technology and raw materials as well as digital design and interior design approaches and methodologies, schematic, they now should include a biomimetic approach to explore nature's database for sustainable solutions and innovations. This study will review key points, case studies of applications of biomimicry in interior design Output and manufacturing and an architectural project that lay the foundation of this important movement. Integrating biomimicry considerations into siting and interior design decisions for hotel and resort developments is important not only for the continued viability and conservation of the ecosystems, but also for the long-term financial success of the hotels and resorts. The tourism industry, including the hospitality sector, depends strongly on healthy ecosystems, because those ecosystems – and the habitats, landscapes, natural attractions that comprise them and Proper planning for the interior design of the hotel in ways that preserve the environment and sustainability in the morphological and ecosystem – are often the very thing that draws tourists to the destination in the first place.

### Keywords

Interior design, Nature, Biomimicry, Design process, Sustainability, Morphogenesis, Biology Bio-inspired design, ecology, subsystems, Design Spiral, Organism, tourist buildings

### Introduction

Biomimetic interior design and architecture is a contemporary philosophy of interior design that seeks solutions for sustainability in nature, not by replicating the natural forms, but by understanding the rules governing those forms. It is a multi-disciplinary approach to sustainable design that follows a set of principles rather than stylistic codes. It is part of a larger movement known as biomimicry, which is the examination of nature, its models, systems, and processes for the purpose of gaining inspiration in order to solve man-made problems.

This paper elaborates on distinct approaches to biomimetic design that have evolved.

A framework for understanding the various forms and levels of biomimicry has been developed, and is used to discuss the distinct advantages and disadvantages inherent in each as a design methodology. It is shown that these varied approaches may lead to different outcomes in terms of overall sustainability or regenerative

potential In the field of interior design.

The scope of this research is the study and analysis of biomimicry as a significant tool for sustainable interior design and construction, focusing on the possibility of applying selected biomimetic principles in the interior design processes of the tourist buildings, thus highlighting an important link between biomimicry and morphogenesis and outlining its potential for future sustainable design in architecture and the interior design of the tourist buildings

This paper focus on a qualitative interpretation of biomimicry in regard to its application in Interior design for the tourist buildings

### Research questions

- What is the potential of biomimicry as a design approach?
- How can biomimicry approaches support interior designers, in the field of sustainable design development?
- How biomimetic principles could be applied in the interior design for the tourist buildings. ?

**Research Aim:**

The main objective of this paper is to research the possibility of linking and applying biomimetic approaches and sustainability in interior design of the tourist buildings, and attempt to explore the potential of both emerging sciences in developing a more sustainable and regenerative interior design and architecture.

**Research objective**

- Explore the possibility of implementing and correlating selected biomimetic principles with the interior design.
- Explore the potential of biomimicry in interior design of tourist building
- Compare The Design Process that nature uses to that which interior designers use to solve problems.
- provide a framework for using biomimetic approaches with the concept of sustainability to support interior design process.

**Biomimicry Definition**

Scientist and author "Janine Benyus" popularized the term biomimicry in her 1997 book *Biomimicry: "Innovation Inspired by Nature"*. Benyus believes that most of the problems that have ever existed have already been solved by nature. Benyus suggests shifting one's perspective from learning about nature to learning from nature as a way to solve human problems. Sustainability issues are among those that can be addressed by applying the biomimicry process to a project. Utilizing an integrated design process can help open up opportunities to identify biological solutions to building problems and include the perspective of nature in the design process—as it is likely that nature already offers a solution

**Concept of Biomimicry**

the design and production of materials, structures, and systems that are modeled after biological entities and processes. (*New Oxford American Dictionary 3rd Ed 2010*)

Biomimicry and biomimetics come from the Greek words bios, meaning

life, and mimesis, also meaning to imitate.

**Bios, meaning "life" + mimesis, meaning "to imitate"**

- Biomimicry = to imitate life

Although, nature has been known as a source of inspiration for innovation, currently there has been an Endeavour to formalize what is described as bio-inspired design. Scientists have recently coined these names for the specific use of nature as an inspiration in design. It uses analogies to biological systems to develop solutions for human problems (*Helms, Vattam, & Goel, 2009*). It is gaining significance as a wide spread movement in design for environmentally conscious sustainable development (*Pedersen Zari, 2007*) that often simulates in creative innovation (*Vincent, 2006*).

- Term first made popular by Janine Benyus in her book, *Biomimicry: Innovations Inspired by Nature (1997)*
  - Viewing nature as role model/teacher—nature has already solved many of the technological and sustainability problems that we face today - learning *from* nature, not *about* nature
  - Imitate nature's processes, not products
- Biomimicry (from bios, meaning "life", and mimesis, meaning "to imitate") is a design principle that seeks sustainable solutions to interior design problems by consulting and emulating nature's time tested patterns and strategies. (*Janine Benyus, 2002*)

Biomimicry, the core idea is that nature, imaginative by necessity, has already solved many of the problems designers are grappling with. Using nature's principles allow interior designers to create products, processes, and policies that are well adapted to design on tourist buildings (*Birkeland, J. 2002*).

**Table 1**

Step	Design approach
1	problem definition
2	reframe the problem
3	biological solution search
4	define the biological solution
5	principle extraction
6	principle application

Step	Design approach Table 2
1	biological solution identification
2	define the biological solution
3	principle extraction
4	reframe the solution
5	problem search
6	problem definition
7	principle application

**Methodology of biomimicry**

Biomimicry is the conscious emulation of nature’s genius– innovation inspired by nature. In a society accustomed to dominating or 'improving' nature, this respectful imitation is a radically new approach; a revolution really. Unlike the Industrial Revolution, the Biomimicry Revolution introduces an ear based not on what we can extract from nature, but on what we can learn from her. Biomimicry's methodology is analyzing nature and mimicking it's functions and deep patterns to create life friendly solutions. It is not the aesthetic mimicry of something without the function, a point especially important for aspiring biomimetic INTERIOR designers. (Margaret McKosky, 2012)

The science of biomimicry provides designers with a framework. In her book,

Benyus offers the following nine basic laws of the circle of life, all of which resonate throughout her work and that of other biomimics ( *Benyus, 2002* )

Nature	Table 3	
	1	Runs on sunlight
	2	Uses only the energy it needs
	3	Fits form to function
	4	Recycles everything
	5	Rewards co-operation
	6	Banks on diversity
	7	Demands local expertise
	8	Curbs excesses within
9	Taps the power of limits	

**Three types of biomimicking**

1. Biomimicry is less about exploiting nature in an extractive sense, and more about it as a source of new learning
2. Biomimicry occurs at at least three levels:

**Biology to Design**

Biology to Design is a specific path through Biomimicry Thinking. This path is most appropriate when your process initiates with an inspirational biological insight (including a Life’s Principle) that you want to manifest as a design.

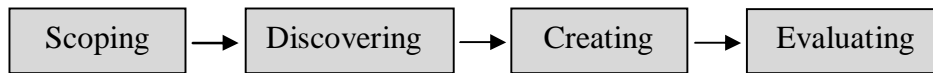
Mimicking Form	Mimicking Process	Mimicking eco-Systems
The connection between nature and mimics is generally visually obvious	The connection between nature and mimics may be scientific	Looking at nature for lessons to help us improve our systems
<b>What’s the design?</b>	<b>How is it made?</b>	<b>How does it fit?</b>
<b>(SIMPLE)</b>	<b>(COMPLICATED)</b>	<b>(COMPLEX)</b>



**Figure 1: Plan on using the Biomimicry Design**  
<http://biomimicry.net/about/biomimicry/biomimicry-designlens/biomimicry-thinking/>

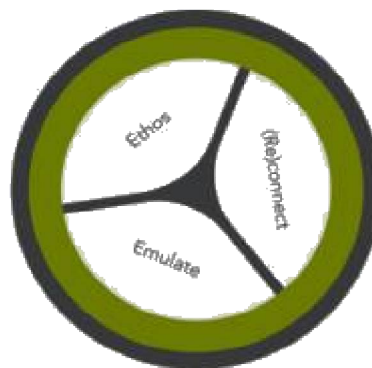
**Essential Elements of Biomimicry Thinking**

Biomimicry Thinking provides context to where, how, what, and why biomimicry fits into the process of any discipline or any scale of design. While akin to a methodology, Biomimicry Thinking is a framework that is intended to help people practice biomimicry while designing anything. There are four areas in which a biomimicry lens provides the greatest value to the design process:



Following the specific steps within each phase helps ensure the successful integration of strategies in interior design process.

