

THE APPLICATION OF BIO-INSPIRATION TO HUMAN-CENTERED PRODUCT DESIGN

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ABSTRACT

Biologically inspired design is an emerging practice based on the premise that nature holds a vast library of strategies, processes and technologies that can lead to innovative, sustainable solutions to human problems. Around the globe, scientific and engineering research efforts in Bio-inspiration have made astonishing discoveries that have impacted future possibilities in the fields of robotics, biomedical technology and material science, amongst many other examples. Yet, despite rising evidence about Biology's relevance to innovative design, examples demonstrating specifics about how it can be applied in the near term in consumer product design are limited. This paper presents a case study wherein Bio-inspired design was used successfully as a tool to help develop novel, viable and product concepts for a packaged-goods industry client. Specifically, emphasis will be placed on how the method of 'biologizing the problem' contributed to redefining the parameters of the challenge, which ultimately drove the project's success. After receiving a focused brief for reinventing the generally unpleasant experience of bathroom shower cleaning, the first round of creative ideation yielded incremental solutions based on the goal of 'mildew removal and extermination.' During the second round of creative ideation, after the problem had been redefined in terms of biological strategies, an entirely different set of solutions resulted from a revised goal of 'mildew prevention.' Such examples of problem redefinition can be propelled by a growing number of free databases like Asknature.org, which enable designers to find useful analogies between their design goals and Biological strategies. As these databases mature, product design efforts will be able to augment their creative output with improved results.

Keywords: bio-inspiration, bio-inspired design, biomimetics, biomimicry, consumer packaged goods, design process, design thinking, human-centered design, innovation, product design, sustainability

1 INTRODUCTION

Contemporary practices in consumer product development rely heavily on understanding current user needs by employing practices of Human Centered Design (HCD) or Design Thinking to uncover unmet opportunities for design. These methods have been popularized by innovation consultancies like IDEO and their counterparts in universities like Stanford's Hasso Plattner Institute for Design [1]. Many large multinational companies and startups have eagerly consulted with these organizations to gain a competitive edge.

Bio-inspiration and biomimetic thought leaders such as Janine Benyus' Biomimicry 3.8 Institute and others have made extensive efforts to codify a process that would help draw inspiration from Nature for the benefit of sustainable design [2]. Processes like these have been used in consultations with large multinational corporations such as Nike, Procter & Gamble, and Interface FLOR amongst many others. In the course of this paper, I will examine a project case study to discuss how bio-inspiration and HCD can be merged to create repeatable platform for developing need-based, sustainable innovation. The result is a proposal for a biology-augmented design thinking process and the necessary development partnerships needed to make it a reality.

2 SHOWER CLEANING BRIEF: INITIAL DESIGN APPROACH

In the past 5 years during which time I held a design leadership position at a product innovation consultancy, we worked for a variety of large and small clients in consumer product design: consumer electronics, kitchen tools, juvenile products and consumer packaged goods amongst other

categories. Consumer packaged goods include any substance that is used and replaced frequently: cleaning products, personal care items, cosmetics, food and beverages and so on. CPGs represent a \$2Trillion industry in the US that in the past decade has seen considerable transformation especially in the arena of home cleaning. Responding to evolving American tastes, values and demographics of the home from the 1950s to the present, companies like Proctor and Gamble have developed category defining innovations like Swiffer® and Febreze®, which have fundamentally changed behaviors about cleaning and caring for the home. Many of P&G's innovations have been viewed enviously by their competitors for creating new opportunity and growth in the marketplace. However, despite good intentions, many of these new generations of home products, like Swiffer®, have fallen short of offering improvements in environmental impact, and in many cases these products have arguably taken a step back by employing disposable rather than reusable options (Swiffer pads are thrown away after one use, whereas traditional dust mops and mops are cleanable and reusable if perhaps less convenient to use).

One client with whom we were contracted had a focus and interest in reinventing bathroom shower cleaning. For the purpose of this paper, we will refer to this client as 'TMC.' TMC's current bathroom cleaning product line was popular and sold well but they desired to 'leap frog' their competition from potential incursions in the marketplace by seeking new opportunities to reinvent the 'shower cleaning experience'. In addition to the goal of creating a highly desirable consumer experience that they could produce with their current resources profitably, TMC also sought to set benchmarks of environmental sustainability as one of the project's chief goals (Fig. 1).

