

## Os frameworks que organizam o biodesign e a atitude em relação a outras espécies

### *The frameworks that organize biodesign and the attitude towards other species*

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#### **Resumo**

Biodesign se refere, entre outras coisas, ao design com outros organismos e sistemas vivos. Este trabalho tem como objectivo refletir e discutir as relações dos seres humanos com outras espécies no biodesign - com base na análise dos frameworks existentes que o organizam. As questões que norteiam a discussão são: (I) Quais são os frameworks que organizam o biodesign? e (II) O que dizem esses frameworks sobre as relações dos humanos com outras espécies no biodesign? Resultando de análise sistemática e narrativa da literatura, sete frameworks foram analisados. A análise aponta para diferentes atitudes em relação a outras espécies. Argumentamos que o biodesign pode não ser uma colaboração.

**Palavras-chave:** Biodesign; Design com seres vivos não-humanos; Frameworks

#### **Abstract**

*Biodesign refers to, among other things, the design with other living organisms and systems. This paper aims at reflecting upon and discussing the relationships of humans with other species in biodesign - drawing on the analysis of existing frameworks that organize it. The questions that drive the discussion are: (I) What are the frameworks that organize biodesign? and (II) what do these frameworks say about the relationships of humans with other species in biodesign? Resulting from systematic and narrative literature reviews, seven frameworks are analyzed. The analysis reveals different attitudes towards other species. We argue that biodesign might not be a collaboration..*

**Keywords:** Biodesign; Design with non-human living beings; Frameworks

## 1. Introduction

There are several terms and concepts used to describe the design practice that involves non-human living organisms, like design with “living materials” [1], “biodesign” [2], “biofabrication” [3], and “multispecies design” [4]. The Master’s Program in Biodesign at the University of Arts London (MA Biodesign UAL) includes: “biophilic design, bio-integrated design, biomimetic design, and bio-informed design” [5]. Vettier uses the term “objet vivant”, or living object (2019). Tamminen and Vermeulen called them “bio-objects” [6]. The Design Museum’s annual Symposium coined the expression “Design with the Living” [7]. As terms widely vary, Camere and Karana [3] eventually reported a “lack of a clear vocabulary” and a “confusion with other approaches that merge biology and design” [3, p. 102]. The MA Biodesign UAL explains that there is no such thing as a universal definition for biodesign [5]. Indeed, it is important to note that there are other uses to the term “biodesign” – it is often applied to refer to biomimetic and biomimicry principled designs [8] and biomedical and biotechnological innovations [9]. Even the Biodesign Challenge seems to have a broader understanding of biodesign: defining a “biodesigner” as “an innovator at the intersection of art, design and biology” [10]. The MA Biodesign UAL’s specific understanding of biodesign is “[...] as a means to incorporate the inherent life-conducive principles of biological living systems into design processes – to transition into a more holistic, sustainable future” [5, p.7]. Daniel Grushkin (2021), the founder and executive director of the Biodesign Challenge, considers definitions are “less important than the groups of people who gather around and advance a particular set of ideas”. To him, leaving definitions vague unleashed the community’s creativity through the editions of the Biodesign Challenge. He writes in “What is biodesign?”: “Today I would say it’s a big tent where everyone who self-identifies as a biodesigner can hang out” [11]. On the other hand, other authors are more strict in relation to the meaning of the word, like Dade-Robertson, he defines it: “[...] design and design research which use living systems as part of their production and operation” [12, series introduction note].

Although it is possible to notice that there is no consensus around biodesign conceptualization, there are different authors that developed frameworks to organize it. This essay aims at reflecting upon and discussing the relationships of humans with other species in biodesign - drawing on the analysis of seven existing frameworks that organize it. To pursue this discussion, we go through the following itinerary: (I) What are the frameworks that organize biodesign? and (II) What do these frameworks say about the relationships of humans with other species in biodesign? We further discuss these results on the lens of a popular world in this literature: collaboration, concluding with recommendations for further discussions.

## 2. Methodological strategy

The methodological strategy was composed of a systematic and a narrative literature review performed from 2020 to 2023. The detailed procedures are described in the thesis “Design with the Living: Learning to work Together” [13, pp. 102-103; pp. 112-127]. Here we revisited this material seeking for frameworks that organize biodesign.

To analyze the frameworks we assembled them on a table, sorting out the categories used to build the frameworks.