The practice of biomimicry embodies three interconnected, but unique ingredients; the three Essential Elements of Biomimicry in interior design represent the foundation of the biomimicry. By combining the essential elements together, bio-inspired interior design becomes biomimicry.



**Figure 2: Essential Elements of Biomimicry Thinking**  
<http://biomimicry.net/about/biomimicry/biomimicry-designlens/biomimicry-thinking/>

<b>Table 5: The concept of Biomimicry Thinking in interior design</b>		
<b>Sc.</b>	<b>Essential Elements</b>	<b>Intellectual analysis</b>
<b>1</b>	<b>The ethos</b>	The ethos element forms the essence of our ethics, our intentions, and our underlying philosophy for why we practice biomimicry in interior design. Ethos represents our respect for, responsibility to, and gratitude for Identity.
<b>2</b>	<b>The (re)connect</b>	The (re)connect element reinforces the understanding that, while seemingly “separate,” people and nature are actually deeply intertwined. We are nature. (Re)connecting is a practice and a mindset that explores and deepens this relationship between interior design and the rest of nature
<b>3</b>	<b>The emulate</b>	The emulate element brings the principles, patterns, strategies, and functions found in nature to inform interior design. Emulation is about being proactive in achieving the vision of designer fitting in sustainably in design.

**Methodology of Biomimicry Thinking in interior design**

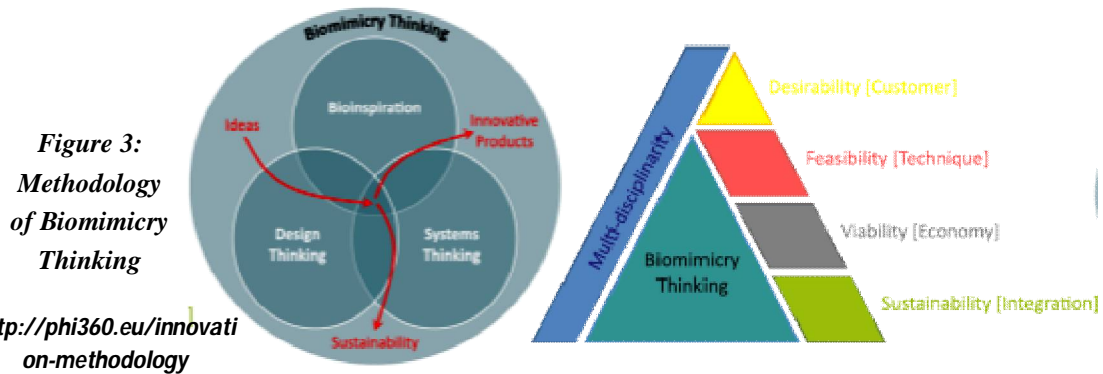
Biomimicry thinking in interior design depend on these approaches in its methodology to:

- reveal all information that will ultimately inspire and help shape the development of value-creating innovations
- develop a more holistic awareness of current and emerging users needs, values, mind-sets, and expectations

- Add value by increasing the practicality and sustainability of new products, processes, and services.

**Table 6: Innovation methodology is based upon 3 cornerstones**

Biomimicry	Design Thinking	Systems Thinking
Designs and processes have been optimized over billions of years resulting in countless solutions that bear the potential of solving the problems we are facing today. While transforming the design principles, inventive potentials, and resiliency that natural systems provide into the technological, organizational or informative space, and realize feasible applications into human-centered environments.	Design-based innovation is the cornerstone for inventive problem solving and creating commercial and social value. It is an inherent part of innovation methodology.  Integrating the potentials of nature with the possibilities of technology and the requirements of the market.	Systemic approach provides the best foundation for dealing with challenges and shaping functional solutions.



Rooted in system dynamics, a scientific field focusing on feedback flows, systems thinking provides a powerful toolkit to problem solving. Rather than in isolation, component parts of a system can be best understood in contextual relationships

Considering the entire system ensures its resiliency and therefore ultimately the impact and traction it will have.

### Biomimicry and Sustainable Design

Reducing human impact on the environment becomes more critical as every day passes. The public, along with designers and clients, now realize the tremendous impact our buildings have on the natural and built environment. As sustainable design becomes widely accepted, new approaches, like biomimicry, are advanced to achieve a sustainable future. (Klein, Lance, 2009)

biomimicry seen as a mentor for design as a new way of viewing and valuing nature. This involves introducing an era based, not on what can be extracted from the natural world, but what can be learnt from it. As a measure of design it uses an ecological standard to judge the rightness in innovations in sustainability.

### Sustainability and interior Design

As a key conduit for biomimicry knowledge, design has to capture the attention and imagination of designers. What does designer wants from design that biomimicry can provide? Systems and solutions that are more responsive to a more dynamic environment, inherent smartness and ongoing improvement are expected from product solutions of the 21st century. Interdisciplinary collaboration across traditional silos such as departments, faculties and professions is increasingly required to generate creative and innovative solutions in today's complex world. These benefits are often attributed to the biomimicry design process.

Biomimicry offers a useful framework as it focuses on functions and outcomes developed with input from a variety of disciplines.

As a result of the demands of reducing energy consumption for the earth to remain fit for human habitation, a new story is quickly unfolding for interior designers. This sustainability and human story has at least two parts, both of which must involve interior designers. The first is upgrading building infrastructures to improve energy efficiency, and the second is changing the behavior of building occupants through interior design, which may be the more critical component of the two. The story recognizes that more meaningful measures for sustainability must include humans but does not understand that humans are the interior designer's realm unlike other building professions. When the two processes are combined, then interior design can become the new vision of sustainability. To realize this vision, interior designers will need a new way of thinking about practice informing research and research to practice with our next generation of interior designers, (Linda Sorrento, 2012)

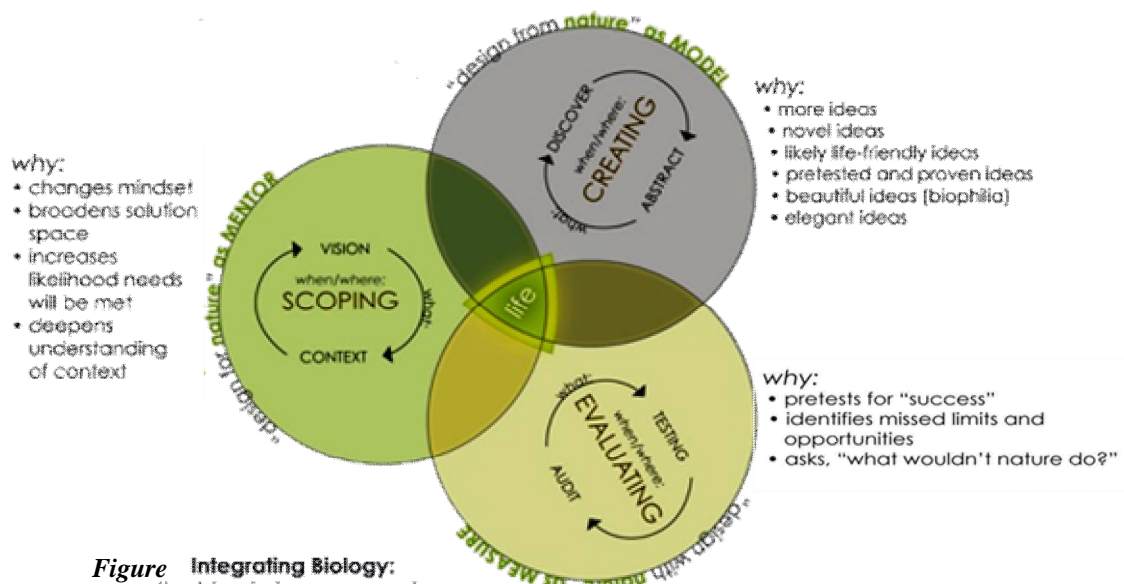


Figure Integrating Biology:  
the biomimicry approach

<http://bioinspired.sinet.ca/content/biomimicry-and-industrial-design-karen-verbeek>

