Biodesign and the allure of ‘grow-made’ textiles: an interview with Carole Collet

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Abstract: Biodesign is at the forefront of innovations in advanced textiles and material futures. Incorporating principles of biomimicry, bioengineering and synthetic biology, a common leitmotif within biodesign initiatives is an ethos of working with or learning from organic processes. Embraced as an alternative to the traditional carbon intensive industrial practices and overconsumption purchasing habits that mark the contemporary fashion and textile industries, biodesigners, in fashion as in other fields, value regenerative production models, biodegradable materials, and circular economic models. Ecological concern is central to the biodesign discourse, where the key potential of biodesign is understood as its ability to overturn models of fast and cheap production and energy intensive procedures that have contributed to the damaging carbon footprint of the fashion industry. Biodesign is not simply a practical endeavour of producing alternative materials, it equally disrupts and rethinks contemporary ideologies of producing and purchasing that have proved ecologically detrimental. At this philosophical level, a number of concerns and theoretical framings intersect the theory of biodesign and issues that are sentient to cultural geographers. In this paper, we explore some of those shared interests through the presentation of a conversation held at Central Saint Martins, UAL in London in December 2018 between Carole Collet (a world-leader in biodesign textile research) and Nina Williams (a cultural geographer researching the ethics of biodesign).

Keywords: Biodesign; Biomimicry; Interview; Textiles; Speculative Ethics

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Introducing Biodesign

Amidst the growing consciousness around ecological crises, public attention is increasingly focused on the unsustainable practices and mindsets fostered through production and consumption within the fashion and textile industries. Biodesign is at the forefront of innovations in advanced textiles and material futures. Incorporating principles of biomimicry, bioengineering, and synthetic biology, a common leitmotif within biodesign initiatives is an ethos of working with or learning from organic processes (Figure 1).

Figure 1. Framework for designing within living systems by Carole Collet (2016)

Embraced as an alternative to the traditional carbon intensive industrial practices and overconsumption purchasing habits that mark the contemporary fashion and textile industries, biodesigners, in fashion as in other fields, value regenerative production, biodegradable materials, and circular economic models. Ecological concern is central to the biodesign discourse, where the key potential of biodesign is understood as its ability to overturn models of fast and cheap production and energy intensive procedures that have contributed to the damaging carbon footprint of the fashion industry. Carole Collet – Professor in Design for Sustainable Futures at Central Saint Martins, UAL and director of the Design and Living Systems Lab in London – is at the forefront of working towards a more sustainable textiles future with biodesign principles. This paper presents a conversation between Carole Collet and Nina Williams held at Central Saint Martins, UAL, in London in December 2018, alongside images that showcase Collet’s design work. As becomes apparent in the dialogue, biodesign is not simply a practical endeavour of producing alternative materials. Although the ‘promise’ of the biodesign initiative is often seen as the production of alternatives to petroleum-based or energy intensive materials such as polyester and cotton, the ethos of biodesign equally disrupts contemporary habits of producing and purchasing that have proved

ecologically detrimental. At this conceptual level, the theory of biodesign intersects a number of themes and concerns that are sentient to geographers. Collet states during our conversation that "if you look at conventional cotton crop it's one of the most toxic crops we are growing on our planet because of the intensive use of pesticides and fertilisers. To grow conventional cotton, we have developed a highly unsustainable, intensive and chemically-enhanced monoculture form of production. Once harvested, it travels around the globe to undergo different transformative processes. If used in a fast fashion context, a cotton garment will be worn as little as once before it gets discarded. What I'm looking for is a real paradigm shift in how we can learn from nature and with nature to develop the ability to biofabricate materials and products in a way that is not detrimental to our local space or to our planet" (Figure 2). The potential of biodesign therefore lies equally in rethinking the ideational props that have sustained fast fashion, for example, by affirming the altered durations that "grow-made" materials necessitate in contrast to rapid production schedules typical of the current economic model and seasonal fashion system (Collet 2017). Beyond the alternative materials produced, then, we demonstrate in this paper that biodesign might have the ability to reframe the social and collective desires, habits and values that have driven unsustainable practice within the fashion industry, through notions of speculative and experimental design techniques as well as attention to the multispecies assemblages making up a design process. The structure of the paper has been organised around three key themes, each of which is suggestive of rich points of convergence between biodesign practice and geographic thought. Namely, these are: the intersections between design and science, experimental technique, and unruly materials.