To explore this brief and find suitable opportunities for design, we tailored an optimized HCD process plan to explore and develop solutions that would resonate with the people who would eventually use them. A principal component of this process was to start by understanding user needs

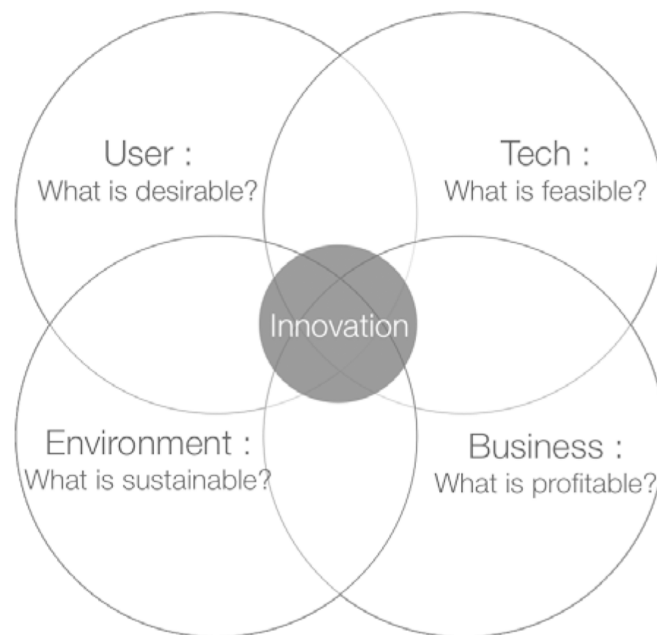


Figure 1: The four interlocking goals of TMC's shower cleaning brief.

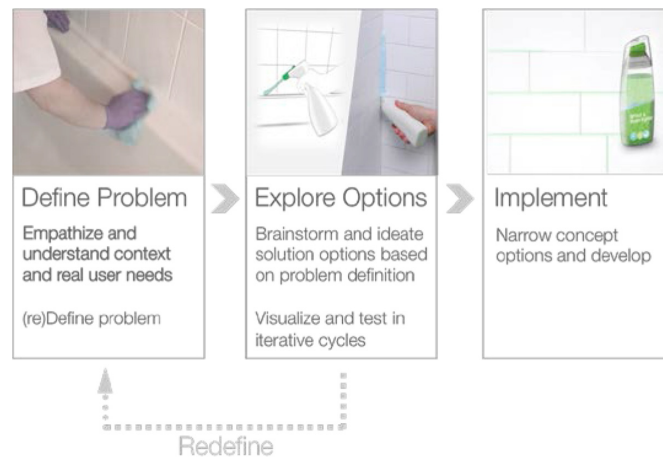


Figure 2: Basic HCD process for 'reinventing the shower cleaning experience'.

first hand by visiting and observing people's behaviors and hearing their thoughts in their own homes.

After conducting this research with 12 screened individual households, we analyzed and defined what the real issues and problems were and used this information as a basis for ideating, visualizing and testing our concept prototypes, sometimes with the same people.

We also conducted a deep analysis of current and new products on the marketplace. Overall, we discovered that current shower cleaning CPG's generally used strong acids and bleach to produce the following outcomes: (1) removal of 'soap scum', which is a residual film left behind by bathing with shampoos, soaps and bodywashes; (2) killing of germs generally perceived to be present and a nuisance to health; (3) renewal of cosmetic appearance, which includes whitening shower tile and shining chrome finishes. It should be added that many newer materials such as granite and nickel finishes that were popularized in the US during the housing boom of the early mid 2000s became trouble areas for these traditional chemistries, which often altered or damaged their appearance. At the time of the project, specialty material-specific cleaning products were being released in great numbers.

2.1 User insights

Three main insights resulted from our in-home research exercise that deserves mentioning here. Unsurprisingly, consumers were looking for ways to reduce the physical effort involved with scrubbing a shower to make it clean. They were also looking for ways to avoid noxious fumes associated with the cleaning formulas, and which could seldom be avoided in the close confinement of a bathroom even with the windows open. Another common grievance was that bathroom showers were breeding grounds for mildew, especially in the humid eastern regions of the United States, which would manifest itself as unsightly black marks on white grout.

Frequently, only heavy amounts of tedious hands-on scrubbing seemed to remove the black mildew stains. Similarly, using traditional strong sprays and formulas seemed to produce limited improvement. In some extreme cases, we found that users would either re-grout or replace their shower tile altogether when they were renovating their bathrooms.



Figure 3: Shower tile with grout mildew stains.

