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Biomimicry

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Abstract: Biomimicry is an approach to innovation that seeks sustainable solutions to human challenges by emulating nature's time tested patterns and strategies. The idea is to adapt the design, products and processes from nature over the long haul. Nature, from the ancient period, has inspired mankind to create long lasting, aesthetic, durable and efficient design for various structures. The biomimicry institute (BI) inspires people to create nature inspired solutions for a healthy planet. Analysis using TRIZ (Theory of Inventive Problem Solving) shows that there is only 12% similarity between biology and technology in the principles with solutions to problems illustrates, and while technology solves problems largely by manipulating usage of energy, biology uses information and structure, two factors largely ignored by technology. Hence, from the point of view of making cost efficient as well as material efficient structures that tackle basic real life problems, more and more nature inspired designs must be studied and implied in mass infrastructure. In this very extract, we cover the case studies of some prominent biomimicry designs that have either been researched upon or applied to structures. Two such examples are:The East gate Complex, Harare, Zimbabwe,Lotusan paints

Keywords: Biomimicry, Sustainable, TRIZ,Biology, Cost efficient.

I. INTRODUCTION

Biomimicry is the imitation of the models, systems and elements of nature for the purpose of solving complex human problems. In this research, the pivotal stage is to understand the design thinking process and biomimicry concept. The way of understanding also will help for high expectations to produce creativity and emotional impact into a design solution. Through a process of reconnecting with nature and researching living organisms, the design teams, together with biologists are looking at how natural systems operate and are asking nature as a means to inform their building design. The underlying idea of biomimicry is that we can use the forms, processes and systems found in nature to inform efficient, sustainable and environmentally sensitive designs. Biomimicry becomes a source of inspiration to solve various design problems. It is the new medium with wide range of options to create a sustainable world in true sense. Biomimicry has had its impact since ancient times over the mankind's thought processes relating to various fields of civil engineering. Leonardo Da Vinci was a keen observer of the anatomy and flights of birds and made numerous notes and sketches on his observations as well as sketches of "flying machines". The Wright Brothers, who succeeded in flying the first heavier-than-air aircraft in 1903, derived inspiration from observations of pigeons in flight. Over the past years, there have been some prominent contributions top the world of cost and energy efficient infrastructure. Some of them are listed as: 1. In the Swift's satire of The Royal Society, there was a most ingenious architect who had contrived a new method for building houses , by beginning at the roof and working downwards to thefoundation, which he justified by the like practice of those prudent insects, the bee and the spider. 2. Henry Mitchell invented a pile so cut that the lower portion of it, of a space of six or eight feet, presents the appearance of a number of inverted frustums of cones, placed one above the other borrowed from nature. Certain seed vessels by virtue of their forms, bury themselves in the earth when agitated by wind or water. 3. Clement Ader designed and built several steam powered aircrafts using the wing design of a bat.The observations of lessons in nature are having a profound impact and are challenging the way things have been done since the industrial revolution.

II. THE EAST COMPLEX, HARARE, ZIMBABWE

The East Gate Complex is the commercial office and shopping complex which includes two 9-Storey office buildings and glazed atrium. In Zimbabwe, the climate is extremely hot, so cooling is essential in buildings. The primary cooling method in East Gate Complex is natural ventilation. The inspiration for the buildings is from termite mounds since termites require their homes to remain at an exact temperature of 30.5 degree Celsius throughout 24 hour daily temperature range of between 16 degree to 40 degree Celsius.

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2.1 Inspiration :

Termite mounds are built from compacted soils and contain a network of tunnels that transport gases from the nest to the mound surface, where they diffuse through many tiny pores that also allow outside gases to enter the mound. Because the individual pores are so small, however, the mound resistes large scale pressure driven air flow such as that induced by winds.The ventilation must instead be driven by some other factor. A critical chimney flanked by smaller buttresses referred as flutes. They proposed that exposed flutes respond quickly to changing temperature and the temperature in the internal chimney remains relatively constant.

