Biomimicry, S.PSS and DRE: Designerly Strategies to Reduce the Knowledge Gap between Design and Nature

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Abstract. Issues of clean and safe sustainable renewable energy are pertinent. It becomes even more relevant when addressing these issues to undergraduate product design students. As design students are frequently exposed to sustainability by means of theoretical concepts such as Biomimicry, they often fail to correlate their bio-inspired concepts against nature’s genius. Design students also face complex conceptual challenges when designing for sustainability. We’ve added sustainable product service systems applied to distributed renewable energy to the synthesis of a design course at a HEI in South Africa and we unpack some of our findings in this paper.

Introduction

Changing climates, unexpected weather patterns and environmental stressors are some of the key energy shifters in the Design for Sustainability research field. In this paper we turn our gaze to Biomimicry and the study of nature’s resilience to sustain life for over 3.8 billion years. While focusing on the challenges and demands of todays lived environment, we recognise that there is a great demand for clean and safe renewable energy, especially within the low-income market sectors. This paper takes a fresh perspective on how theoretical concepts such as Biomimicry, sustainable product service systems and distributed renewable energy informed the design process of a student group who developed a safe fire prevention stove for informal settlements in Cape Town, South Africa which uses natural waste products as fuel.

Background to Research

In recent years, the societal role of the product designer has been under crossfire from design writers such as Victor Papanek in his book Design for the Real World who famously explains how product designers are the cause of the worlds’ changing climate, and that to save the world; one should get rid of designers [1]. A few pages later in the same book, Victor elevates a sense of hope by explaining that through smart and critical design exercise, designers could heal the world from its bad design practice [1]. With the current research debates in designing for sustainability, the topic of carbon emissions, consumerism and product ownership speaks to the designer’s role in combating climate change [2]. More recently, environmental movements in design have given rise to academic debates around sustainability, cleaner energy resources and the investigation into renewable energy [2, 3].

The increasing trend to unpack and discover the secrets of Designing for Sustainability (DfS) has provided researchers with three plausible study themes: 1) Biomimicry 2) Sustainable Product Service Systems (S.PSS) and 3) Distributed Renewable Energy (DRE). Honing in on Biomimicry, this area of study focuses on the ability to learn from nature [4]. Biomimicry recognises that nature has the blueprint to sustainability as it is nature who has sustained 3.8 billion years of life on earth through various climate changes and environmental stresses on the lived environment [5]. Examples can be drawn from organisms or natural occurrences such as a leaf’s ability to efficiently optimize the rays of the sun, and how the abduction of this process could improve solar cell efficiency through studying nature’s genius [6]. Unfortunately the practice of Biomimicry does not always yield uninspired product solutions from the natural world, and often result in superficial bio-inspired solutions which copies nature without any critical design thought behind the solution [7].
As a response to this praxis of Biomimicry, this research paper aims to unpack and analyse the understanding of Biomimicry applied to renewable energy solutions within complex systems designs.

The aim of the research has guided us to investigate Biomimicry within a Higher Educational Institution (HEI) in Cape Town, South Africa. At this HEI, the practice of the product design course introduces Biomimicry to undergraduate students. After analysing the students’ work, we found that the knowledge gap between design and nature often resulted in superficial Bio-inspired design concepts. These observations underpinned the problem area that we’ve identified as there was no clear understanding of an organism, the natural processes associated with the organism and the organism’s position within a larger eco-system, from the students. Additionally, biomimicry was of the few design theories taught at undergraduate level on the subject of DfS. However, within the existing course framework, an opportunity came to expand on the theoretical approaches of DfS through the inclusion of S.PSS and DRE into the curriculum of the product design course.

Following this problem area, we’ve made a hypothesis that the students lacked critical design decision making skills, and that the understanding of Biomimicry could inform these decisions while students go through their design process. Thus, our statement on this study is that Biomimicry is a theoretical approach that informs critical design decisions.

Therefore our research question responds to this statement by asking: “How would a theoretical approach such as Biomimicry inform critical design decisions when it is applied to S.PSS and DRE?”