## Impact of Biomimicry on interior Design

Biomimicry serves as a lens that expands the solution space by directing us to the functional solutions already available in nature. It becomes second nature for us to ask questions about the natural strategies and principles. The degree to which strategies can be understood and applied depends on circumstance, communication and opportunity. This presents a broadened role for designers as biomimicry educators and advocates, not unlike the role designers play in advocating for sustainable design.

Design has always been a collaborative, facilitative process that brings about solutions based on asking the right questions. Using biomimicry as a framework allows these questions to be

framed in a sustainable context. The solutions are based on a much wider solution space yet are based on a much more focused functional subset. Biomimicry is so much more complex and complete in how it addresses systems issues, resilience, symbiotic relationships and benign materials: the very issues we have been highly unsuccessful in dealing with to date.

Our entire manufacturing and world-wide economy is petroleum-based and relies on resource-extracting manufacturing processes. This has prevented us from exploring natural water-based, low-temperature processes that are at the heart of biomimicry, and that are the focus of green chemistry. Life is supported by dynamic non-equilibrium as an operating condition. Managing dynamic non-equilibrium to provide the continuous

change and control for our human needs will take creativity, insight and co-operation. This is a completely different paradigm and a new exciting landscape.

#### Concerns that have been mentioned in using the biomimetic approach:

- the shift in the design approach – integrating the biological discovery phase into design
- managing the changing role and opportunities of design
- role of the designer as educator and advocate
- strong and varied examples

- the learning curve and time for the discipline to be adopted
- translating the principles (abstraction to the design concept)

#### Design Spiral

The Design spiral has been introduced by Carl Hastrich, enables to bring designer's sensibility to a process. He suggests that the process in a spiral would be visually understandable to designers. This system is used by Janine Benyus and Dayna Baumeister to teach and practice biomimicry.

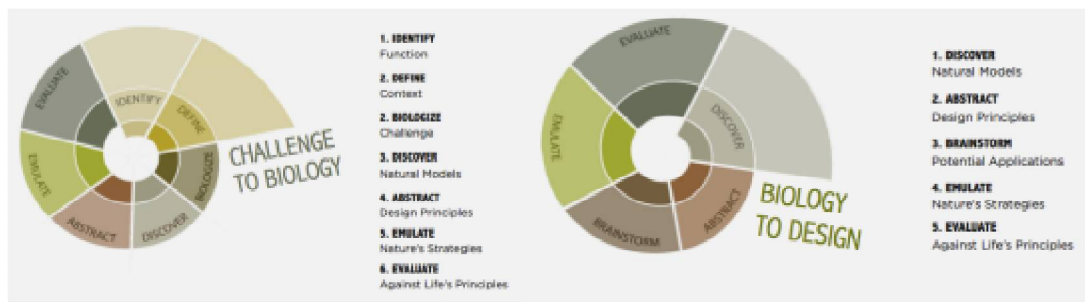


Figure 4: Design Spiral

<http://ben.biomimicry.net/curricula-and-resources/university-curricula/reading-materials/>

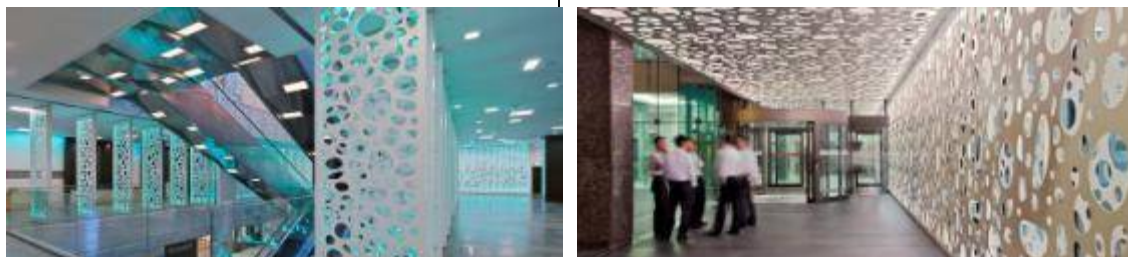
Design Spiral includes six steps; **Identify, translate, observe, abstract, apply, and evaluate** performed in an iterative fashion. It helps for innovators to biologize a challenge, query the natural world for inspiration, then evaluate to ensure that the final design that mimics nature at all levels: form, process and ecosystem (*Biomimicry Institute, 2007*)

#### Patterns from natural subsystems in interior design

External forces that try to have highest rate of functioning while being formed affect a nonliving natural form. For Triangular grids are the basis of the natural organism's geometry, which function on the minimum parts and maximum operation inspired from plants:

##### ▪ Formal patterning

In this type of patterning imitation, there is no attention to fundamentals of structure.



<http://imaginethese.blogspot.com/2012>

Figure 5: Convention Centre Interior Design | Hanwha 63 Convention Center | Hanwha Hotels and Resorts | Seoul | South Korea

A contemporary nature theme updates the convention floors and visually unifies all spaces. Textured stone, wood veneer, abstracted forest patterns and flowers are some of the elements of the materials palette. Spanning two stories in the atrium, pivoting laser-cut metal panels

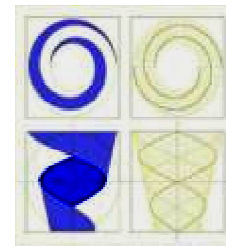
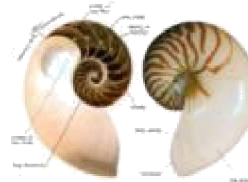
inspired by water drops create a screen to the central escalators from the venues and filter sunlight. An entry canopy made of the same laser cut panel extends from the street into the vestibule, drawing visitors into the building with an ultramodern experience.

▪ **Metaphoric patterning**

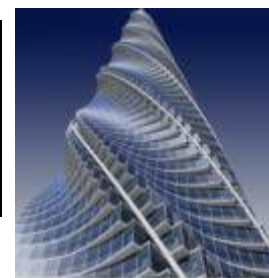
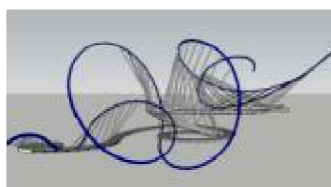
An abstract form of nature is used for equilibrium and sustainability. Metaphor keeps us from being superficial towards extents and we know it as a way towards creativity in architecture (*Antoniades, Anthony, 2002*)

**Hotel and resort in Dubai, the World Islands – Sri Lanka**

*Figure 6:* “The World” islands in Dubai suggest a hotel resort under a unifying spiral canopy roof. The heart of the design is the central future dome sphere. The roof spins around this sphere and creates spiral wings fading into the ground. These wings contain hotel rooms with private balconies and beaches and create perfect views to the surrounding ocean.



