

The attitude towards other species in biodesign: an analysis of different frameworks

A atitude em relação às outras espécies no biodesign: uma análise de diferentes frameworks

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Abstract: Biodesign refers to, among other things, the design with other living organisms and systems. This paper aims to reflect upon and discuss humans' relationships with other species in biodesign - drawing on the analysis of existing frameworks that organise it. The questions that drive the discussion are: (I) What are the biodesign organising frameworks? and (II) What do these frameworks say about how humans relate to other species in biodesign? Seven frameworks were analysed, resulting from systematic and narrative literature reviews. The analysis reveals different attitudes towards other species. We argue that biodesign might not be a collaboration. This is an expanded version of an XI ENSUS 2024 conference paper.

Keywords: biodesign; design with non-human living beings; frameworks.

Resumo: *Biodesign se refere, entre outras coisas, ao design com outros organismos e sistemas vivos. Este trabalho tem como objetivo 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. Esta é uma versão expandida de um artigo apresentado no XII ENSUS 2024.*

Palavras-chave: *biodesign; design com seres vivos não-humanos; frameworks.*

Introduction

This is an expanded version of an XI ENSUS 2024 conference paper.

There are several terms and concepts used to describe the design practice that involves non-human living organisms, like design with “living materials” (Camere; Karana, 2018), “biodesign” (Myers, 2018), “biofabrication” (Camere; Karana, 2017), and “multispecies design” (Metcalf, 2015). 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” (UAL, 2022). Vettier uses the term “objet vivant”, or living object (2019). Tamminen and Vermeulen called them “bio-objects” (2019). The Design Museum’s annual Symposium coined the expression “Design with the Living” (Design Museum, 2021). As terms widely vary, Camere and Karana (2017) eventually reported a “lack of a clear vocabulary” and a “confusion with other approaches that merge biology and design” (Camere; Karana, 2017, p. 102). The MA Biodesign UAL explains that there is no universal definition for biodesign (UAL, 2022). Indeed, it is essential to note that there are other uses for the term – it is often applied to refer to biomimetic and biomimicry principled designs (Polites, 2019) and biomedical and biotechnological innovations (Yock; Zenios; Makower, 2015). 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” (BDC, 2021). The MA Biodesign UAL sees biodesign “[...] 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” (UAL, 2022, p. 7). Daniel Grushkin (2021), the founder and executive director of the Biodesign Challenge, considers definitions “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” (Grushkin, 2021). On the other hand, other authors are more strict about 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**” (2021, series introduction note). This last definition will be the basis of this paper’s understanding. Biodesign examples include chairs grown directly while moulding the trees, leather grown by mushrooms, coral reef construction designs, and cellulose biofilm materials grown with bacteria.

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

Ethical concerns

When working with other living organisms to build artefacts, many ontological and axiological issues are raised regarding an anthropocentric perspective of the world (Melkozernov; Sorensen, 2020). Grushkin observes, “There’s a general appreciation for the Gaia theory of James Lovelock

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and Lynn Margulis, where all life has evolved as a singular planetary whole; this gives the biodesign field a different view of what it means to be human” (2021).

Trying to understand other worldviews through empathy might be an interesting path. Mancuso (2019), for example, remarks that because plants evolved with different strategies than animals, they do not have faces or similar recognisable structures – therefore, we do not understand them. Because we do not understand plants, we render them invisible, treating them as parts of the landscape.

We could better understand and communicate with other non-human living organisms to work with them. Pataranutaporn, Ingalls, and Finn (2018) argue that new technological frameworks need to be developed to describe and design the interface between biological systems and digital systems, which would imply opening the boundaries between living and non-living matter. This movement, however, would inevitably raise “ethical questions around exploitation and bioethics” (Pataranutaporn; Ingalls; Finn, 2018, p. 5).

Vettier (2019) discusses the ethical aspects of several biodesigned projects. The author asks: “To what extent is it acceptable to replace mechanical and industrial systems with biological processes? Who controls the living matter? Does it need to be controlled?” (Vettier, 2019, p. 28). Vettier questions the use, purpose, ecosystem, and lifecycle of the living object and “Who decides the end of the object’s life?” (2019, p. 28).

Ethical issues are also being discussed in emerging online communities for designing with living materials, open forums, and hackerspaces that promote international challenges and arise from open-source technology made available (Kera, 2014; Vettier, 2019). These initiatives often imply synthetic biology practices as well, such as genetic modifications in organisms. Research and discussion happen collaboratively and horizontally in the communities, joined by artists, universities, independent researchers, designers, and engineers. Ethically, there is a concern presented by Kera (2014) about this experimental collaborative process to build protocols, which could lead to what the author cites as “scientific self-regulation” or “scientist-centric ethics” and “models of justification”. Those terms presumably imply deregulation, the demise of governance, and could be prone to commercial pressure (Kera, 2014). On the other hand, the author considers this setting an opportunity to encourage interactions between codes, norms, and protocols with public participation in science, along with other benefits, such as network formation and knowledge transfer (Kera, 2014).