Figure 2. Mycelium Textiles samples exhibited at La Fabrique du Vivant, Pompidou Centre, Paris by Carole Collet (2019)

In the dialogue introduced as part of the first theme, 'Design-Science', biodesign is understood to intersect principles in art & design and science in a manner that resonates with the

interest in art-science collaborations in geography (Dixon 2008; Gibbs 2014; Lapworth 2020; Fannin et al. 2020). An important tenet of this relationship for Collet is that the creative aspects of biodesign are not simply enrolled to communicate scientific issues to wider publics, as tends to be seen as the benefit of collaborations between the arts and sciences. Collet values a more active role for creative practice than simply "enhancing 'public-awareness'" (Lapworth 2020, 1), where the expressive capacity of aesthetics is valued simply as a connotational force. Instead, Collet is interested in what design can *learn* from life and biological principles, so that her design practice might operate within a circular eco-system.

The second theme, 'Experimental Practice' is organised around a sense of experimentalism in Collet's philosophy of practice, one which resonates with contemporary attempts to frame experimentation in geographic method (Last 2012; Jellis 2015; Williams et al. 2019). Collet is using a tacit knowledge in craft and textiles to set up experiments with living systems, where an important approach to working with nature is through serendipity, failure, and the happy accident. Emphasising and embracing failing in a Beckettian spirit has long been endorsed as part of geographic thought (Dewsbury, 2010), and Collet's practice here is aligned with Ingold's conceptualisation of 'making' as "the flows and transformation of materials" rather than the end products (2011, 210); in other words, as open-ended experimental process rather than as finalistic endeavour. Importantly, this challenges the postulates of the fashion industry that Collet works within, including the traditional telos of material to product, as well as traditional durations of practice. Experimenting with plant systems in this way necessitates a mode of slow textile production: the time of waiting for a plant to grow, for instance, requires new expectations and ways of responding to the materials involved in a design process. Collet's experimental approach invites us to consider the alternative temporalities that the textile industry can work within as part of an endeavour to work towards more sustainable fashion futures.

Within the biodesign discourse, a key concern is to challenge an extractive and instrumental process of engaging with nonhuman living systems and the concomitant recognition that those

systems pertain their own ‘lively’ capacities as agents in the world. Resembling the emergent interests in multispecies approaches (Dooren et al. 2018) and philosophies of ‘plant thinking’ (Marder 2013; Ginn 2016) in geography, as well as the discipline’s rejection of a traditional ontological distinction between nature and culture (Whatmore 2002), contemporary design fields are versed in a rhetoric of collaborating with, as opposed to extracting from, ‘nature’ (Escobar 2018; Gatto and Macardle 2019; Fletcher et al. 2019). In the third section, ‘Unruly Materials’, our discussion of the plant systems engaged in biodesign makes manifest a certain curiosity for agencies, beyond the rational actions of human beings, that shape what happens in the world. What for geographers might be novel here, is that, in as much as biodesign is sentient to the agency the materials have in shaping the design process, the field is of course attuned towards a utilitarian and needs-driven project of design. In this way, the dialogue gives rise to a less harmonious view of a designer’s ‘collaborations’ with nature, precisely because Collet is upfront about manipulating geotropic forces or killing a plant organism to produce an end product. The biodesign stage of killing the plant in particular can provide a critical angle into theories of multispecies relations, by accepting that “killing and death circulate alongside care and life” (Ginn et al. 2014, 113).

What our conversation points towards is a mode of ethics not predicated upon the human, raising questions about biodesign practice that are equally pertinent to geographic enquiry. From a geographical perspective, one question would be about where ethics starts and what it might include, of “who or what receives ethical standing (trees, cats, bacteria, or monuments),” and of the fraught relations between those things (Ruddick 2017, 121). One way of navigating such a complicated ethics, following Maria Puig de la Bella Casa, is to do so *speculatively*, so that “the “ethics” in an ethics of care cannot be about a realm of normative moral obligations but rather… a hands-on, ongoing process of re-creation of “as well as possible” relations” (2017, 6). Certainly the biodesign ethos evinces a principle of care that doesn’t start and end with the human. And yet Collet’s practice offers a provocation to the idea that caring must be conflated with sustaining life, or that death is the necessary limit of life. Donna Haraway’s notion of composting (2016) is