Methods

We leveraged on the opportunity to incorporate S.PSS and DRE in unpacking DfS for the first time at the HEI. An 8 week course was drawn up to form part of a larger LeNSes research project at the HEI. LeNSes is an acronym for the Learning Network on Sustainable Energy Systems which is targeted against the European Union’s Sustainable Development Goal (SDG): Clean Energy for ALL. The course gave a brief introduction to the concepts of sustainable product service systems in relation to distributed renewable energy as well as an in-depth theoretical take on Biomimicry. The scaffolding around S.PSS is built upon the product ownership of the company who manufactures and maintains the product so that customers can make use of the company’s provided services without having to own the product [8]. This reduces the demand of product ownership and offers potential business opportunities in low-income market sectors as the client only pays a reduced amount to use/rent the product [9]. Applying this model to DRE the value offering increases as low-income market sectors can now afford renewable energy product solutions and services ranging from solar lights, solar cooking stoves to solar powered televisions or refrigerators on a pay-per-use or pay-per-hour or pay-per-day business model [10].

The capacity building in DfS seemed to have growing potential for the design students. However, SPSS and DRE are not conducive to offer design skills in product design, and therefore we’ve introduced Biomimicry to support the design work of the students. Part of the course required a field trip to the local botanical garden where a biologist informed the students of the various plant species’ strategies to survive and thrive in the natural environment. The cross-disciplinary exercise yielded a positive response from the design students who studied the plant species under magnifying glass.

The out-of-classroom situated learning space [11] offered design students first-hand experience with the natural world and understanding organism, processes and eco-systems; in so doing, drawing design and nature closer together.

Case Study

Returning to class-based studio learning after the field trip, one student group was tasked to identify energy opportunities in an urban settlement within Cape Town, South Africa as part of their design brief. The group had to design a product solution which incorporates Biomimicry and answers the local setting’s demand for DRE through applying S.PSS in the final designed solution.
The student group presented their work in oral format and explained, through contextual imagery as visual aids, their observations about their identified site. The site location was in informal settlement with houses less than 30cm apart from each other. Fire hazards were a concern and the group chose this as a focus area of their project. Due to a high risk of paraffin stoves tipping over during use and causing widespread fires in the settlement, the group decided to redesign the cooking stove. The DRE requirement of their brief required of them to seek potential renewable energy solutions in the informal settlement. The current state in the settlement required waste management to be operated on the bucket system. The group identified ways to use the waste products as fuel in their attempt to find sustainable renewable energy solutions.

During the product’s redesign, the group revisited their experiences of the botanical garden to understand how the strelizia flower sustains its reproduction. The flower has a ‘landing pad’ which expose pollen once a bird lands on the extruding ‘spike-like’ structure. The pollen is only exposed once the structure has weight added on top of it, and protects the pollen once the weight is removed by closing. By understanding this natural process, the student group abducted design concepts from the flower to redesign the valve unit of the gas stove by using a Biomimicry approach called Challenge to Biology [4].

Figure 1. Learning from nature.

Figure 2. Challenge to biology.
The concept solution required gas to be processed from a methane digester which would be located near the informal settlement with a canisters refuelling station where a local entrepreneur rents filled canisters to customers on a rent-per-use basis. The S.PSS model makes the concept viable for low-income settlements as the business value provides the waste-fuel to the customer at less monetary cost than the existing paraffin fuel.

The final design draws inspiration from nature’s champion, the *strelizia flower*, with a valve that works on a pressure plate. Once a pot is introduced to the pressure plate, the weight opens a spring valve which releases cooking gas for domestic use. This safety feature of the design prevents shack fires as soon as the pot is removed, or the entire gas stove capsize during use, the spring valve closes the gas outlet to protect the end-user from the risk of open flames during cooking.

**Summary**

This paper unpacked how Biomimicry was used as an approach to inform design decisions applied to S.PSS and DRE. A case study was used to indicate how a group of students understood the survival strategy of the *strelizia flower* and used their knowledge about nature to inform their group’s design decisions during the design process. We have found that the design knowledge gap between design and nature was decreased through Biomimicry and that applying Biomimicry to S.PSS and DRE requirements yielded in a product solution that relies on renewable waste fuels as well as tackle some of the wicked problems found in the socio-economic environment of a particular low-income sector in Cape Town, South Africa.

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References