2.2 Concept :

The concept of passive cooling is used in the working of the East Gate Complex. Passive cooling works by storing heat in the day and venting it out at night as temperature drops. It utilizes on site energy, available from the nature environment, combined with the architectural design of building components rather than a mechanical system to dissipate heat. Passive cooling covers all natural processes and techniques of heat dissipation and modulation without the use of energy.Applying passive cooling means reducing difference between outdoor and indoor temperatures, improving indoor air quality and making the building both a better and comfortable environment to live or work in. It can also reduce levels of energy use and environmental impacts such as greenhouse gas emissions. A well designed envelope maximize cooling movement of air and exclude the sun in the summer. Design strategies that minimize the need for mechanical cooling systems include proper window placing, and daylight design, the selection of suitable glazing for windows or skylights, proper sized shading of glass when heats gains arte being avoided, the use of light or reflective colored materials for the building envelope and roof, careful sighting and wise orientation decisions alongside appropriate landscaping designs. Passive cooling structures with specially designed hooded windows, variable thickness walls and light colored paints to reduce heat absorption have been used in the East Gate

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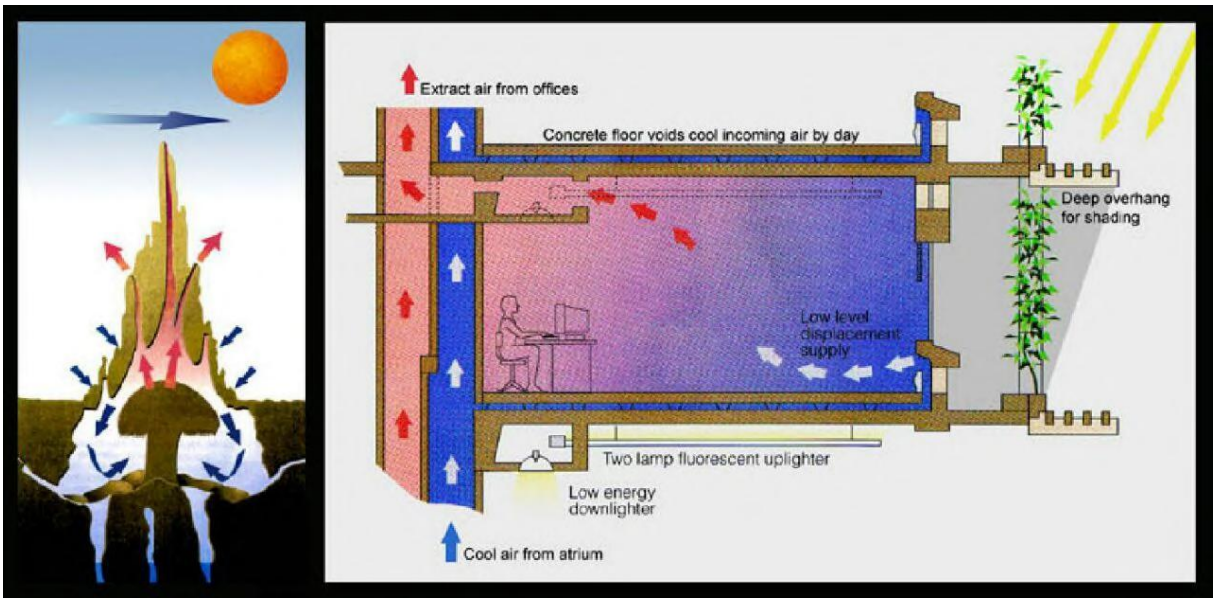
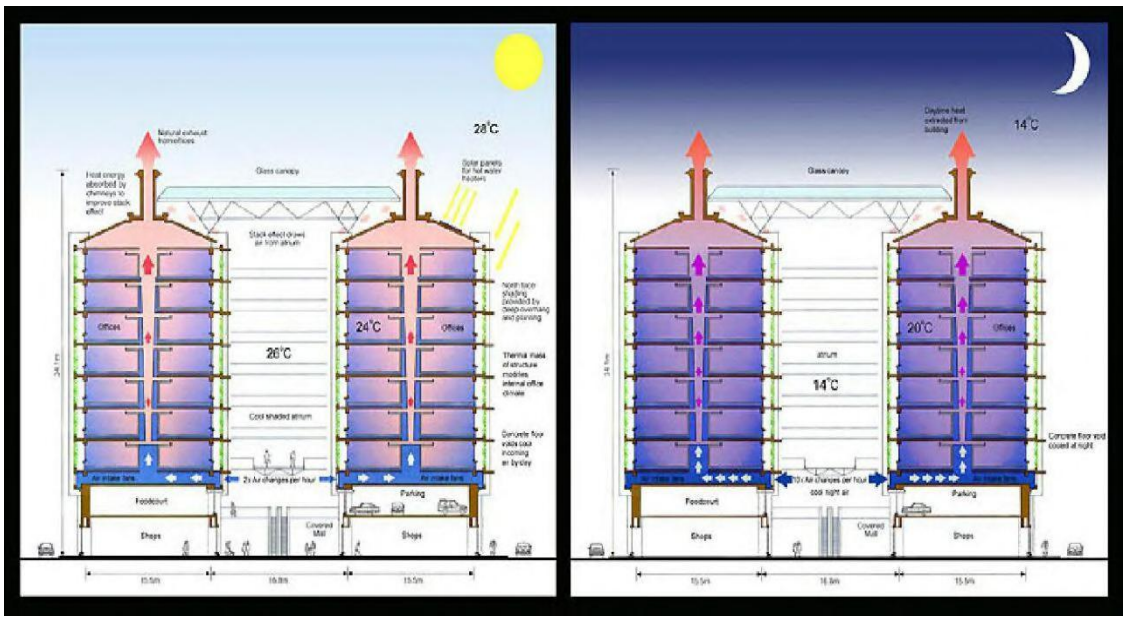
Complex.Some of the notable features of East Gate Complex are large number of small windows, massive protruding stone elements to protect the small windows from the sun but also increase the external surface area of the building to improve heat loss to space at night and minimize heat gain by day.