pertinent in this context, as a space and process in which the "questions of finitude and mortality are prominent, not in some kind of depressive or tragic way" but as facts coexistent with the ongoing vitalities of composting systems (Haraway in Franklin 2017, 2). The potential provocation of Collet's speculative practice, then, is that, in lieu of a normative, moralising ethical sentiment, it "instead transposes obligations into types of generative constraint which themselves develop only in relation to specific events and milieus and their concomitant unfolding" (Gerlach 2020, 200). Biodesign thus presents an opportunity to elaborate a speculative ethics as an ongoing, contextually specific, experimental endeavour. Here, the questions about 'good' practice remain open and sentient to both the singularity of a situation as well as the broader contexts it traverses. What remains paramount, taking a prompt from Guattari's *Three Ecologies*, is that "instead of clinging to general recommendations we would be implementing effective practices of experimentation, as much on a microsocial level as on a larger institutional scale" (2000, 34).

Design-Science

Nina: As a textile biodesigner you are drawing on a background in textiles whilst also experimenting with biological principles. Where do you envisage your work at this intersection between art and science?

Carole: So I don't talk about the arts when I talk about my work, I really talk about design. I do use creative and artistic tools in my work but it's situated in the context of design practice, which is designing for someone, for human and non-human species, or for a place. I think there's been a shift from science thinking artists and designers can communicate science: yes we can do that but that's not what drives my work. I'm interested in what design can learn from principles of life, biologic principles, and how we can learn to make things the way nature does. Fundamentally I think the biological advantage is that in nature anything operates within a circular eco-system. But if you look at materials in particular, living materials are made at ambient temperatures with local

ingredients, without creating toxic by-products. Anything we call waste in our human-designed systems actually becomes nutrients in a natural system. If we could learn to manufacture in such a way, we wouldn't be facing current environmental problems.

Nina: What linguistic barriers or other challenges arise for you when attempting to produce work that intersects design and science?

Carole: Back in 2007, in discussion with Professor Dame Amanda Fisher (Head of the Institute of Clinical Sciences in the UK) I learnt that there are parallels between the language of biology and the language of textiles. For instance, we compare DNA to a thread, in biological terms, you can 'unzip' a cell. Professor Fisher instigated the project 'Nobel Textiles', a collaboration between the Medical research Council and Central Saint Martins UAL to explore topologies and language across biology and textiles. Five researchers at Central Saint Martins and five Nobel Laureates were paired up. The objective was for us as design researchers to translate, conceptualise and understand the Nobel Laureates'contribution to biological knowledge to produce a final design artefacts to be exhibited at the Institute of Contemporary Art and Green Park in London. I was paired with – well I picked – Sir John Sulston who is known for his research into the genetic programmation of Apoptosis, using a worm called 'C elegans' as a model organism. The term refers to suicidal cell behaviour. Apoptosis is instrumental to morphogenesis, and this is how he explained it to me. During the embryonic process of growth, one cell multiplies into two, then into four and so on and so forth: that's how an organism grows. But some cells actually 'commit suicide' so that others can grow in their place. Research into apoptosis is critical to medical research because if cells over 'commit suicide', this can lead to degenerative disease for instance. And when cells don't 'commit suicide' enough, that can lead to the development of tumours and cancer, so the regulation of the gene that says, 'kill yourself', is actually integral to our health system. I had several conversations with John Sulston about this process and the principles of apoptosis. This was quite intimidating

because of course he was a well-known and a highly knowledgeable biologist but he had a brilliant ability to translate very complex biology principles into very simple terms. For instance, describing Apoptosis, he said 'the cells in between your fingers have killed themselves so that your fingers can grow', and I thought 'so, it that's like a sculpting technique.' That means if you could control this, you could programme a biofabrication process and control the shape of an organism. For me, between reading Janine Benyus [author of *Biomimicry: innovation inspired by nature* (1997)] and those conversations with Sir John Sulston, I started to think 'there's something really interesting there, something different to how I was taught in terms of textile making.' It was quite difficult to understand at first how I could translate biology principles into an actual design or material. But these were two key affirmation moments in terms of thinking that as designers we need to first understand how nature works so that we can then adopt biological principles in the designing and making process. Reading biology is now part of my everyday so I can converge and 'travel' the language of biology and the language of design.

Experimental technique

Nina: You talk about your design practice as experimental, indicating an ad-hoc approach to the materials and process, as well as affirming failing in the design process. Could you elaborate on the experimental nature of some of your biodesign techniques?