<http://www.architectureartdesigns.com/luxury-hotels-that-offer-the-sweetest-escape-in-dubai/>



<http://www.designboom.com/architecture/the-chicago-spire-by-santiago-calatrava/>

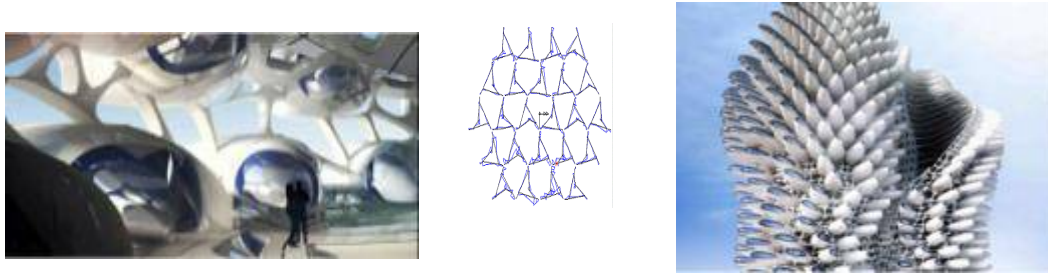
*Figure 7:* The 'chicago spire' by Santiago Calatrava. The twisting design was inspired by nature, as most of Calatrava's work is particularly influenced by spiralling snail shells. Each floor is rotated 2.44 degrees from the one below, totaling 360 degrees.

▪ **Pattern from natural rules:**

Application of natural rules is the best for getting natural inspiration. Bio-inspired design is relevant to a wide array of applications – including places (communities, landscapes, buildings,

rooms), furnishings, tools, and technologies. There are obvious connections between bio-inspired design, engineering, and emotion centered design, all of which aim to connect emotional experience more explicitly to the sensory and perceptual qualities of spaces and products.

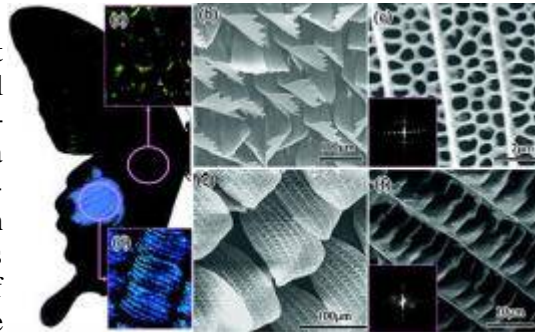




**Figure 8** :Spiraling Skyscrapers rising among the skyscrapers of New York, The Mangal City concept by design team Chimera is modeled after the complex ecosystem created by the mangrove tree, the project is an “urban ecological system” composed of modular pod capsules that shift to adapt to environmental and contextual conditions. A beautiful example of biomimicry and certainly a flight of fancy, the plan propose a futuristic building system based upon flexibility.( *Mohamad Reza, 2001*)

<http://www.greendiary.com/10-most-stunning-and-sustainable-spiraling-towers>.

**Figure 9**: In 2009, scientists discovered that butterfly wings have scales that act as natural solar collectors, which absorb light in an ultra-efficient way. Using a natural butterfly wing as a template, researchers were able to improve light-harvesting in dye-sensitized solar cells, which have the highest light-conversion efficiencies among all solar cells. Best of all, this method of producing solar collectors are more cost-effective than others that were previously used.



**Figure 10**: The Shangri-La Hotel Bangkok has just installed solar panels on a 938-square-meter portion of the rooftop. The BT 13 million investment will power a solar water heating system, generating enough renewable energy to heat 25 million liters of water a year, sufficient hot water production for the 802 guestrooms

<http://www.fivestallaralliance.com/articles/eco-friendly-luxury-hotels-shangri-la-bangkok-installs-solar-panels>

### International Hotels Environment Initiative (IHEI)

- The International Hotels Environment Initiative was set up by the hotel industry to encourage continuous improvement in the environmental performance of the hotel industry worldwide.
- Travel and tourism forms the largest and fastest-growing industry in the world, with hotels at the very core of its activity. Hotels are also the most resource intensive buildings after hospitals. IHEI was established to mobilise hotels to minimise their footprint and resource consumption and to maximize the positive impact they can have through their supply chains, in their communities and in their own operations.
- The Initiative provides a non-competitive platform through which hotel groups share information and pool resources to raise environmental awareness and provide guidance to the wider hotel industry, tour operators, government bodies, the media, academia and hotel industry suppliers.

### Application of biomimicry in tourist facilities (Case study)

Recent success stories exist in terms of how biomimicry can be applied to building design. While buildings serve to protect us from nature's extremes, this does not mean that they do not have anything to learn from the biological world. In fact, nature regularly builds structures with functionality that human-built structures could usefully emulate. Biomimetic research, science, and applications continue to grow and are already influencing the next generation of building products and systems as well as whole building designs.

### 1. Honeycomb Restaurant Interior

By SAKO Architects, Shenzhen, Guangdong, China - The white surfaces of the large space undulate in a place, and form six bands of 'pleats' that become the boundary for each space. In section, they appear like six 'honeycombs', leaving guests feeling like small bees in a hive. Over 1,000 oval shaped holes were created, and create continuity throughout the main dining area. In addition the restaurant houses a large traditional hall for groups, along with VIP rooms for private parties.

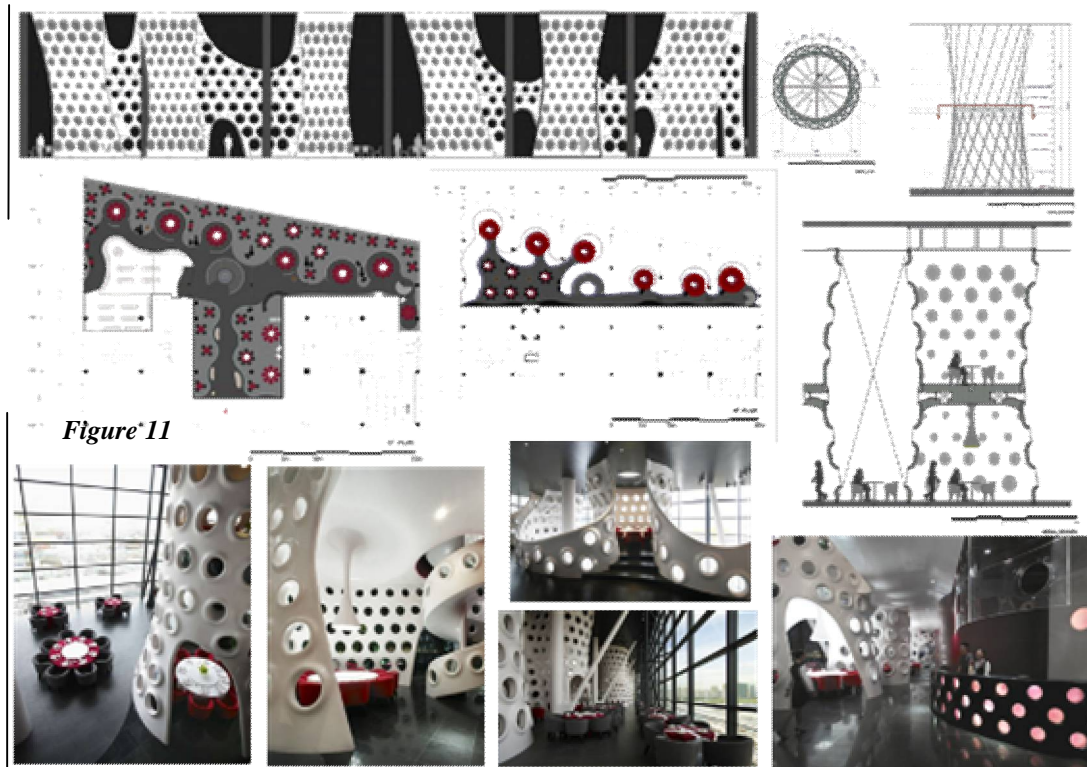


Figure 11

The inner side of the white surface is divided into two levels, consisting of a large room and private rooms. A spiral staircase penetrates between the levels, and in the center, about twenty-five thousand acrylic balls hang from the 9.2 m ceiling above. Drops of water dribble along the lines of the acrylic balls, and glitter under the strong ceiling light, creating quite an impressive focal point upon entering.