## 3. Frameworks that organize biodesign

Nesta Answering the first question (I) What are the frameworks that organize biodesign? - seven frameworks are discussed here: (1) Myers’s from 2018 (originally published in 2012)

[2]; (2) Collet's from 2013 [14]; (3) Collet's from 2017 [15]; (4) Collet's from 2020 [16]; (5) Camere and Karana's from 2017 [3]; (6) Dade-Robertson's domains of information from Living Construction from 2021 [12]; and (7) Dade-Robertson's fabrication strategies also from 2021 [17]. They are briefly described in the following paragraphs.

(1) "Biodesign: Nature, Science, Creativity" from Myers is a seminal reference in biodesign [2] – it contains curated works organized by the chapter's structure. This chapter's structure may be considered a framework, categories would be: Architectural Hybrid; Ecological Object Engineering; Experimental Functions; and Dynamic Beauty.

(2) Another seminal organization of the possible biodesign categories is the 2013 exhibition "Alive: New Design Frontiers", which took place in Paris in 2013 [14]. The exhibition's curator, Collet, organized them into: Plagiarists; The new artisans; Bio-hackers; New Alchemists; and Agents Provocateurs.

(3) The same author later released a framework to organize biodesign: Nature as a model; Nature as a co-worker; and Nature as a "hackable" system [15].

(4) Finally, she released in 2020 a new organization [16]: Bio-informed (nature as a model); Bio-integrated (nature as a partner); Biofabricated (which would be the intersection in-between Bio-integrated and Bio-engineered); Bio-engineered (nature as a re-programmable system); and Bio-based (nature as a resource).

(5) Camere and Karana [3; 1] also propose a framework to organize approaches to designing with nature. Collet [14] was their starting point, but the authors mapped other initiatives from exhibitions and further references. They point out that it is very usual for cases to fit in the description of more than one of the approaches and thus stay in the intersections between these categories, which are: Augmented Biology; Digital Biofabrication; Biodesign Fiction; and Growing Design.

(6) Finally, Dade-Robertson's [12] "diagram of domains of information in biological fabrication", could also be a structure to organize biodesign: Bottom-up design or Top-down design – to which information might be embedded: In Vivo; In Vitro; and/or in Silico.

(7) In "Can we grow a city?" Dade-Robertson [17] and the Hub for Biotechnology in the Built Environment team outline four fabrication strategies, which could be considered as an organizing framework as well: Materials made of living cells; Materials made by living cells; Materials which are induced by living cells and Materials that are made active by the inclusion of cells.

Table 1 presents a summary of them all, providing a brief description of each category.

**Table 1:** Overview of Design with the Living (biodesign) organizing frameworks

Myers (2018, first published in 2012)	Collet( 2013)	Collet( 2017)	Collet (2020)	Camere and Karana ( 2017)	Hub for Biotechnology in the Built Environment (Dade-Robertson, 2021b)	Dade-Robertson (2021a)
<b>Architectural Hybrid</b> Living structures and new ecological integrations; architectural scale;	<b>Plagiarists</b> Biomimicry principles	<b>Nature as a model</b> Biomimicry principles and a “natural” nature (contemplation – nature is above)	<b>Bio-informed (nature as a model)</b> Biomimicry principles	<b>Augmented Biology</b> Synthetic biology is employed to redesign nature seeking to solve challenges	<b>Materials made of living cells</b>	<b>Bottom-up design</b> “bottom up design is seen in attempts to construct novel artificial life from scratch” (DADE-ROBERTSON, 2021a, p.60)
<b>Ecological Object Engineering</b> Replacing industrial and mechanical processes; human scale; usability	<b>The new artisans</b> Nature as a co-worker	<b>Nature as a co-worker</b> Designer as cultivator using husbandry principles and a “natural” nature (working with – nature is side by side)	<b>Bio-integrated (nature as a partner)</b> Bio-assembly principles, for example, mycelium leather	<b>Digital Biofabrication</b> Use of advanced computational tools to ‘hack’ biological systems to open up possibilities	<b>Materials made by living cells</b>	<b>Top-down design</b> “Modifies existing organisms”
<b>Experimental Functions</b> Speculative objects, teaching tools, and provocations, intersection with disciplines; possible but improbable	<b>Bio-hackers</b> Reprogram a "synthetic" nature	<b>Nature as a “hackable” system</b> Designer as biologist using bioengineering principles and a “synthetic” nature (intervening – nature is under)	<b>Bio-engineered (nature as a re-programmable system)</b> Synthetic Biology protocols, for instance, Microsilk by Bolthreads	<b>Biodesign Fiction</b> Debate the implications of biotechnological futures	<b>Materials which are induced by living cells</b>	<b>In Vivo</b> Design information in the cell - to better develop the desired material qualities while the material is being formed by the organism: in vivo, or in the living