Carole: I start with very experimental work, not necessarily knowing where it's taking me and that's what I like, that sort of sense of enquiry but not knowing where I'll go with it. That is what I like about academic practice-based research: starting with a research question as opposed to a commercial design brief. In industry, the pace at which designers have to work is very intense and dictated by seasonal trends and rhythms. You could have to design ten, twenty or more collections a year, so in a commercial textile and fashion design setting, there's no time for a profound rethink of how we design and make materials and how we can adapt our production system to become

inherently ecological. I situate my research enquiries within sustainable and regenerative design and usually start a project by asking very simple questions ‘Have we looked into this? What can we learn from that? And where does that take us? What would be a life-conducive and regenerative alternative? Who else is researching this’? And failing experiments is part of the process to answer the research questions. It is as important to identify what works as what does not work.

Nina: So what does that look like in the context of your practice?

Carole: The fundamental question that drives my work, is ‘How does nature make a textile?’. Every project starts with framing a question, and then I research a technique or a recipe, but it is very experimental and hands-on. I am a maker. When working with mycelium for instance, changing the temperature or the growth medium has radical implications for the final result. So, when I develop biomaterials, my roles is to set up the experiments, test, prototype and document: and that’s what I like about this a practice-based experimental approach. The Mycelium Textiles project I am currently working on aims at investigating whether we could use mycelium as a patterning technique to replace current oil-based finishing processes. For instance, can we reproduce the puff binder coating effect with mycelium (Figure 3)? Can we use mycelium as a binding agent to create textile assemblies? Can we revisit the traditional process of tie-dye with mycelium (Figure 4)? Or as a means to pleat natural fabric at ambient temperature (Figure 5)? I also work on different projects in parallel for which I have to develop new techniques and protocols, so there is usually quite a huge learning curve for each of my research enquiries.

Figure 3. Left: conventional oil-based puff binder; Right: Biodegradable mycelium-based coating that achieve a similar effect by Carole Collet (2019)

Figure 4. Tie-Grow, Mycelium on cotton by Carole Collet (2019)

Figure 5. Permanent pleating of cotton with mycelium by Carole Collet (2019)

Nina: By calling for a renewed understanding of the relation between form and matter in the design process, you present a concept of form that does not exist prior to the design practice. I was wondering how your resistance to the hylomorphic model coincides with the experimentalism that you describe in your approach?

Carole: Exactly: to what extent form comes before matter or matter comes before form and where is the hierarchy? But I think what's really interesting is that when you work with biodesign tools, you engage with a living organism for the production of a material. Traditionally, a textile designer would start their transformative process with an inert material (cotton or polyester for instance). Even if it was grown, the design stage happens once harvested or produced into a textile fibre. So, you start with a given material and to transform and shape it into a finished product. – there is an order of things - but when you work with mycelium to grow materials or to develop a bio-based finishing process, you grow the shape at the same time as the material and that's a very different way of thinking creatively. You're not applying force to an existing material; you're controlling the parameters and living forces to grow the material in the shape you want, and that's a very experimental process for me. If you think of it in terms of architecture, instead of taking brick and mortar to slowly build a house, you grow a house as a whole. So, you have to control the parameters of life of an organism so that it grows in the shape you want , and that is a fascinating emergent process. I think it is a completely new way of thinking about being creative as a designer: when desiging with living systems, the goal is not to transform inert matter, it is to guide living matter. That's a real shift in thinking.

Unruly Materials

Nina: You sometimes refer to the materials of your practice as a bit of an ‘unruly working partner’, could you say a bit more about your working relationship with plant systems?

Carole: Sometimes, not always. So in one of the experiments, the mycelium became quite unruly, and created patterns without my intervention or control (Figure 6). This is where I’m interested in a sort of feedback response, the inherent properties of a biological system are that it is relying on self-assembly and it is dynamic. This sample consists of 100% waste coffee ground as feedstock, and one culture of mycelium, grown over three weeks. It was still covered in coffee when I decided to stop the experiment, I thought it had not worked, and then I baked it to kill the living culture. I then took it out of the oven to wash it: it’s only under the tap that four fractal patterns became clearly visible. This was pure serendipity as I had not intended to create any pattern, but rather wanted to know how this particular culture of mycelium grew on coffee grounds. In scientific research, happy accidents happen too and often lead to new discoveries. Sometimes because a protocol wasn’t really followed properly or because there was a trace of something left in the equipment and then suddenly an unforeseen discovery happens. In creative practice we also celebrate the ‘happy accident’ and I really like when a whole new pattern emerges out of serendipity.