Another ethical concern is the intellectual property of life and processes with living organisms. Ginsberg et al. ask, “How are we to manage the ownership of life’s materials?” (2014, p. xi). Attias, Danai, and Abitbol (2020) reviewed the literature analysing industrial design and architecture applications for mycelium. They found that most of the scientific literature does not detail species and productive processes in a reproducible manner due to commercial protection patenting issues.

All things considered, ethical implications branch from how we as humans see other living beings and the environment; the boundaries of living and non-living; how we relate to living organisms; passing by regulation issues; and the ownership of knowledge and life itself.

A different design relationship

One common ground found among authors in biodesign is the change in the role of the designer and the design practice (Oxman, 2015; Bernabei; Power, 2016; Collet, 2017; Camere; Karana, 2017; 2018; Dew; Rosner, 2018; Collet, 2020). Collet writes, "What I can not grow, I can not understand" (2020, p. 6). The designer's role would expand from form-giving to growing. Camere and Karana (2018) conclude: "Growing Designers forge the conditions for invention of new matter, which could not exist otherwise" (Camere; Karana, 2017, p. 111).

Besides the impact of the living qualities of the organisms in the design process, there seems also to be a change of attitude of the designer towards the designed artefact. Camere and Karana found that designers change how they perceive their relationship with the artefact when working with living materials: "You have a sense of death", as one of their interviewees stated (2018, p. 576). Camere and Karana (2018) refer to these new perceptions, skills and competencies as "new designerly sensibilities" - new competencies that lie primarily in the intersection with biology.

Methodological strategy

The methodological strategy included a systematic and narrative literature review developed from 2020 to 2023. The detailed procedures are described in the Ph.D. dissertation "Design with the Living: Learning to Work Together" (Strobel do Nascimento, pp. 102-103; pp. 112-127). Here, we revisited this material, seeking frameworks that organise biodesign.

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

Frameworks that organise biodesign

Answering the first question (I) What are the frameworks that organise biodesign? - seven frameworks are discussed here: (1) Myers's from 2018 (originally published in 2012); (2) Collet's from 2013; (3) Collet's from 2017; (4) Collet's from 2020; (5) Camere and Karana's from 2017; (6) Dade-Robertson's domains of information from Living Construction from 2021; and (7) Dade-Robertson's fabrication strategies also from 2021. They are briefly described in the following paragraphs.

(1) Myers's (2018) book "Biodesign: Nature, Science, Creativity" is a seminal reference in biodesign—it contains curated biodesign works. The chapter's structure may be considered a framework; categories would be Architectural Hybrid, Ecological Object Engineering, Experimental Functions, and Dynamic Beauty.

(2) Another seminal organisation of possible biodesign categories is retrieved in the "Alive: New Design Frontiers" exhibition, which took place in Paris in 2013 (Collet, 2013). The exhibition's curator, Collet, categorised artworks and designs into Plagiarists, The new artisans, Bio-hackers, New Alchemists, and Agents Provocateurs.

(3) The same author later released a framework categorising biodesigns in Nature as a model, Nature as a co-worker, and Nature as a "hackable" system (Collet, 2017).

(4) She also released a new framework in 2020 (Collet, 2020a) organised into Bio-informed (nature as a model), Bio-integrated (nature as a partner), Biofabricated (which would be the intersection

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 (2017; 2018) also propose a framework to organise approaches to design with nature. Collet (2013) 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 at the intersections between these categories: Augmented Biology, Digital Biofabrication, Biodesign Fiction, and Growing Design.

(6) Dade-Robertson's (2021a) "diagram of domains of information in biological fabrication" could also be a structure to organise 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 (2021b) and the Hub for Biotechnology in the Built Environment team outline four fabrication strategies, which could be considered as an organising 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) organising frameworks. Source: Organised by the authors (2021) based on Myers (2018), Collet (2013; 2017; 2020a), Camere and Karana (2017; 2018), and Dade-Robertson and the Hub for Biotechnology in the Built Environment (2021a; 2021b).

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

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

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

(1) Myer's (2018) seems to organise the biodesign initiatives according to scale (architectural structure or human objects); based on the technology "readiness" (if materialised or still in 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 considering what the other living organisms do or are.

