Generative designing with biological systems - searching for production tools aimed at individualization

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Generative designing with biological systems – searching for production tools aimed at individualization

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Abstract

We intend to design and study systems that produce artifacts with biological generative systems, where nature's randomness and physiological needs have an important role in defining form. To understand these systems we will develop, analyze and criticize experimental models with ants, bees and mushrooms. In these models the matrices of construction and the system are defined, but the outcomes will be uncertain due to their dependence on biological variables.

Our goal is the development of artifacts in an embryonic stage as well as of the constraints for their development. By defining the matrix and some guidelines, we aim to make available to the general public systems that reproduce artifacts that are similar in their genesis, but which become unique due to their biological actuators. Among other factors, these artifacts seek to enhance an emotional bond between users and object; this bond happens due to the empathy that is generated by the proximity and the time that is required for their *growth*, and by the better comprehension of their morphogenesis and process. This nurturing is essential for the evolution of the matrix into the desired product.

The final products are unique and unrepeatable, and the end result arises from the close relation between the cooperators: the designer that develops the system, the person that uses it and the actuators that execute it. We believe the deeper understanding of the artifacts geneses and the bond that is created with it may result in new aesthetic qualities.

KEYWORDS: biological design; generative; customization; open-source; Open design

1. Introduction

In an increasingly digital era, where the materiality of artifacts tends to devaluation when compared to the information and symbolism from which they are composed, the opportunity presents itself to question the standardization that results from mass production (Bill, 2010). Furthermore, the new potential that resides in customized local production that result from the democratization of digital fabrication, does not guarantee innovative artifacts, designed for a specific individual and not for the masses (Grimm, 2012).

This research seeks to study and propose models for the production of artifacts in generative systems, or with generative potential, where nature's randomness and physiological aspects have a defining role; this epigenesis is seen as infusing new values and characteristics (Dewey, 2000). To understand the conjectural elements of these systems, we propose the development of models for functional testing, analysis and critique, where the matrix and the system are designed and made available, but the final results are reliant on the choices of those who manipulate them and by the variables of the biological actuators.

With the presented systems we intend to enhance the production of artifacts that have been designed not only to attend to the needs and desires of their users, but also with the capacity to foster emotional connections that arise of their nurturing and by the understanding of their genesis (Dewey, 2005). These systems seek to develop artifacts in a *sprouting* stage as well as the constraints for their growth. Due to the openness and the generative potential of these systems, the role of the designer is not only focused on giving form but on informing (i.e., the designer does not conceive the artifacts' shape, but rather focuses on the system that will produce it later). The final product is the result of the actions of various actors: the designer who developed the system, the one who manipulates the system and the actuators that define it.

Artifacts resulting from this process seek to be the result of a close relationship between the various constituent elements, the system will only outcome in a final product if it is understood and nourished. The end result is singular and unique, with aesthetic qualities that arise from the understanding of the artifact and the connection created with it.

With the systems that we propose to develop, we seek alternatives to the traditional models of production from where unique, uncopyable, artifacts are created. In addition to the understanding of the systems itself, it is necessary for their production, a close relationship between the system and who manipulates it, the aim is that the end product is more than a mere physical objects resulting in products that evolve into strong emotional relationships between people and their stuff. However, it is not intended at this stage to develop a typology of artifacts, what is intended is to develop and document the various systems so that others can experience and set them to their wills.

2. Testing

Bees, ants and mycelia (the vegetative part of a fungus, consisting of a network of fine white filaments) are the selected biological actuators for the essays in development; we chose these actuators because of their geographical proximity, resilience, low-cost and mainly for their capacity for *fast* transformation of the matrix (between 2 and 60 days depending on the actuators), and this transformation being of great impact.

2.1. Bees

We seek to build matrices in beeswax, which will be placed in beehives to be subsequently extruded by the swarms. These honeycombs, with pre-conditioned configurations, will be subject to the variability that outcomes from the labor of the bees, by lost-wax casting these honeycombs can then be forged in more durable materials.

The experiments elaborate with bees, seeking to establish the formal limits of the matrices, we intend to understand the patterns that bees prefer and which are rejected. Another approach seeks to understand our ability to print the matrices and if these printed matrices are of the bees liking.

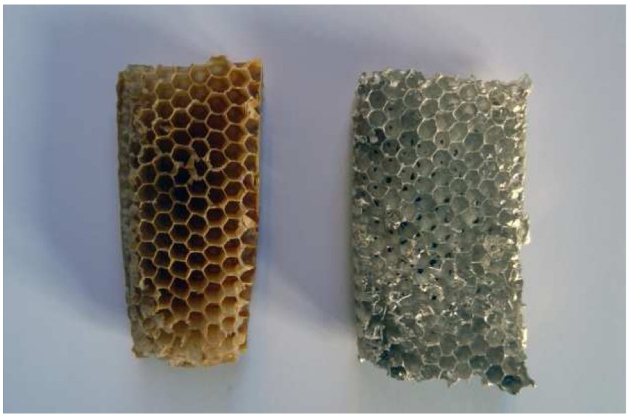

Figure 01 - Honeycomb in beeswax and honeycomb in silver by lost-wax casting

Projects like *Honeycombe Vase* (Droog, 2000) by Studio Libertiny for Droog Design and the sculptures of Aganetha Dyck (Dyck) have shown the potential of working with bees and there honeycombs. In contrast with these projects, the intent is to achieve artifacts that have a reproducible matrix allowing anyone to produce their own specimen.

