Biophilia

Design for poly-sensorial biophilic experience by Tibor Antony

Doctoral research:	Application of Microalgae in the Context of Industrial Design
Realization:	2014 — 2019
Researcher:	Mgr. art. Tibor Antony, ArtD.
Research supervisor:	Prof. Peter Paliatka
Text:	Michala Lipková

Second generation of Spirulina
Lamp working prototype

As a part of ongoing experimental design research initiated within Tibor Antony's dissertation project, Spirulina Lamp #2, focuses on implementing microalgae into urban interior objects. Spirulina is an organism with multifunctional properties, holistically contributing to people's well-being indoors — especially when considering the oxygen cycle, introducing natural greenery, food, and light.

The project aims to increase the interior artifact efficiency by utilizing the multiple functions that microalgae provide, ranging from the greatest nutritional impact with a low environmental blueprint to creating a poly-sensorial biophilic experience through an integrated indoor object design. The product's essential part is its internal polyfunctional component; it underwent three distinct stages and gave birth to two patents.

Through this case study of designing for nourishing polyfunctionality, Tibor Antony offers a new look at the role of industrial design in the reality of accelerating climate crisis: the creation of new sustainable lifestyle scenarios.

Today's increasing trend of home-office lifestyles and people's rapid migration to cities causes urban inhabitants to spend around 90 percent of their time indoors, with 66.6 percent of this time spent in their homes (Dimosthenis, 2013). Antony (2022) points out the entanglement of worldwide high-impact food production problem in the following way:

"According to OECD, in 2050, 70 percent of the world's population will live in urban areas (Kitamori, 2012). An expected increase in the total global population to ten billion by the same year will create extra demand for food by 69 percent compared to the current state (Raganathan, 2013). Agriculture is responsible for 70 percent of water use among other sectors (industry, households), and it takes up 37 percent of agricultural land. Based on a study by the European Commission, meat and dietary production has an increasingly higher energy consumption (Monforti et al., 2015). Reducing the footprint requires a rapid dietary shift toward vegetarian and vegan foods. Some possible alternatives are synthetic meat, insect-based diets, and microalgae proteins. When we look at the energy embedded in food, around 74 percent is consumed during its processing, distribution, packaging, and cooking" (Antony, 2022, 81).

How might we achieve the required drastic reduction of goods and services consumed per person? In his text, Antony suggests addressing the need to consume and produce less with a new approach to industrial design, represented by the Spirulina Lamp case study. Antony introduces the notions of 'nourishing polyfunctionality' and 'elemental richness' as necessary characteristics of all future appliances, quoting Lance Hosey:

"If we could dramatically improve the effect that every physical thing has on our quality of life, we'd surely end up with fewer things. Environments large and small, public and private, would be shaped by neither excess nor scarcity but, instead, by a kind of elemental richness where everything is more fruitful and fulfilling" (Hosey, 2012, 98).