Figure 6. Self-patterning mycelium rubber by Carole Collet (2016)

Sometimes my research is more applied and sometimes it is purely curiosity driven. Processes of nature for me – whether a system, a material, a behaviour – are models of excellence when it comes to sustainable biological eco-system. Let’s think of a tree for instance. A tree will make matter (cellulose for instance) and grow using local soil nutrients that are enriched by fallen leaves. It runs on rainwater and sunlight, and it fabricates its components at ambient temperature without damaging its own eco-system. In a sense, that’s how I look at nature, not as a romantic space, not as

a separate space even because we are part of it, but as a temporal fluid ecosystem. I am particularly interested in plant systems, and root systems.

Nina: A key aspect of the biodesign discourse is to unsettle an extractive model of design and work more collaboratively with living systems. In what ways do you see your work as a form of collaborating with the materials of your practice?

Carole: Biomimicry is about understanding that every living thing belongs to an eco-system, which by default is a set of relations. There are different ways to talk about it and there are different terminologies, but that's why for me biomimicry is the model we all need to explore to understand the regenerative and circular interconnectedness of nature. If as a designer, if you simply focus on upcycling for instance, it is not enough. You need to think about the entire system, from cradle to grave. If you look at circular design, which comes from biomimicry, it is really about connecting the dots between segregated systems so that we can create a flow of nutrients as opposed to generate toxic by-products and non-biodegradable waste. With the Mycelium Textile project, I'm experimenting with developing new recipes for textile finishing process in collaboration with mycelium cultures which dictate what is biologically possible. But I also kill my co-worker as such. Once the process is complete, I bake the samples to kill the mycelium culture and stop the growing phase. So yes, it's nice to talk about co-work and co-design but I eventually bake it to kill it so that the end material becomes inert and inactive. And that causes a lot of confusion, often people ask, 'Oh but is it still alive?' In another project 'Botanical Fur' (Figure 7), I use geotropisms to grow textile assemblage with living root systems, once the pattern is achieved, I remove the roots form the agar plate to dry them, and by default kill the plant systems.

Figure 7. Exploring geotropic forces to grow textile-like patterns with furry root systems by Carole Collet (2019)

Nina: I find this stage of killing the plant fascinating because it challenges a romanticised view of collaboration as being mutually beneficial to all parties, and because it demonstrates that multispecies relationships, whether they involve humans or not, might indeed be deadly.

Carole: I think it is interesting because if you look at 20th century poetry, there's a lot of reference to nature as a sort of romantic space but actually I'm not sure how much our collective consciousness has evolved to realise how damaged and endangered Nature has become. We've penetrated every little corner of the planet with micro-plastic from Antarctica to the equator, so it is a new type of nature we have to deal with, an artificially intoxicated nature. I think it's important to acknowledge that understandings of nature today are not the same as nature 20 years ago and to not look at an outmoded notion of nature as a romantic space, in the way nature documentaries have tended to, because that works against evolving ecosystems. We are part of nature, but we are the only species that is now impacting on the geological forces of the planet to a point of jeopardizing our own survival; that's never happened before. By exploring what we can learn from plant systems, their interactions, their sentient abilities and their survival strategies, we can derive new ways to design and make. Overall my work is about gaining a better understanding of how living systems work - what can we learn from them and what can we adopt to inform better practices in fabrication, in particular for future sustainable and regenerative textiles and materials.

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CAROLE COLLET is Professor in Design for Sustainable Futures at Central Saint Martins, University of the Arts London, London, UK, N1C 4AA. Email: c.collet@csm.arts.ac.uk. Carole Collet is Director of Maison/0, the CSM-LVMH Sustainable Innovation Programme set up in 2017 in partnership with the luxury group LVMH. She is also co-director of the Design & Living Systems Lab, a research lab which explores the inherent properties of biological living systems to develop new knowledge in the field of ecology via creative practices in art, design and architecture. As an educator, she has pioneered the integration of sustainability in the curriculum by founding new courses such as MA Textile Futures in 2001 (now Material Futures) and the first MA in Biodesign in 2019. In her research, Collet questions how and what we can learn from living systems to develop inherently sustainable and regenerative new propositions for design. She curated the first international biodesign exhibition *'Alive, New Design Frontiers'* in 2013 to propose a sustainable framework for designing with living systems. Her work has been featured in international exhibitions such as the V&A and the Pompidou Centre. She regularly contributes to conferences on the subjects of biodesign, biomimicry, permaculture, sustainable and regenerative futures.