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ScienceDirect

Procedia - Social and Behavioral Sciences 179 (2015) 154 – 164

Procedia
Social and Behavioral Sciences

International Conference Green Architecture for Sustainable Living and Environment (GASLE), 29 November 2014

On architecture and energy: the concept of (generating) form through adaptation

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Abstract

Sustainability means different things to different people but it signals an important direction for current architecture, namely that green technologies are there to serve society and its development. Within sustainability there resides the dominant theme of energy efficiency through mitigation and adaptation. But there are other drivers such as social cohesion and economic growth. This balance makes the delivery of sustainable development important. Architecture and energy is the initial way to understand how green concept iterated in built environment. As a part of design strategy in architecture, this paper tries to define the process of generating form in adaptive indigenous ways through a descriptive method using case studies of exemplary buildings.
It addresses the past, present, and future of systems that manage energy in the built environment. It is also intended to provoke a reconsideration of the connections between style, performance, and design.

Peer-review under responsibility of Department of Architecture, Faculty of Civil Engineering and Planning,Institut Teknologi Sepuluh Nopember (ITS).

Keywords:theory; architecture; energy, green design

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Peer-review under responsibility of Department of Architecture, Faculty of Civil Engineering and Planning,Institut Teknologi Sepuluh Nopember (ITS).
doi:10.1016/j.sbspro.2015.02.418

1. Introduction

In the eyes of common beholders, buildings as architectural designs are nothing more than frozen forms in their given space. The natural aspects that surround them, however, are permutable as a mechanism to achieve an ecosystem equilibrium. At least, that is what we would like to believe: the consistency of ecosystem equilibrium. Unfortunately, the last two decades have proven otherwise. The balance of nature, or an equilibrium in ecosystem has become an elusive concept. The usual mechanism of nature in stabilizing its opposing aspects has been disrupted by an unprecedented human intervention through the excessive combustion of fossil fuel, from which has triggered what is now commonly known as global climate change. This is a compelling condition that calls for an adaptive paradigm in the way we live our lives, including the way we design and develop our dwellings.

Thankfully, such an adaptive paradigm can be adopted from the adaptive traits of organisms—such as human beings, animals, and plants; all of which have the ability to adapt to their ever-challenging environments in order to survive through acclimatizing themselves or accomplishing homeostasis within their metabolic system as an adaptation to their environments. For instance, humans perspire and urinate to maintain optimum corporal temperature in response to external temperature changes. Similarly, animals and plants have their own mechanisms to preserve their most-favorable vigor in different external conditions: dogs are panting and breathing with open mouth to let cool air in, trees in tropical rainforests grow a lot of leaves in order to collect sunlight as a source of energy for their metabolism, cacti absorb water from their roots and hold the water in their stems before using it efficiently, or some plants develop special stems that act like funnels to draw more water or oxygen to their roots. Some of these adaptive traits of organism are applicable in designing and developing buildings, as long as they can accommodate physical human use and human sensibilities. For instance, it is not sensible to build a house that can perspire externally to cool the interior, but it is sensible and applicable to utilize the laws of thermodynamics to flow favorable air inside and drive unfavorable air out.

Adaptive traits are vital to ensure the survival and success of organisms, and so is true for our buildings: an adaptive paradigm is a prerequisite for any building design. Hence, the adoption of an adaptive paradigm requires its incorporation into the form and pattern language of an architectural design, in which a favorable form language should be able to shape a favorable pattern language. For instance, a house with excellent air flow system should be able to minimize or even eliminate the necessity to use an electrical air conditioning system which contribute the largest to energy consumption of typical houses in tropical countries; hence, energy conservation can be obtained.

2. Research theory

Fernández-Galiano (2000) in his book *Fire and Memory: On Architecture and Energy* stated that there are several important matters on the concept of architecture and energy conservation in a building. First, the correlation between built form and design with energy consumption pattern. Second, how energy is transformed into a building through the implementation of photovoltaic panels on the exterior of a building. And third, how the analogy of natural ecosystem can inspire the concept of architecture and energy conservation in a building. He emphasized on the comprehension and implementation of the laws of thermodynamics through several cases of exemplary buildings.

Thermodynamics is closely related to the law of energy and system mechanics in physics. Principally, the concept of thermodynamics elaborates on the process of form change or energy exchange. The law of conservation of energy (the first law of thermodynamics) states, “Energy can be converted from one form into another, but it cannot be created or destroyed.” And this is the theoretical ground for Fernández-Galiano to elaborate on the mechanism of energy conservation in a building.

The law of thermodynamics in his viewpoint is proposed through an analogy of building exterior as the insulation of a system. The exterior can transform and/or conserve energy. It is an interesting concept due to its similarity to the function of skin on organisms. The natural mechanism of energy exchange through the regulation of body temperature by the means of the outer cover of organisms (*i.e.* skin). But it does not explain how entropy as a consequence of the implementation of the laws of thermodynamics on building exterior can ensure the efficiency and efficacy of energy conservation on a building system, which principally is embedded in an open system.

Furthermore, Fernández-Galianodelved into theses from Vitruvius up to Le Corbusier, and distilled them into a paradigm of thermal space in architecture. Within the context of his book, he proposed that there is a symbiosis mutualism between architecture and energy by means of building materials being used. Energy is generated through