Figure 02 – Honeycomb Vase, 2009. Studio Libertiny for Droog Design.
Figure 03 – Aganetha Dyck. Studio em Winnipeg. © Winnipeg Free Press 2007.

2.2. Mycelia

By constraining and defining the area for the expansion of the mycelia, the first configuration of the organism is achieved: with the opening of the constraining packaging, the mycelium erupts and fructifies. The natural process of the fungus can be stopped at any time by its sterilization and after dehydration it acquires characteristics in its consistency and density that are similar to those of styrofoam.

Figure 04 – Test with shitake mushrooms.

Tests are been developed in the search for a substrate with characteristics that allow its use in printers and simultaneously that allow the inoculation of the mycelium. The new packaging for Dell computers, designed and produced by Ecovative LLC, is just one example of the big potentials of this material

Figure 05 - Packaging for Dell Computers by Ecovative.

2.3. Ants

Unlike the other models presented, in which the actuators add material to a matrix, ants are used to remove material from a predefined matrix. An initial volume is excavated by the ants and this process of excavation is conditioned by obstructing or giving incentives to the ants, so that they choose more intensely some directions over others. The tunnels left by the ants can be approached in two different ways: if the matrix material is of a durable material like clay, the matrix itself can be seen as the final product, but if the matrix is of a more transient substrate as is ant gel (material that acts as a substrate, food and water source for ants living in an enclosed ant farm), it may subsequently be filled with liquid materials (plaster, resin, metal, etc.). After solidification, these materials are separated from the surrounding support substrate, resulting in new artifacts.

Figure 05 - Ant tunnels in resin.

Tests with ants have focused on the search for consistent and homogeneous substrates, but also on the different ways to induce ants to dig in predefined areas over others. We look forward to obtain constraints that are not just physical barriers, new tests focus on using heat and electrical current to induce the ants into digging in predefined areas. (Slowik, 1995)

3. Short-term goals

As mentioned above, the intention is not to use these models to achieve a single category of artifacts. The aim is to understand, condition and document the results to make them available to third parties. These models seek to offer new ways of approaching the production of artifacts; the intention is to replicate the building matrix with the help of Computerized Numerical Control technology (CNC) and 3D printing but achieving unique end results, due to the variability and inconstancy of each biological actor. To achieve replicable matrices and guarantee the constraints as designed, CNC and 3D printing technology are critical; they will ensure that the impermanence of the forms is totally dependent of the unpredictability of the biological actuators. The main goal is a generative process where there are constant and variable components: only with balance between these two aspects we can guarantee objectivity, through the repeatability of the elements, and individuality, by the variability of the elements caused by the biological actuators.

The dependency that this study looks for in digital technologies is also seen as essential to ensure the sharing of findings: first of all it allows the repeatability of the matrices with accuracy; furthermore it eliminates logistical and geographical constraints by allowing the downloading and sharing of files for their construction. The development of a digital platform will be the tool created for the dissemination and sharing of findings. It is understood that the contents of this platform must exist in an open system, facilitating active participation of contributors, thereby encouraging the proliferation of knowledge. This *Hyper-craft* as explained in *Open Design Now* is "is not primarily concerned with the objects that are being made. Its focus is on the process of making itself and the responsibilities that makers take – for the monsters they may be creating, for the process of creating, and for the ingredients used" (Abel et al., 2011).

4. Case studies

There are several projects that explore generative processes (I & II) and the randomness of biological entities (III & IV) as generators of new aesthetic qualities:

I) in the project *idea of a Tree* by Misher'traxler (fig. 06), a Vienna based design studio, their autonomous production system combines an inconstant input (sunlight) with a mechanical process. The variable sunlight confers unique characteristics to the object in production, i.e., more sun = thicker layer and a lighter color, less sun = thinner layer and a darker color (Mischer'traxler, 2008).

Figure 06 – the idea of a tree – recorder One by Misher'traxler.

II) In the *Automake* project (fig. 07), a combination between the software that randomly selects or removes units into the matrix and the interaction of the user by specifying when to stop the process and which units the computer selects, results into one-of-a-kind artifacts that give the users a sense of ownership (Marshall et al.).

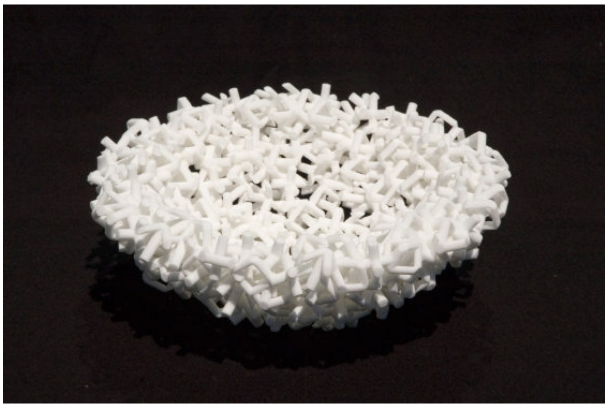

Figure 07 – Automake bowl.