The space and avant garde design is accomplished in a red, black, and white color scheme, creating the perfect modern and simple background to showcase the interior designer's creative concept.

### 2. Biomimicry's Cool Alternative: Eastgate Centre in Zimbabwe

The Eastgate Centre in Harare, Zimbabwe, typifies the best of green architecture and ecologically sensitive adaptation. The country's largest office and shopping complex is an architectural marvel in its use of biomimicry principles. The mid-rise building, designed by architect Mick Pearce in conjunction with engineers at Arup Associates, has no conventional air-conditioning or heating, yet stays regulated year round with dramatically less energy consumption using design method inspired by indigenous Zimbabwean masonry and the self-cooling mounds of African termites.

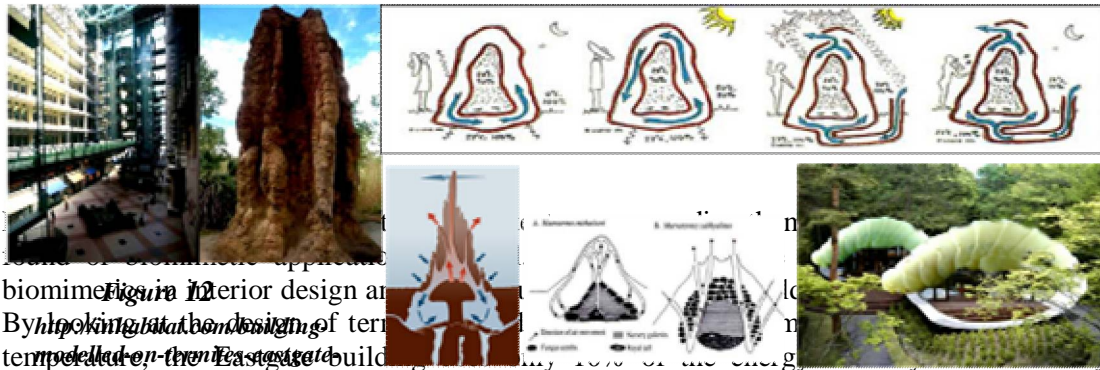


Figure 12 Biomimetic applications in interior design and architecture. By looking at the design of termite mounds on the Eastgate Centre building, which is 10% of the energy designed building of a similar size. This reduction in energy use has resulted in obvious economic benefits as well, in its first five years of operation the energy savings was \$3.5 million dollars (Zolli, 2004).

### 3. Blue Frog Acoustic Lounge and Studios

**Building Type:** Bar/ Restaurant/ Performance Space, **Location:** Mumbai, India, **Design:** Chris Lee / Kapil Gupta - **Total Area:** 1000 sqm, **Client:** Blue Frog Media Pvt. Ltd, **Completion:** November 2007

The deep structure that was employed is of a cellular organization composed of circles of varying sizes in plan approximating a horse-shoe configuration. The differential extrusions of these circles encapsulated at different levels as tiered cylindrical seating booths, allow the eye level of diners and standing patrons to be distributed across staggered levels that increase in height away from the stage. These booths seat between 4-10 people and are arranged around an open centre that can either double up as a potential 360 degree stage or accommodate standing patrons, bringing them closer to the main stage to create an intimate viewing experience. These mahogany paneled cylindrical booths maintain not only uninterrupted views to the stage, but also constant distance between diners irrespective of how crowded the lounge gets.

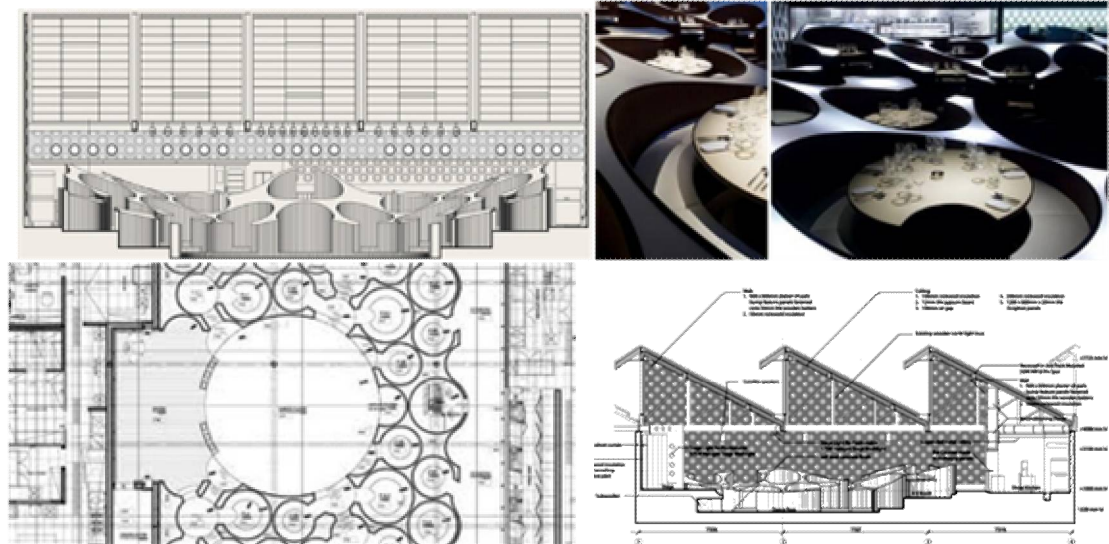
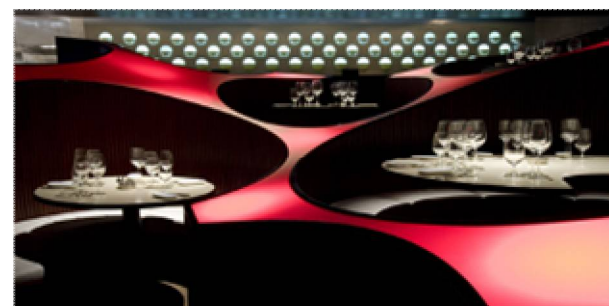


Figure 13: The undulating height of the seating booths is gently modulated by a glowing acrylic resin surface, which unifies the disparate types together and retains the presence of the architecture even in the midst of the spectacle of a state-of-the-art sound and light show at the Blue Frog.



## Application of biomimicry in tourist buildings (Applied Study)

### Nature's concepts and ecologically sustainable design

Design being a problem-solving methodology needs a good understanding of the essence of sustainability. Ecologically sustainable design is the use of design strategies which help reduce the ecological impact of buildings resources, by using minimum materials and energy, while producing less waste (RAIA 2010).