2.2 Concept ideation

These insights along with TMC's knowledge of chemistry served to drive many of our concept ideation brainstorming sessions. Priorities focused on cleaning power and frequently ideation sessions would begin with questions like 'how can we focus our formulas to "exterminate" mildew?' After several rounds of brainstorming ensued, we were left with dozens of promising ideas about how to solve this issue, a leading concept emerged: to produce a strong bleach-based chemistry with a thicker, more viscous substrate, that like tooth paste or shaving cream would remain in place overnight rather quickly running down the tile wall. This would allow the active ingredient time to perform its task and 'exterminate the mildew'. This direction also appealed to the client because they principally produced sprays and had considerable intellectual property, resources and experts in spray formulations so they could leverage their in-house strengths to engineer and produce such a product.

Like many of their other products, this concept tackled the problem of grout cleaning and upkeep using a familiar approach, reminiscent of the Cradle to Cradle motto for the first Industrial Revolution: 'If Brute Force does not work then you are not using enough of it'. [3] Notwithstanding our awareness of the sustainability shortcomings of this approach, this idea, along with eight others, was prototyped to a working and esthetic level with active chemistry that had been custom formulated. An applicator for the thick spray was made alongside a visual model, which included a mock name and instructions about how to use it. The ergonomics of the bottle were designed to make application onto grout as easy as possible while protecting the user's fingers. The design of the gel itself was meticulously and iteratively developed to adhere to vertical grout surfaces overnight.

Once tested, the product was met with mixed results in real life circumstances as a 'take home' concept evaluation. While the promise of a 'mildew killer' was enormously appealing, users expressed doubts – the gel stayed in place but also had to be cleaned up the following morning. It was easy to forget about and users worried someone would touch the harsh chemistry by accident in

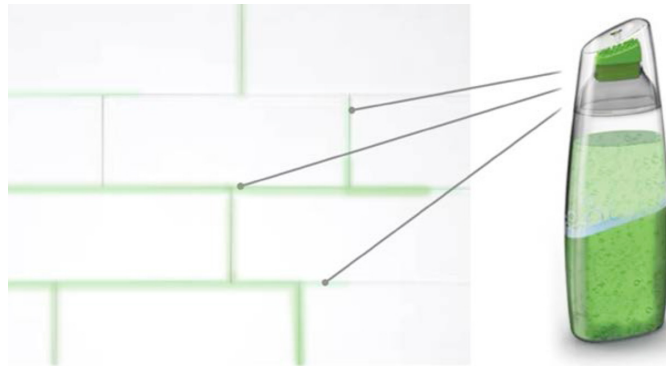


Figure 4: Illustration of an overnight mildew exterminating gel prototyped for in home testing.

the shower. This was not fatal flaw but enough of a setback to consider other possibilities. In essence, we decided to reconsider the approach to tackling the problem.

3 SHOWER CLEANING BRIEF: BIO-INSPIRED DESIGN APPROACH

Somewhat fortuitously, about the same time we had heard the feedback about the ‘mildew killer’ we had the opportunity to work with a part time in-house mechanical engineer who had some expertise and interest in Bio-Inspiration and Biomimetics. None of the core design team had any experience with the subject so we asked her, as an experiment, to host a bio-inspired brainstorm based on the user needs we had uncovered previously. Coming from a workshop hosted by the Biomimicry 3.8 Institute, she proposed an interesting question at the outset of our first brainstorm: ‘Instead of thinking about how to “exterminate mildew” how would nature approach this problem?’ This question was intriguing but produced many similar results, based on venomous creatures found in nature. The goal of ‘killing mildew’ persisted. Later in the day, a significant shift in our approach to the problem occurred. After being introduced to the Asknature.org database [4], we discovered Lotus leaves, which apparently deter water from congregating on them based on a hydrophobic microscopic texture. As a result, we immediately reframed our challenge in similar terms: How might we prevent mildew from arriving in the first place rather than exterminating it once it grows? This act of ‘biologizing the problem’ [5] or thinking how nature might approach a problem such as ours provided a clean slate of opportunity and marked a significant step for the project moving forward. From that point on, our focus evolved to conceiving solutions for ‘ridding moisture’ from the shower rather than ‘killing mildew’ on grout.