III) Jason de Caires Taylor is a sculptor that creates figurative structures that are submerged into the ocean allowing the creation of new coral habitats (fig. 08), these sculptures are configured by the artist but are only concluded and meaningful when the biological actuators interact with them and give them their true dimension (Taylor).

Figure 08 – Jason de Caires Taylor's underwater sculpture.

IV) Hubert Duprat works with caddis fly larvae (fig. 09), he removes their natural cases and submits them to an environment of alternative materials (gold specks, opals, lapis lazuli, pearls, etc.) from which they recreate their protective sheaths, after their metamorphism the fly's leave the precious amalgam that is sold as jewelry (Duprat and Besson).

Figure 08 – Hubert Duprat's caddis fly cocoon.

5. Context

In the systems presented we intend to look beyond these aspects because they are dependent on the relation between the user options for their growth as well as the freewill of the biological actuators. We intend with this to provoke new ways of relating to our things, as stated by Deyan Sudjic in *The Language of Things*: "the role of the designer when working for the industry is more than the one who conceives the form of things, it is to think out the interaction between people and the artificial world, and in particular how we become attached or not to things". (2009)

As Sudjic, many authors propose a change in the way we relate to the artificial world, suggesting a connection by emotion and understanding more than the mere relationship of possession. From Enzo Mari in the 1970s stimulating *Do It Yourself* (DIY) as to a way to create affections with objects (AA Exhibitions), to Bruce Sterling (2005) who affirms that objects are more than just products, they are information and interaction sources with complex networks linked to them. It is believed that the relationship with the artifacts resulting from these production models is innovative and worthy of further analysis, seeing that the understanding of the system is necessary and that to achieve an end product there has to be room for an active engagement with the systems.

Being the final product result of a generative process conditioned by biological actuators while filling their physiological needs, we will not get a final shape *polished* and free of imperfections, but one that is inconstant, gnarly and sinuous. Leonard Koren, in his book *Wabi-Sabi for artists, designers, poets & philosophers,* shows imperfection, impermanence and unfinished features as enriching and with the capacity to generate beauty (1994). Paul A. Fishwick on *Aesthetic Computing* (2006) argues that aesthetic considerations are primarily related to the experience and Christopher Alexander in *The Nature of Order – The Phenomenon of Life (2002)*, presents industrial processes and rules that command them as unable by themselves of producing artifacts holders of "true" order and the consequent beauty that comes with it.

Generative or semi-generative biological systems are presented as tools which enable one to design and produce for personalization, where variables like randomness, the production time and especially the natural functions of the biological actuators are cherished and allow us to *grow* unique objects. The intention is that these systems function as study models of issues that arise when analyzing the consequences for design as a discipline in the presented context: can the authorship of the designer be called into question since he does not define the final product but the system to obtain it? Are the barriers that separate design from the fine arts being dazed in these production systems that do not follow traditional manufacturing processes? And if they are, why is there a need for the separation of these two realities? Given that the production of these artifacts is dependent on the close relationship between user and system, and that in order to obtain results time and dedication is needed, will this hence engender a closer relationship between object and user?…

As suggested by Neil Gershenfeld, the production capacity of artifacts will be democratized by the increasing availability of emerging manufacturing technologies (2005). How does one define the role of the designer in this scenario where the boundaries between professional and amateur are not sealed, giving place to a *post-professional era*? (Atkinson, 2010). In the systems shown, another aspect generator of entropy is added, since this hybrid inter-species conformation places the designer as the one who designs the template and its constraints but does not define it entirely. Instead, this role is intended for the interaction of the biological actuators with the remaining system.

In the book *The Semantic Turn* (2006), Klaus Krippendorff sets a new principle of design that is characterized by a change in semantics, where the idea that design is not just about making things but fundamentally about making sense of things, this is "design is a sense-making creative activity making products that make sense to their users". The author suggests a new principle that is practical and philosophical, a science of making and a philosophy of understanding the artifacts with and for them. Attention should focus on, "meaning-sensitive design methods as well as a language to talk about such design."

In this scenario, where the production of systems that produce artifacts which need an understanding of the process and have to be nurtured so they can grow and evolve into the end result, will we present a model that reinforces the relationship between things and their users or on the contrary, will these artifacts be rejected because of their complexity and the time needed to actually get to the final product?

6. Conclusions

With the systems presented we intend to contribute to the discussion about new production models that may be alternatives to mass production. With these systems we seek to catalyze greater empathy between objects and their users.

Aware that these production models raise several controversial issues as to the role of design and the designer, it is believed that the study of these systems will also contribute for this debate.

To achieve artifacts that are traded in an embryonic stage, and are dependent on the user for their evolution and final conformation is one of the expected results, but also that the impermanence and "roughness" that outcomes from the actions of the biological agents will be perceived as elements that provide new aesthetic qualities (Carvalhais, 2010).

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