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<b>Dynamic Beauty</b> Artwork; not necessarily a function; discussing aesthetics and meaning	<b>New Alchemists</b> Create new hybrid organisms	-	<b>Biofabricated (which would be the intersection in-between Bio-integrated and Bio-engineered)</b>	<b>Growing Design</b> Cooperation with nature to achieve specific designs; no synthetic biology, more like a craft	<b>Materials that are made active by the inclusion of living cells</b>	<b><i>In Vitro</i></b> Design information in the environment  “refers to a broader notion of the human control of the chemical and physical environment” (DADE-ROBERTSON, 2021a, p.62)
-	<b>Agents Provocateurs</b> Conceptualize and imagine nature	-	<b>Bio-based (nature as a resource)</b> Bio-circular principles, an example would be grape leather	-	-	<b><i>In Silico</i></b> Design information held within a computer, altering in vitro parameters
<b>Scale, technology “readiness”, function to humans</b>	<b>What designers do?</b>	<b>Relationship and ethical stand</b>	<b>Relationship, ethical stand and making techniques</b>	<b>Making techniques and technology “readiness”</b>	<b>What do organisms do to materials?</b>	<b>What is the hierarchical level of intervention? Where is the information?</b>

Source: Organized by the authors (2021) based on Myers [2], Collet [14; 15; 16], Camere and Karana [1;3], and Dade-Robertson and the Hub for Biotechnology in the Built Environment [12; 17]

Following the question (II) What do these frameworks say about the relationships of humans with other species in biodesign? - we analyze each one of the frameworks:

(1) Myer's [2] seems to organize the biodesign initiatives according to scale (architectural structure or human objects); based on the technology "readiness" (if materialized or still on a speculative stage); and about the function for the humans (functional or strictly aesthetic). The relationships in this framework seem to take the human as the measure – not taking into consideration what the other living organisms do or are.

(2) Collet's 2013 [14] exhibition organizes biodesign based on what designers do, and the designers' roles, mainly in relation to the other living organism: to imitate them, to co-work with them, to "hack" them", to create new hybrids with them, or to imagine them. The focus still lies on the human and its agency toward the organism.

(3) Collet [15] advocates each design approach to nature will have its own ethical implications. In her 2017 framework, the organization of biodesign seems to follow the attitude of the designer towards nature, it is based on relationship and ethical stand. "Nature as a Model" would recognize the mastery "of solutions that have evolved over 3.8 billion years and their ecological advantage" [15, p.5]. "Co-working with Nature" would have embedded values of "cooperation and partnership". In contrast, "Nature as a hackable system" would imply "values of control and dominance inherent to the twentieth-century idea of Nature as an exploitable limitless commodity" [18]. In this framework, the agency still pivots on the designer, but it implies an action from the other living organisms (under the term "nature") in one of the categories: "co-working".

(4) Finally, Collet proposes a new organization that considers the above, adding notions of fabrication techniques and creating new categories [16].

(5) Again, Camere and Karana's [3] framework also takes into consideration human action, the different ways of making (handcraft, or digital fabrication), and the technology readiness (if only speculative or if a development for a near future).

(6) Dade-Robertson's framework [12] also focuses on the human, by organizing levels of intervention (top-down and bottom-up) and where the information is to manipulate the living organism (in vivo, in vitro, or/and in silico).

(7) Finally, The Hub for Biotechnology in the Built Environment [17], on the other hand, organize biodesign according to what the organism does to matter: if it makes it, if it induces it, or if it is made active by them. This perspective obliterates the human, referencing it indirectly by the term "material".

As equações podem ser formuladas por meio de diferentes editores de equações, seja do office ou por meio de outros aplicativos de edição de fórmulas, como *mathtype*. A citação no texto pode abranger apenas uma fórmula, referenciando como Equação 1. E para se referir a mais de uma equação em sequência, deve-se citar Equações 2-3.

#### 4. Discussion – a collaboration?

One of the learnings through this research process, is that many authors use the term collaboration [14; 19; 20; 21]; or co-performance [22; 1]; or co-working [14; 15; 23]; or co-creation [3; 19]; or cooperation [20]; and even co-designing [24; 25; 18] to describe the relationships developed with the other living organism in a biodesign development. The

organization of the frameworks does not show this relationship, except for Collet's 2017 and 2020 frameworks [15; 16].