One key concept that emerged from this second round of brainstorming was a hydrophobic coating that could be applied to grout and tile without altering the shower’s appearance and which would last for at least a few weeks so that it was less effort use than cleaning the grout routinely by hand. The client and team were hugely excited about the prospect of this concept, but the search for a hydrophobic coating that would cause water to bead and disperse from grout proved to be a challenge. Biology had supplied a model for approaching the problem in a fresh way but even at a large CPG company with an army of chemists, there were no known formulas that could produce the desired results. It is also worth noting that producing a hydrophilic grout and tile would be a great opportunity for building products manufacturer but for TMC’s distribution channels and core competencies, this path would have not suited their business goals of remaining in this knowledge area of spray formulations.

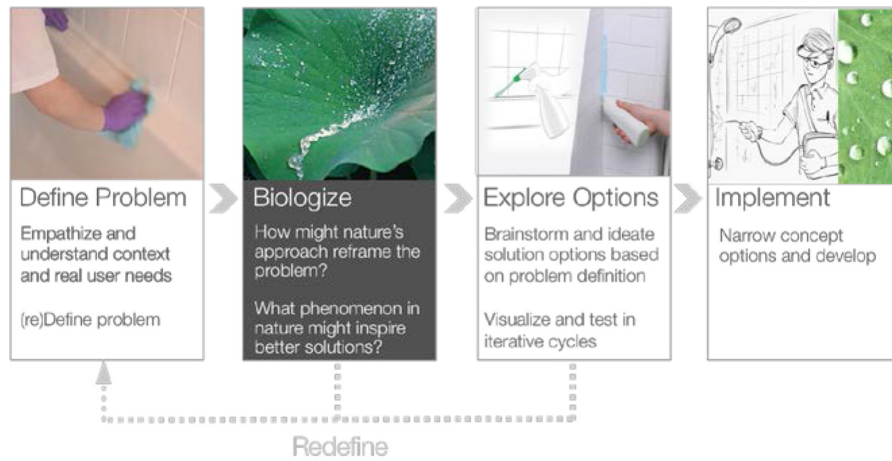


Figure 5: Overview of the Human Centered Design process with the added step of 'Biologizing'.



Figure 6: Stylized illustration of hydrophobic 'Liquid Slip' spray for ridding excess water build up in the shower.

At this stage, TMC's development team elected to retain a technology research agency called RTI [6] to help support this endeavor. After a month of investigation, RTI found a German company that produced a hydrophobic chemical spray, which we informally referred to as 'Liquid Slip'. Similar to a US product called RainX, which helps disperse rainwater from car windshields, TMC explored a relationship to license or possibly purchase the 'Liquid Slip' chemistry technology outright for this application. Later on, the partnership agreement dissolved and eventually the hydrophobic spray concept was shelved.

3.1 Hindsight

While it was certainly disappointing that the ‘Liquid Slip’ treatment did not proceed into development (although it is unknown what the status of the project is now), it is undeniable that the Bio-Inspired techniques improved our design process and delivered superior concepts for keeping grout clean in the bathroom shower. On the other hand, that the chemistry did not fulfill the project’s sustainability goals by achieving biodegradability comparable to a Lotus leaf was also disappointing. Looking forward to future projects like this one, it is important to document that additional steps need to be made to support the development of Bio-Inspired concepts in order for them to succeed in the marketplace in the near term future.

4 CONCLUSION: A NEED FOR A BIO-INSPIRED ENGINEERING CENTER

Interest in the potential of Bio-Inspired Design is steadily growing and promises to produce significant sustainable impact in coming decades. At present, Bio-inspired design activity in the US is predominantly conducted in the realm of University academic research and with endowed research centers like the Wyss Institute at Harvard [7] and the San Diego Zoo Centre for Bioinspiration [8]. These institutions are producing significant discoveries much the way Bell Labs and Xerox PARC did in their prime. In these centers, Biological phenomenon is being studied and analyzed for their potential to be engineered and adapted to commercial applications.

The important question to ask moving forward is how can the promise of Bio-Inspired Design be made available to support near term industry projects similar to the case study discussed in this paper? The Biomimicry 3.8 Institute has provided much support by offering valuable consultation to large companies in process, but does not provide the implementation know-how to carry a need-driven design solution to a market-ready state. In the product development case of mildew prevention, taking a concept to an implementable solution faces many challenges, principally because companies like TMC do not often have the combination of Life Scientists and Bioengineering expertise on the payroll to develop and execute a market-ready solution. As such, willing product development companies need access Bio-Inspired Engineering support to realize projects like these. While Bio-Inspired HCD processes can guide the development of exciting concepts, dedicated resources in Biology and Bio-Engineering are essential for ensuring concepts such as ‘Liquid Slips’ will be able to be produced and make an impact.

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