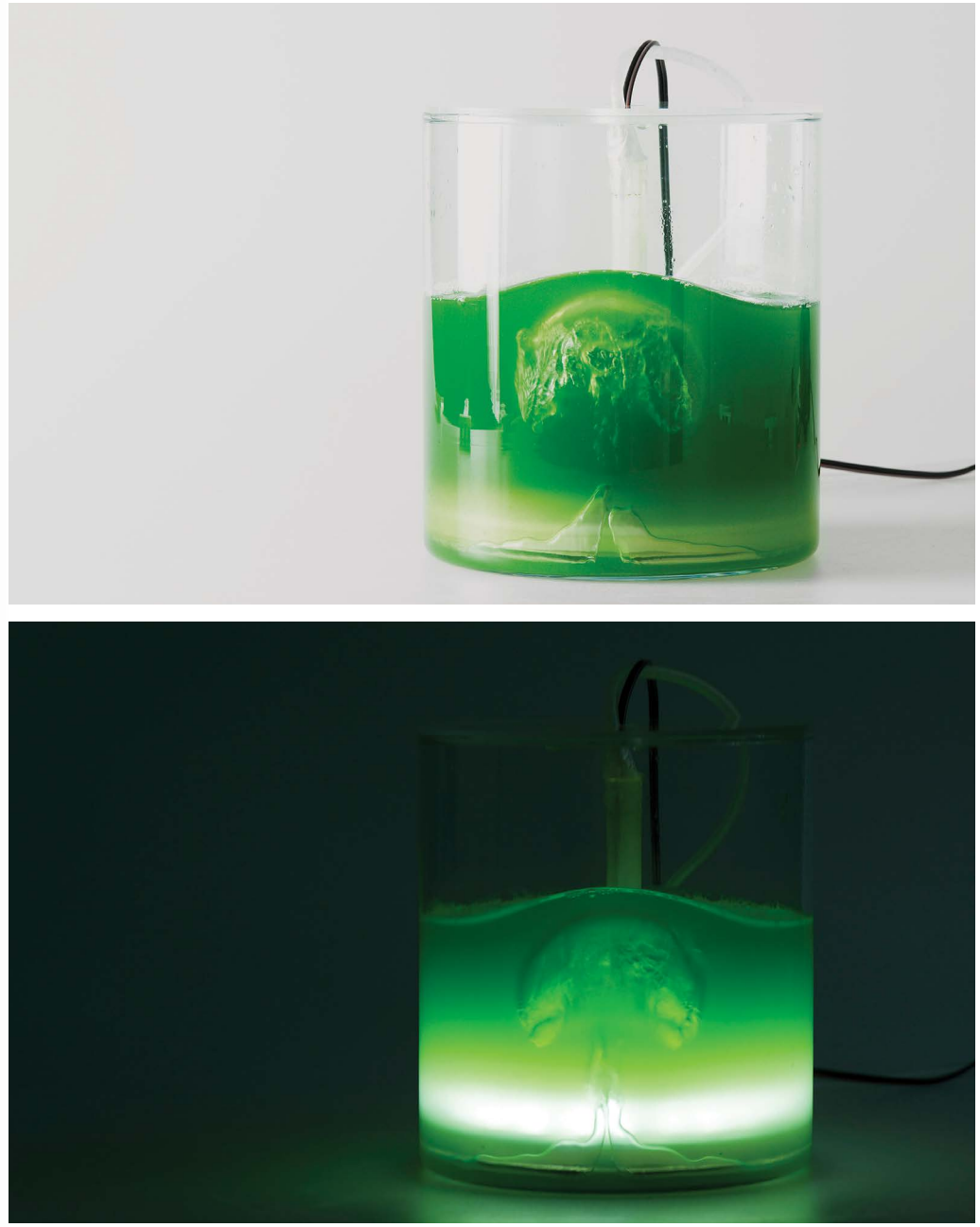
Designing to achieve 'polyfunctional qualities' of the product forms the conceptual basis for Antony's case study. He formulates his research hypothesis as follows:

"Design for Environmental Sustainability should not only be concerned with problems such as emissions reductions, energy efficiency, and material recyclability. The so-called 'Eco-Design' should purposely seek solutions with healthy and positive benefits for human beings and the ecosystems surrounding them. Such a strategy's implied richness and abundance can be achieved by integrating living systems into an industrially made artifact, taking advantage of polyfunctional quality" (Antony, 2022, 84).

Indoor microalgae cultivation was chosen as the research subject due to its holistic contributions to a healthier indoor environment. The choice was mainly influenced by Spirulina's synergistic potential to 1) provide healthy food, 2) provide natural greenery, 3) facilitate oxygen generation, and 4) CO_2 absorption, and at the same time, provide the opportunities to interact with 5) light and 6) living acoustics. Having the highest nutrient density of plants, allowing them to achieve the greatest nutritional impact with the least volume, Spirulina meets the requirements for future environmentally friendly food production. According to Antony (2022), the project focuses on local, indoor Spirulina cultivation for personal consumption with no need for logistics or packaging.

So far, produced for human nutrition almost exclusively on an industrial scale in a cultivator, container, or a reservoir (so-called 'photobioreactor'), Spirulina's cultivation process requires access to light (for the photosynthetic process to occur), mechanical agitation of water mass, maintenance of a specific temperature spectrum, and addition of dosages of a nutrient medium, influencing its nutritional quality and speed of growth.

Except for the few ongoing attempts (LillyBot 2.0, Spirugrow, Spirawline) to create a domestic appliance for Spirulina cultivation, mapped by Antony, there has been no successful example of introducing a home appliance with this purpose on the market so far. Commercial cultivators active on a factory scale are focused on the productivity and quantity of food without taking advantage of other enriching aspects of microalgae and their capacities for the individual or the community.



One of the working prototypes of Spirulina Lamp's integrated core mechanism, demonstrating the creation of air bubbles at the bottom of the reactor

First two from the top: 3D prints of different air agitators for the first generation of Spirulina Lamp prototype

Bottom: A dimmer and a 3D printed cover working as a light diffuser

“The product is conceived as a sophisticated interior lighting device enabling Spirulina cultivation in a domestic or commercial environment. The product’s basic value remains identical — direct consumption of fresh Spirulina at home without intermediaries. The light is not only used for photosynthesis; its part is released into a room.”