Additionally, those concepts usually imply that there is a common goal between the parts involved [26]. Considering this, a more difficult question would be: "What does the other organism want?" - to which Dade-Robertson asks his students: "We ask whether mycelium wants to be a brick" [12, p.99]. On that matter, Vettier [6] cites Tristan Garcia: that a living organism spends energy to defend the difference between being and not being, and as Weber pointed out, in contradiction: "if you build a pavilion out of fungi, you would essentially kill a lot of fungi" [27]. In that light, the relationship in the design process might not be a collaboration after all, the intention still lies in an anthropocentric perspective of science, it still thinks in means to operationalize collaboration with living organisms in terms of a useful resource - and within an inevitable relationship of power. In our analysis, this relates to the fact that most of the ways biodesign frameworks organize biodesign initiatives have the human as the measure (as in the human scale or usefulness for the human) or the human as the protagonist in relation to the other living organism (the way in which the human does something, like techniques and materials).

On a bright side, one might speculate, as is the case in this study - that the hope is to lead to a respectful conscience and way of treating living organisms, and a more ecocentric attitude towards design [28]. Indeed, not all biodesign initiatives kill the organism at the end, which is the case of Fullgrown: after the chair is cut from the tree, the tree will continue to grow and be shaped into another chair [29]. Furthermore, appealing in favor of the biodesign practice, Camere and Karana [3] argue that in biodesign, designers forge the conditions for organisms to grow, which would not exist otherwise. This would be consistent to what Tristan Garcia [6] referred to, as for the organism defending the difference of being and not being.

The issue would be on how to name or categorize the human and non-human relationships in biodesign? Keune [24; 25] uses the term mediation. In a similar sense, Carol Collet writes that there has to be a negotiation of the design intention [15]. Also, Myers suggests: "Can designers learn to empathize with other forms of life and surrender a small amount of control of their work to them?" [2, p.9]. Hence, considering an inevitable relationship of power, the concept of "negotiation" seems to better describe the relationship that happens in biodesign. In the literature, Camere and Karana [1] also used the term negotiation (along with the term co-performance) (p. 579):

[...] designers perceive their practice as co-performed with an organism that has an agency of its own. When working with living systems, designers negotiate the final form of an artefact with a highly responsive material, an alive one, which limits the intentionality of designers and makes the outcome unpredictable.

Last but not least, in these negotiations, we may never know the other organism's real desires, since "[...] we are only just beginning to understand the language of our collaborators" [12, p.9]. This discussion is by no means closed.

## 5. Conclusion

Terminology and conceptualization in biodesign still seem to present some theoretical challenges. This essay aimed at reflecting upon and discussing the relationships of humans with other species in biodesign drawing on existing frameworks that organize it.

Seven frameworks were discussed here: (1) Myers’s chapter organization from 2018 (originally published in 2012); (2) Carol Collet’s exhibition curation from 2013; (3) Collet’s framework from 2017; (4) Collet’s framework from 2020; (5) Camere and Karana’s framework from 2017; (6) Dade-Robertson’s domains of information from Living Construction from 2021; and (7) the Hub for Biotechnology for the Built Environment’s fabrication strategies also from 2021. Those were retrieved through systematic and narrative literature reviews previously conducted by the authors. We found that most frameworks emphasize the human in the design project relationships: Myer’s framework emphasizes technology “readiness”, function to humans, and scale (in relation to humans); Collet’s 2013 framework focuses on the role of the designer; Collet’s 2017 framework highlights the relationship and the ethical stand from the perspective of the human toward nature – an exception in this structure is the category “nature as a co-worker”, where an action is attributed to the other living organism (co-working), represented by the term “nature”; Collet’s 2020 framework evolves the previous one; Camere and Karana take into consideration the different ways the human can make with the living organism and the technology “readiness”; Dade-Robertson bases an organization of hierarchical level of interference in the other living organism and where the information to be manipulated is; finally, the Hub for Biotechnology for the Built Environment’s framework obliterates human action and focuses solely on the organism’s agency (named as living cells).

Although a considerable part of the literature names the design process involving other non-human living organisms a collaboration, a co-performance, a co-work, a co-creation, a cooperation, or a co-design – we think that a more appropriate term to name this relationship is a “negotiation” as seen in Collet [15] and Camere and Karana [1], because not all participants share the same goals and the interaction happens within a relationship of power. The analysis of the frameworks corroborates this perception.

The discussion continues as biodesign develops and future studies may propose a framework that could better translate the relationships that happen in design involving other non-human living organisms. References like Dona Haraway, Vinciane Despret and Tim Ingold seem to be relevant to better understand and advance the discussion – as well as Behavioral Ecology studies.

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