(2) Collet's 2013 (2013) exhibition organises biodesign based on what designers do and their roles, mainly regarding other living organisms: to imitate them, co-work with them, "hack" them, create new hybrids with them, or imagine them. The focus still lies on the human and its agency towards the organism.

(3) Collet (2020b) advocates each design approach to nature will have its ethical implications. In her 2017 framework, the organisation of biodesign seems to follow the designer's attitude towards nature. It is based on relationship and ethical stand. "Nature as a Model" would recognise the mastery "of solutions that have evolved over 3.8 billion years and their ecological advantage" (2020b, p. 5). "Co-working with Nature" would have embedded "cooperation and partnership"

values. 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” (2020b, p. 5). In this framework, the agency still pivots on the designer, but it implies action from the other living organisms (under the term “nature”) in one of the categories: “co-working”.

(4) Collet proposes a new organisation that considers the above, adding notions of fabrication techniques and creating new categories (2020a).

(5) Again, Camere and Karana’s (2017) 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 (2021a) also focuses on the human by organising 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 (Dade-Robertson, 2021b), on the other hand, organise 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”.

Discussion – a collaboration?

One of the learnings through this research process is that many authors use the term **collaboration** (Collet, 2013; Bernabei; Power, 2016; Kirdök et al., 2019; Gough et al., 2020); **co-performance** (Parisi, Rognoli, 2017; Camere; Karana, 2018); **co-working** (Collet, 2013; 2017; Cohen; Sicher; Yavuz, 2019); **co-creation** (Camere; Karana, 2017; Bernabei; Power, 2016); **cooperation** (Kirdök et al., 2019); and even **co-designing** (Keune, 2017a; 2017b; Collet, 2020b) to describe the relationships developed with the other living organism in a biodesign development. The analysis of the frameworks does not provide evidence for this relationship, except in part for Collet’s 2017 and 2020 frameworks (Collet, 2017; 2020a). Even in this frameworks the relationship seems one-sided, considering the use of the term “nature” to refer to the other species – as if humans would be somehow different from nature.

Those concepts (collaboration, co-performance, co-working, co-creation, cooperation, co-designing) usually imply a common goal between the parts involved (Heemann; Lima; Corrêa, 2010). The human, we want to build objects, artefacts. However, a more difficult question would be: “What does the other organism want?”. Dade-Robertson asks his students: “We ask whether mycelium wants to be a brick” (2021a, p. 99). On that matter, Vettier (2019) cites Tristan Garcia: a living organism spends energy to defend the difference between being and not being; in other words, the other organism wants to live. Weber pointed out, in contradiction: “If you build a pavilion out of fungi, you would essentially kill a lot of fungi” (Weber, 2023). In that light, the relationship in the design process might not be a collaboration after all, the intention still lies in an anthropocentric perspective, it still thinks in means to operationalise 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 organise 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 (how the human does something, like techniques and materials).

On the 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 (Melkozernov; Sorensen, 2020). Indeed, not all biodesign initiatives kill the organism in 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 (Fullgrown, 2024). Furthermore, appealing in favour of the biodesign practice, Camere and Karana (2017) argue that in biodesign, designers forge the conditions for organisms to grow, which would not exist otherwise. This would be consistent with what Tristan Garcia (Vettier, 2019) referred to as the organism defending the difference between being and not being.

The issue would be naming or categorising the human and non-human relationships in biodesign. Keune (2017a; 2017b) uses the term mediation. Similarly, Carol Collet writes that the design intention must be negotiated (Collet, 2017). Also, Myers suggests: “Can designers learn to empathise with other forms of life and surrender a small amount of control of their work to them?” (Myers, 2014, p. 9). Hence, considering an inevitable relationship of power, the concept of “negotiation” seems to describe better the relationship that happens in biodesign. In the literature, Camere and Karana also used the term negotiation (along with the term co-performance) (2018, 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” (Dade-Robertson, 2021, p. 9). This discussion is by no means closed.

Conclusion

Terminology and conceptualisation in biodesign still seem to present some theoretical challenges. This essay aimed to reflect upon and discuss humans' relationships with other species in biodesign, drawing on existing frameworks that organise it.

Seven frameworks were discussed here: (1) Myers’s chapter organisation from 2018 (originally published in 2012); (2) Carol Collet’s exhibition 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 emphasise the human in the design project relationships: Myer’s framework emphasises 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 towards 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 organisation 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 attributing agency to the other living organism in the equation, this last framework concentrates exclusively on how the organism can contribute to developing a material to be used by humans.

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 (2017) and Camere and Karana (2018), because not all participants in the design share the same goals and the interaction happens within a power structure. 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 relevant to better understand and advance the discussion – as well as Behavioral Ecology studies.

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