2.3 Working :



The East Gate Complex, largely made of concrete has a ventilation system that operates in a similar way. Outside air that is drawn in is either warmed or cooled by the building mass depending on which is hotter, the building concrete or the air. It is then vented into the building floors and offices before exiting via the chimney at the top. The complex also consists of two buildings side by side that are separated by an open space that is covered by glass and opens to the local breezes .



Air is continuously drawn from this open space by fans on the first floor. It is then pushed up through the vertical supply section of ducts that are located in the central spine of each of the two buildings. The fresh air replaces stale air that rises and exits through exhaust ports in the ceilings of each floor. Ultimately it enters the exhaust section of the vertical ducts before it is flushed out of the building through chimneys.

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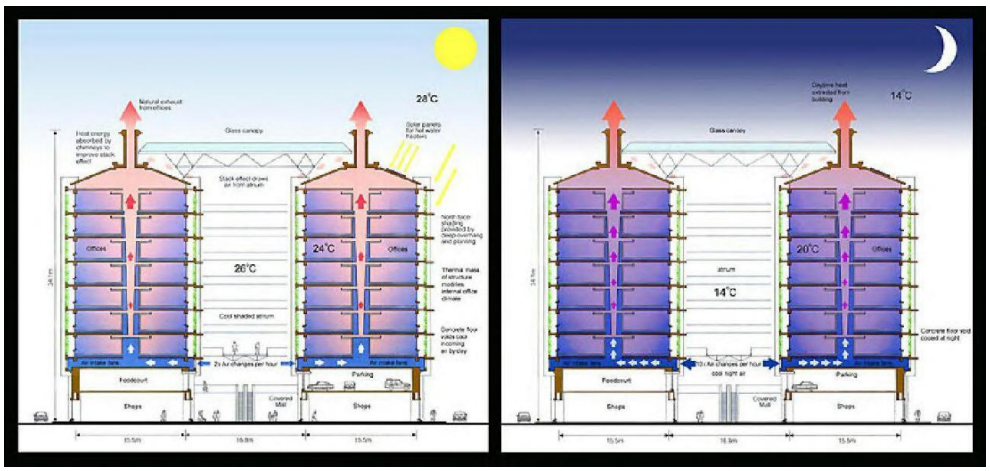
III. LOTUSAN PAINTS