After exploring different design concepts (Oxygenic wall, Microalgae curtain, Spirulina Lamp, Dining table, Meditation cultivator), Antony decided to proceed with the design concept of an indoor multifunctional lamp, which seemed to have the simplest construction and allowed for a straightforward manufacturing process with a limited budget. The product development began with the first step of developing the device’s inner structure.

Before initiating the lamp’s design, Antony conducted experiments, allowing him to gain real-world experience with Spirulina cultivation. Antony states that experiments carried out during the design and prototyping phases are presented as a synthesis of three disciplines: Chemistry, Phycology, and Design. The realization of four prototypes of the inner photobioreactors aiming to verify the working mechanism has led to the creation of specific knowledge, successfully filed for a patent registration procedure (Patent Nr. SK288927B6, titled “Multifunctional Component Designed for Agitation of Microalgae Cultures in Photobioreactors,” registered at the Industrial Property Office of the Slovak Republic). In his research paper, Antony provides the following simplified description of the solution:

“The component transfers heat from a LED chip to the water mass in close surroundings. Therefore, it acts primarily as a heater for the microalgae culture and presents a light source for the photosynthetic process. Besides these two functions, the component helps with the bio-culture’s agitation through the air bubble release cycle. It also prevents biomass sedimentation at the vessel’s bottom” (Antony, 2022, 85).

The development of the internal mechanism concluded with the execution of the final prototype — the first generation of the Spirulina Lamp. The lamp’s integrated core component is the essential part of the product and enables its complex functionality: internal illumination of the Spirulina culture; secondly, it works as a heater for the culture by dissipating heat from the installed LED chip; and thirdly, it provides the culture with mechanical agitation by producing bubbles at the vessel’s bottom. The author describes the prototype as follows:

“The product is conceived as a sophisticated interior lighting device enabling Spirulina cultivation in a domestic or commercial environment. The product’s basic value remains identical — direct consumption of fresh Spirulina at home without intermediaries. The light is not only used for photosynthesis; its part is released into a room. Such function of complementary room illumination transforms the object into an integrated addition to the living space” (Antony, 2022, 87).

Antony quotes Victor Papanek (1995) on the biophilia thesis, which, in his words, “states that our biological systems feel a sense of satisfaction when exposed to actual natural greenery, seasonal cycles, fresh air, or daily light.” The Spirulina Lamp aims to support our innate tendency to seek connections with nature by exposing the natural elements (the Spirulina biomass) through translucent glass and light. The dynamic and visually stimulating green ‘scenery’ inside the reactor vessel and the rhythmic stream of air circulation can resemble actual greenery.

The first generation of the functional Spirulina Lamp prototype informed the following second generation, constructed already as a part of the follow-up start-up project after the successful defense of the doctoral thesis. The redesign included a new approach to the solution of the internal patented part: the second generation of the core experimented with a spiral motion of the water mass and integrated air-lift pipe for biomass harvesting. The third stage was focused on simplicity and combined the best from the first two prototypes: i) spiral motion, ii) LED heating, and iii) gravitational harvesting. From the form factor perspective, the second generation’s main vessel prototype has a more vertical form, and it is placed on a vertical stand (or a “leg”) working as a support for the reactor, enabling easy access (height) to the harvesting dish and makes the whole product completely independent of the room furnishings.

The author concludes the paper published in The International Journal of Designed Objects with thoughts on the project’s overall impact:

“Integrating a living organism into a human-made object presented a promising path toward creating richness and abundance in a product. The objective was to achieve at least some of the efficiency and polyfunctionality of natural structures. Such a method seemed applicable to any product type in the context of an urban interior. However, a detailed examination of Spirulina and other microalgae proved that every living system has its own properties and makes a specific, individual contribution to human beings and the environment. It meant that integrating microalgae into any interior or product is not universal unless there is a strong connection between the product’s function and the living system’s biomechanics. (...) Experimental design with the ambition to create a new type of lamp presents one of the ways of bringing this biotechnology closer to humans” (Antony, 2022).