In devising such strategies, many ecological principles have evolved;

- Green' principles
- Sustainable' principles
- Ecological' principles

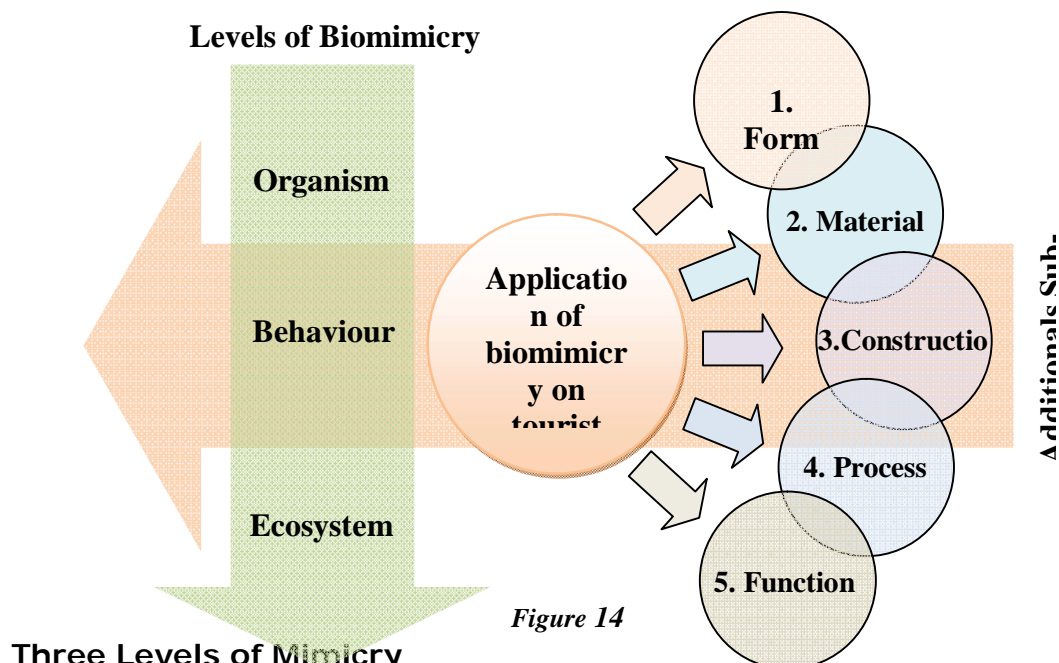
Ecologically sustainable design takes into consideration Nature's eco-system as a model as defined through ecological principles such as green design, ecological design, bioclimatic design and low energy design. (Van der Ryn and Cowan 1996).

They have challenged the conventional focus on issues such as function, aesthetics and immediate context to a more environmentally-conscious approach. New design approaches have emerged that are more environmentally-directed.

Ecological sustainability recognizes the ecological function of Nature in relation to its context. Ecological design is a way of understanding the integration of human functions with Nature's own flows, cycles, and patterns. (Arosha Gamage, 2012)

Biomimicry strives to apply biologically inspired functions into direct application. These are listed into six major categories: **Form, Material, Construction, Process, and Function** Respectively, these categories deal with shape and structure, the steps taken to achieve an ultimate end goal, and how Three Levels of Mimicry: **Organisms, Behaviour and Ecosystem** relate together to achieve the goal.

Through an examination of existing biomimetic technologies it is apparent that there are three levels of mimicry; the organism, behaviour and ecosystem. The organism level refers to a specific organism like a plant or animal and may involve mimicking part of or the whole organism. The second level refers to mimicking behaviour, and may include translating an aspect of how an organism behaves, or relates to a larger context. The third level is the mimicking of whole ecosystems and the common principles that allow them to successfully function. (Ahmar, Salma, 2011)

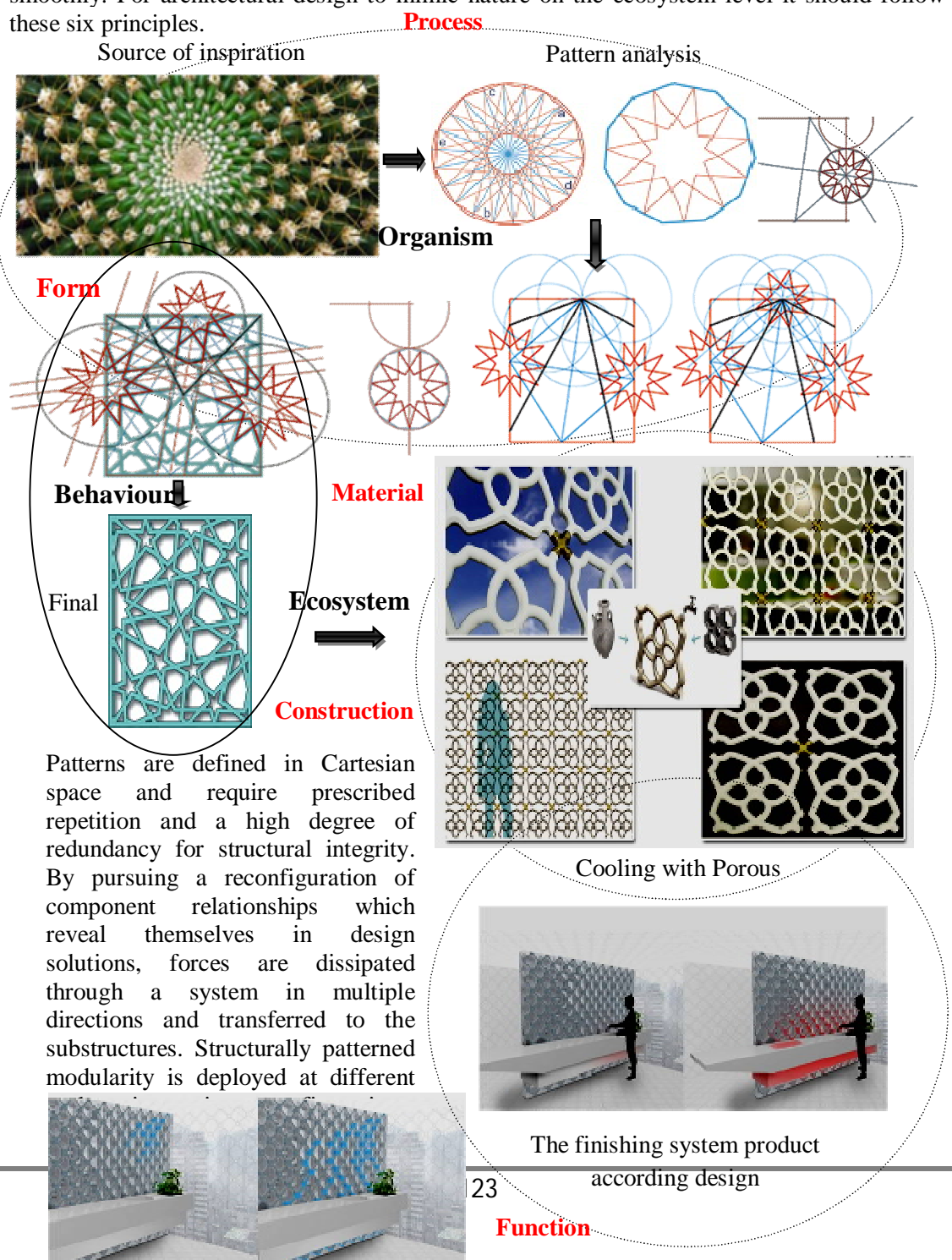


Biomimicry can work on three levels: the organism, its behaviors, and the ecosystem. Buildings on the organism level mimic a specific organism. Working on this level alone

without mimicking how the organism participates in a larger context may not be sufficient to produce a building that integrates well with its environment because an organism always functions and responds to a larger context. On a behavior level, buildings mimic how an organism behaves or relates to its larger context. On the level of the ecosystem, a building mimics the natural process and cycle of the greater environment. Ecosystem principles follow that ecosystems are dependent on:

- (1) Contemporary sunlight
- (2) Optimize the system rather than its components
- (3) Attuned to and dependent on local conditions
- (4) Diverse in components, relationships and information
- (5) Create conditions favorable to sustained life
- (6) Adapt and evolve at different levels and at different rates (*El Ahmar, Salma, 2011*)

Essentially, this means that a number of components and processes make up an ecosystem and they must work with each other rather than against in order for the ecosystem to run smoothly. For architectural design to mimic nature on the ecosystem level it should follow these six principles.