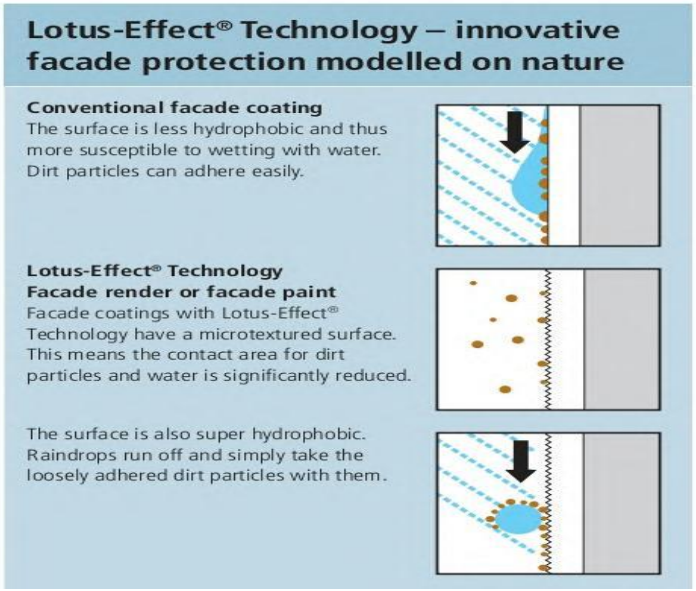


Lotusan is a biomimetic paint and coating product based on the Lotus effect, discovered in the 1970s by German Botanist Prof. WillhemBarthlott. By using the (at the time) recently developed Scanning Electron microscope technology he systematically studied surface structures of plants on a nanoscale for the academic research. Thereby the Professor discovered the self cleaning properties of super-hydrophobic hierarchically structured plant surfaces.

3.1 Inspiration :

When it rains, Nelumbo Lotus leaves shed water droplets, dirt and other particles with the help of micro and nano scale surface structures and gravity. This "Lotus Effect" is created by multi scaled, waxy bumps on the leaf surface that causes water to bead up; and roll away. Unlike the exterior paints that become soiled over time, Lotus an's self-cleaning property makes it low maintenance and long lasting coating for exterior applications.

3.2 Working :



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StoCorp. , a Georgia based manufacturer of building materials, duplicated this effect in the S to coat Lotus an self-cleaning paint. The acrylic paint has a similar micro texture to the lotus leaf; it too sheds water and dirt, leaving a dry , clean surface on which algae and fungi have difficulty colonising. Lotus an materials , such as the surface layer of the pitcher plant, wick water into microscopic ridges, creating super slick surfaces. This concept inspires anti-fouling surfaces such as (SLIPS) Slippery Liquid Infused Porous Surfaces and super wicking surfaces for indirect evaporative cooling. Similarly, Sharked mimics the scale of shark skin to repel bacteria. In addition to the excellent buildings physical properties, lotus an facade paints and renders also incorporate the unique lotus effect. The lotus effect ensures that beautiful facades remain beautiful for longer.

IV. CONCLUSION

Application of biomimicry principles in architectural designs can become a reality by exploring the practical ways of implementations. Biomimicry can be assumed as a realisation design tool for an architectural design solutions. There is need to explore how the theories on Biomimicry can be implemented and used in the design processes in the architectural disciplines.The paper highlights two cases under successful applications of Biomimicry in the infrastructure field. Further exploration needs to be put on to reveal the marvels of nature that may inspire cost, material and energy efficient structures which are of prime concern in today's exponentially growing population and their demands.

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