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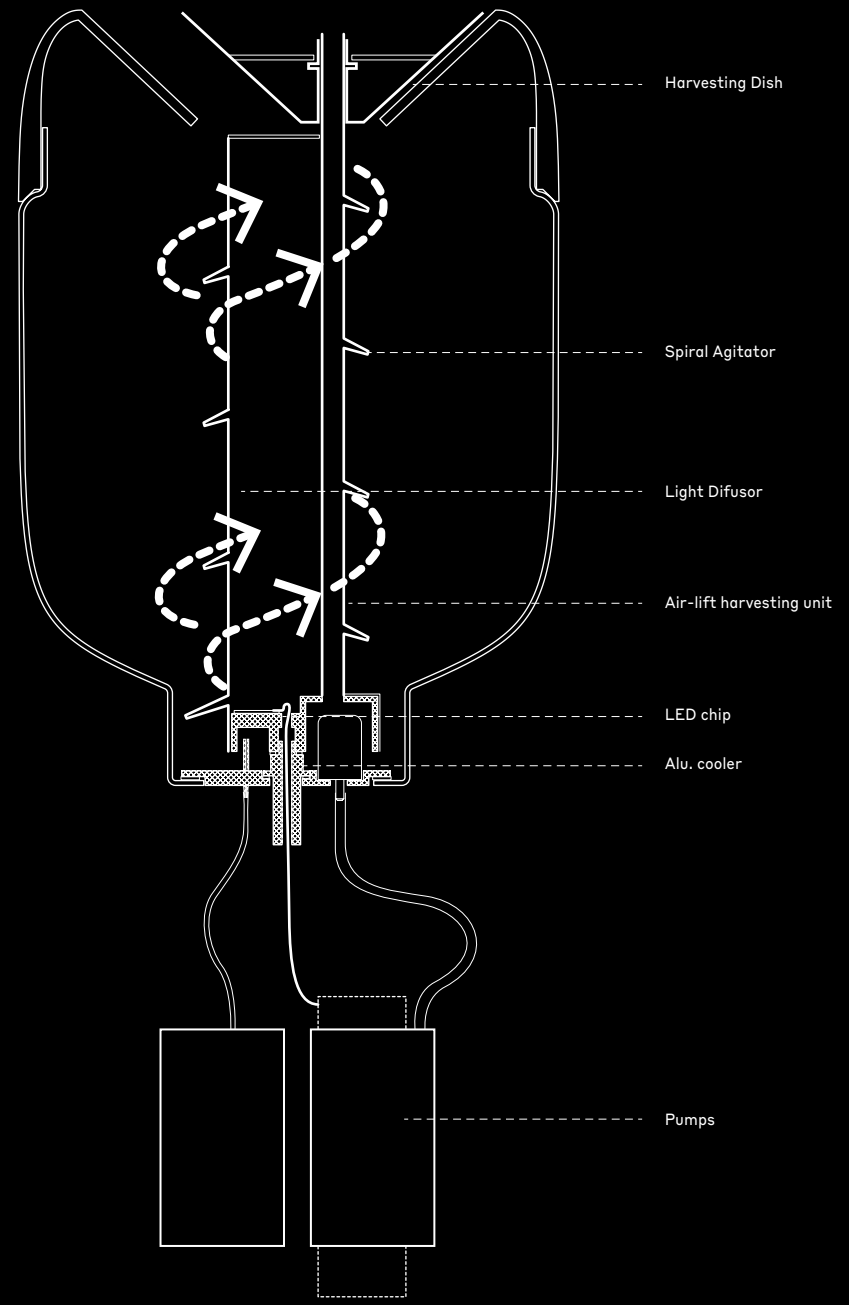
After working for several years in industrial design, Tibor Antony currently works as an Assistant Professor at the Institute of Design at the Slovak University of Technology in Bratislava. He has co-founded the start-up Living Elements, dedicated to applying microalgae biotechnology to the consumer market. He is the author of 2 patents.

Technical drawing of the second Spilurila Lamp prototype, illustrating the spiral motion of the integrated core element



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Publication

Michala Lipková: Prototyping Change
Doctoral design research projects
at FAD STU in Bratislava

Publisher:
Faculty of Architecture and Design,
Slovak University of Technology
SPEKTRUM STU Publishing, 2023
ISBN 978-80-227-5335-7

Text author:
Michala Lipková

1st edition, Bratislava 2023

Proofreading:
Katarína Kasalová

Edition:
100 pieces

Graphic design:
Chmela studio

Typeface:
Styrene by Commercial type

Print:
VACH print

Paper:
Koehler Eco® Black 270 g/m² (cover)
and Crush Corn 100 g/m² (core)
distributed by Europapier Slovensko

Exhibition project

DESIGN × SCIENCE
Doctoral design research projects
at FAD STU in Bratislava

Location:
Designblok - 25th edition of Prague
International Design Festival,
4.— 8. 10. 2023,
Openstudio at The Trade Fair Palace,
Dukelských hrdinů 47,
170 00 Prague 7, Czech Republic

Featured authors:
Tibor Antony, Matej Dubiš,
Petra Hurai, Vlasta Kubušová,
Martin Mjartan, Soňa Otiepková

Exhibition curator:
Michala Lipková

Production:
Petra Hurai,
Michala Lipková

Installation design:
František Dorko,
Martin Sombathy

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ISBN 978-80-227-5335-7