Patterns are defined in Cartesian space and require prescribed repetition and a high degree of redundancy for structural integrity. By pursuing a reconfiguration of component relationships which reveal themselves in design solutions, forces are dissipated through a system in multiple directions and transferred to the substructures. Structurally patterned modularity is deployed at different



## 1. Form and Pattern

As interior design solutions become more challenging, designers are now looking closer at how natural processes work for inspiration. Once scientists start looking closely, they will realize that nature is filled with incredible design solutions for common and uncommon design problems (*Hensel M. et al 2010*)

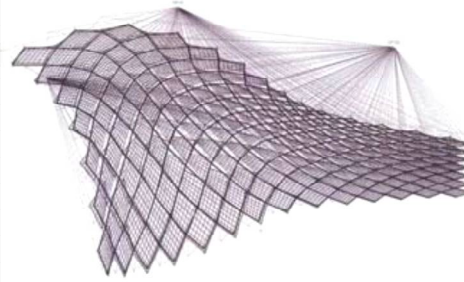


Figure 16: Computational model of the canopy.

At an abstract level, the existing design process is compatible with the concepts of systems thinking: interior designers will still identify goals, develop concepts, attempt to embody them and test prototypes, iterating the cycle as required. Applying principles from ecosystems will change and add to the list of goals that interior designers, developers and manufacturers set for their products and services. Designers will likely expand the bounds of the systems they analyze in the design phase. (*Norbert Hoeller, 2007*)

Patterns may incorporate information derived from theories, principles and strategies, but must express that information in pragmatic and practical terms. According to Appleton (*B. Appleton, 2000*) "A pattern is where theory and practice meet to reinforce and complement one another, by showing that the structure it describes is useful, usable, and used!" Appleton has identified the following characteristics of a successful pattern.

- It solves a problem: Patterns capture solutions, not just abstract principles or strategies
- It is a proven concept: Patterns capture solutions with a track record, not ... speculation .
- The solution is not obvious: ... The best patterns generate a solution to a problem indirectly -- a necessary approach for the most difficult problems of design "
- It describes a relationship: Patterns don't just describe modules, but describe deeper system structures and mechanisms."

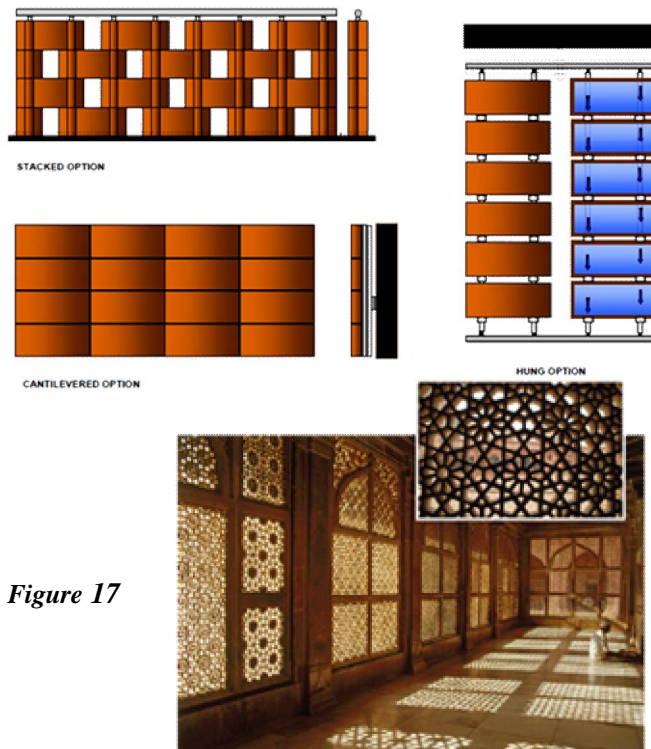


Figure 17

## 2. Material Systems

Material and morphological characteristics are derived through iterative feedback loops, which continuously process the material system's interaction with statics, thermodynamics, acoustics, and light and so on. In contrast to the currently predominant modes of utilizing computation first for formal expressions liberated from all constraints of construction, and then for the economically driven rationalization of the resultant, tectonically complicated buildings, this approach utilizes computation to recognize and exploit the material system's behavior rather than merely focusing on its shape.

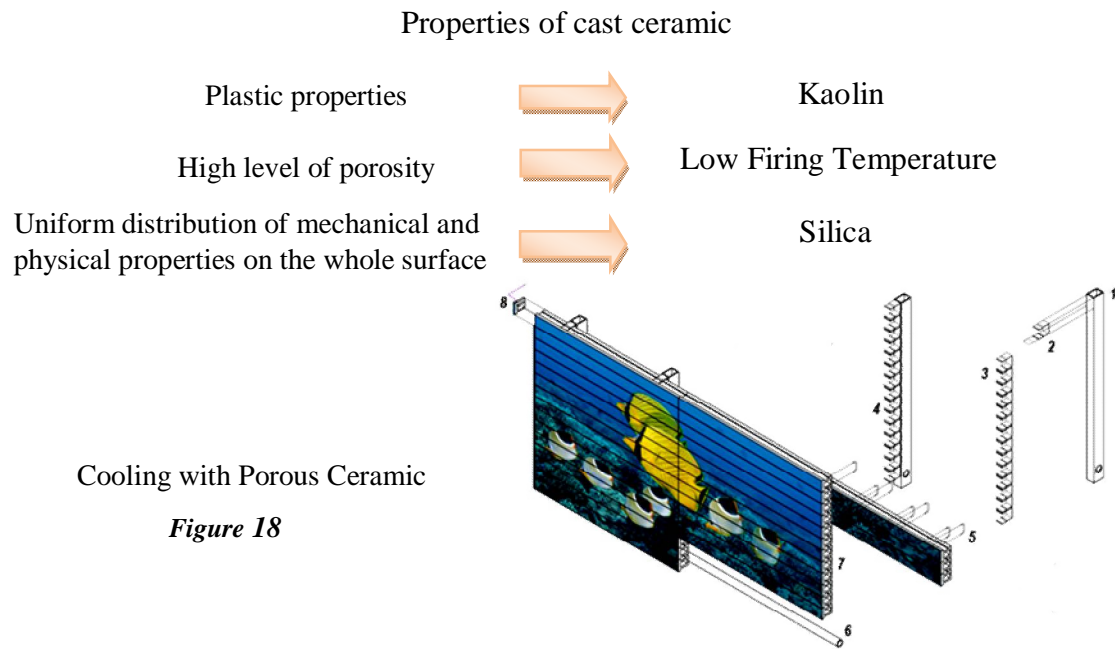


Figure 18

### 3. Construction - Principles of Ecosystem Biomimicry

By conducting a comparative analysis of related knowledge of ecosystem principles in the disciplines of ecology, biology, industrial ecology ecological design and biomimicry, a group of ecosystem principles aiming to capture cross disciplinary understandings of ecosystem functioning was formulated. It is intended that this biomimetic theory in the form of a set of principles based on ecosystem function could be employed by designers, to aid in the evolution of methodologies to enable the creation of a more sustainable built environment. (Pedersen Zari, M. and J, 2012)

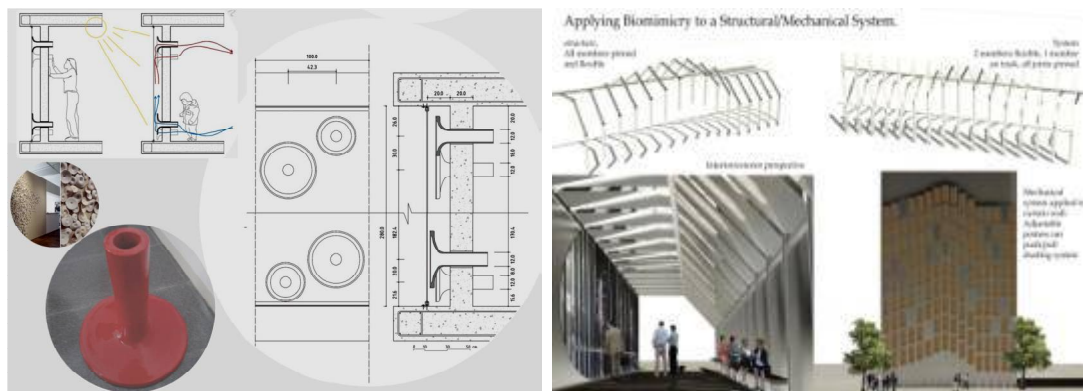


Figure 19

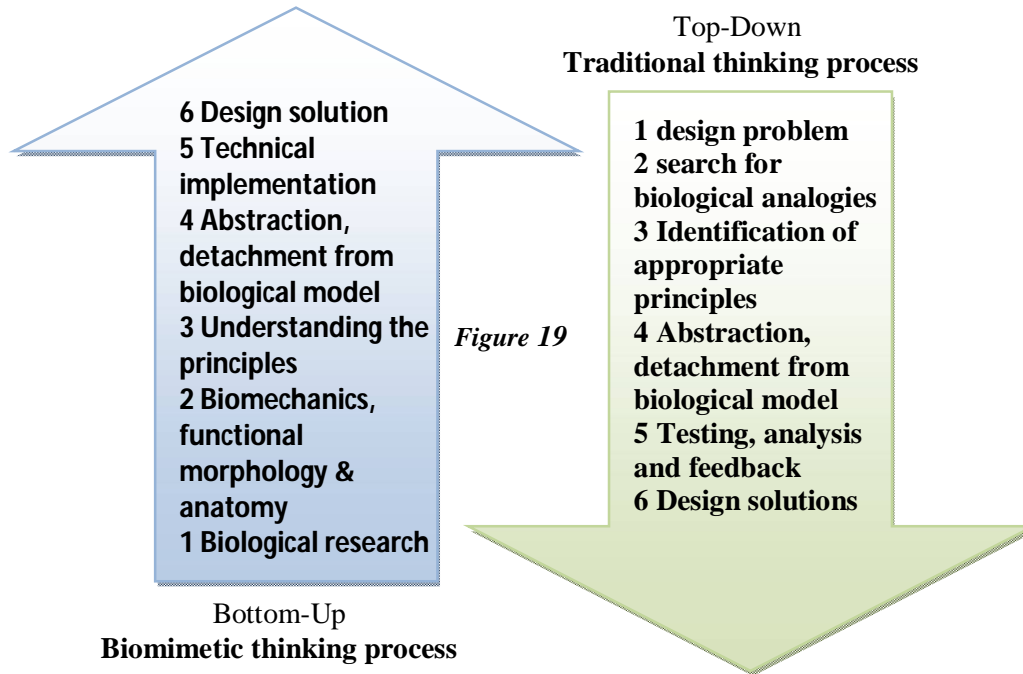
The approach consists of using ceramics not only as elements for accumulating energy in the Trombe wall, but also as materials that serve to open and close the convection currents. There is an assembly of ceramic pieces using a trumpet as a reference. These are set in openings in the wall, with the larger part trapped in the air chamber. The “trumpets” can be moved by hand according to the user’s needs, such that, when stuck to the glass, they let no air through and when separated from the glass, they allow a flow of hot air during the night. (V. Echarrri Iribarren, 2009)

### 4. Thinking Process

In any creative process it is always difficult to know when you have what is needed to move into the next stage of thinking. Moving from research, the gathering of insights, into ideation, transforming those insights into action, is almost always a surprisingly difficult process.

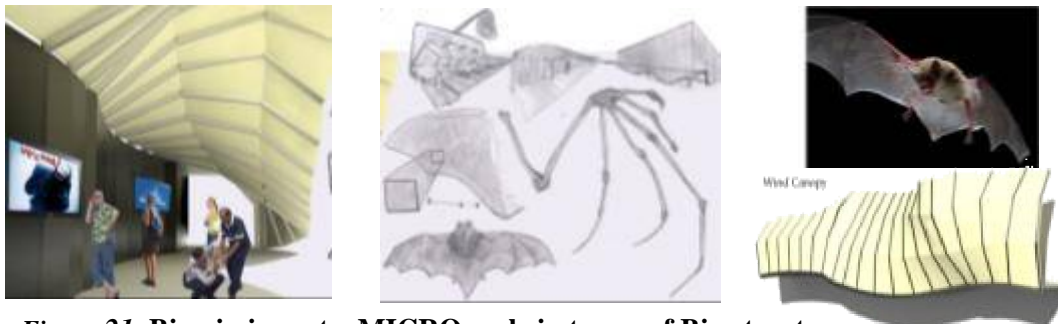
For this project which depend on biomimetic approaches the first stage of the design process was articulating an understanding of the design challenge and translating observations into questions of nature. The core challenges at this stage being;

- What are the core challenges or opportunities within the design project? (IDENTIFY)
- How to start researching natural models. (TRANSLATE)
- How to inspiration from natural models to define the design concept (INSPIRE)
- How to application the concept on form level and function level (APPLICATION)



## 5. Function

On the organism level, the architecture and interior design look to the organism itself, applying its form and/or functions to a building. Mimicking an organism alone however without also mimicking how it is able to participate in and contribute to the larger context of the ecosystem it is in, has the potential to produce designs that remain conventional or even below average in terms of environmental impact (Reap et al., 2005). Because mimicking of organisms tends to be of a specific feature, rather than a whole system, the potential also remains that biomimicry becomes technology that is added onto buildings rather than being integral to them, particularly if designers have little biological knowledge and do not collaborate with biologists or ecologists during the early design stages. While this method may result in new and innovative building technologies or materials, methods to increase sustainability are not necessarily explored. (Pedersen Zari, M. 2007)



**Figure 21: Biomimicry at a MICRO scale in terms of Bio-structure, Visualize of biomimicry design concept (form, material and function)**





**Figure 21: Tang Palace Design by FCJZ**

The restaurant is located on the top floor of a superstore in the new town area of Hangzhou, with 9-meter high story height and a broad view to the south. Composite Porous Ceramic are selected as the main material, conveying the design theme of combining tradition and modernity.

In this design, the designer create diversified and yet an interrelated interior spaces through the different usages of the new Porous Ceramic which has the most effective ways to cut down the ecological footprint of buildings is to follow the lead of nature through biomimicry.

In the hall, to take advantage of the story height, some of the private rooms are suspended from the roof and creating an interactive atmosphere between the upper and lower levels, thus enriching the visual enjoyments. The original building condition has a core column and several semi-oval blocks which essentially disorganized the space. Hence, our design wants to reshape the space with a large hollowed-out ceiling which is made from interweaved thin bamboo boards; and extending from the wall to the ceiling. The waved ceiling creates a dramatic visual expression within the hall. - The original story height and thereby creates an interactive relation between the levels. We also wrapped the core column with light-transmitting to form a light-box, which transforms the previously heavy concrete block into a light and lively focus object.- The semi-transparent wall provides a subtle relationship between the inner and outer spaces, bestowing people with a special spatial experience.

## Results

- Biomimicry development can take years

of input, discussion and refinement. In addition, further effort will be required to look for relationships between biomimetic approaches to sustainability and its applications in interior design for the tourist buildings that will allow a client specific framework and a new language to emerge.

- Biomimetic approaches to sustainability and its applications in interior design for the tourist buildings may come new insights and new perspectives on the problems being addressed, which, in turn can lead to new and novel solutions.
- The research concludes that ceramic materials can help efficiently to create sustainable and energy-efficient solutions in the interior design of the tourist buildings.
- Ceramic materials adapted with the most varied forms and surfaces, durability and their lack of maintenance and manufacturing economy. Ceramic materials can be used in passive and active conditioning systems, in systems with high technological backing, and in other bioclimatic systems and contribute to creating more sustainable interior design.

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