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COMMENTARY

The Eco-Normative Profiling of Technology and Design: a Commentary on 'What Does it Mean to Mimic Nature? A Typology for Biomimetic Design'

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Abstract
This commentary considers the typology and conceptual and normative heuristic framework as proposed by the authors as a valuable contribution to the new field of philosophy of biomimetics and to the growing demand for critical evaluation of technology and design (decisions) in terms of ecological sustainability. However, further steps are needed to develop a more comprehensive normative analysis and evaluation. To inspire these efforts, I outline some additional normative dimensions of what I propose to call the 'eco-normative profiling' of technologies and design.

Keywords Biomimetic design · Technology and nature · Anthropocene · Technology assessment · Philosophy of biomimetics · Ecological sustainability

When asked about the presumed significance of the concept and practice of biomimicry, one of the key figures in the burgeoning research field of philosophy of biomimicry, Henry Dicks, confidently replied that biomimicry '[i]s an idea whose time has come!' Indeed, in recent years, the notion – along with similar notions such as 'bionics', 'bio-' or 'nature-inspired design,' or 'biomimetics' (Bensaude-Vincent, 2019) – has gained traction in various fields both in practice (engineering, synthetic biology, chemistry, materials science, agriculture) and in theory (philosophy and ethics of technology, environmental philosophy, normative assessment of technology). Now that the research field of philosophy of biomimicry is emerging, it is valuable and helpful to take stock, outline existing approaches, and delineate the field, to gather terms and concepts, reveal underlying philosophical assumptions, propose conceptual clarification and classification or typological ordering, and above all, suggest a heuristic framework that addresses and synthesises all the aforementioned

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tasks. Alessio Gerola's, Zoë Robaey's, and Blok's 'What Does it Mean to Mimic Nature? A Typology for Biomimetic Design' is dedicated to this challenging issue (Gerola et al, 2023).

Compared with existing accounts that have attempted to categorise and typologise 'biomimetic practices' and approaches – to use an umbrella term of the authors – the article heralds the filling of multiple research gaps by overcoming biases and limitations of previous philosophical reflection, such as the reliance on dichotomies. A key bias in existing typologies – and probably also in the scholarly literature – is the almost exclusive focus on 'disciplines such as materials science, computer science, electrical engineering, biomedical engineering, chemistry, robotics, etc.' while tending to neglect 'disciplines such as permaculture, agroforestry and agroecology, ecological restoration, ecological design and industrial ecology, as well as indigenous practices of landscape management' (65). In terms of philosophical analysis, the underlying conceptualizations of 'nature' and 'life/bios' and implicit normative assumptions of biomimetic approaches have not been sufficiently investigated so far. In particular, the relationship to ecological sustainability aims and 'ecological appropriateness' (65), i.e., the reduction of risk and harm to ecosystem degradation and ecological impact of design and technologies, deserves more analytical and critical attention. This is all the more true since, as Vincent Blok has recently substantiated, nature-based design does not inherently involve ecologically sustainable design and material choices (Blok, 2023; see also Mathews, 2019).

In general, I agree with the appraisal of the literature on biomimetic design and technology and the strong focus on the analysis of 'normative dimensions' (Gerola et al, 2023), especially on the concern of ecological sustainability or 'ecological appropriateness' (65) of biomimetic design approaches and practices. Indeed, the question of the possibility of ecological sustainability of technology – both in general, and in the concrete practice of actual design and infrastructure – leads to the core philosophical and social question of the relationship between technology, production, and 'nature' *in light of the Anthropocene*. This means, in the face of large-scale and major technology induced environmental changes, i.e., irreversible climate change, changes in geobiophysical and chemical cycles and patterns, ecosystem degradation, leading to losses of biodiversity, habitable soil, and ecosystem functions.

Thus, when thinking about technology and nature in a profound and timely way, I would argue that what is ultimately at stake is the question of the Anthropocene and the role that technologies and design decisions (can or do) play in consolidating the pathway towards 'hothouse Earth' (Steffen et al., 2018) and a polluted and uninhabitable Earth, and in opening up pathways that allow the mitigation of the extent of climatic and ecological changes and degradation. In short, when it comes to the relationship between biomimetic design and ecological sustainability, it is – or should be – also about the concern, and indeed the narrative, of 'how technology can (not) save the planet (?/!)' (see Dicks & Blok, 2019). What is the temporal and spatial scale, and the quality of intervention in ecosystems that is caused by the production and application of a particular technology or design? Could it cause *irreversible damage* or *change*? To address these concerns, approaches driven by ecological sustainability have entered the domain of Life Cycle Assessment of products, indicating carbon, environmental and biodiversity footprints, and resource consumption.

The question, then, is how can normative theorising and analysis support an ecologically driven evaluation of technology and design (decisions) and their sustainability claims. In this respect, the framework proposed by Gerola, Robaey, and Blok can be seen as a valuable and useful contribution to building a strong normative evaluation and critical assessment of biomimetic approaches. The framework, or heuristic grid, also successfully overcomes the above-mentioned biases and narrow scope of the existing philosophical literature. Using the triad of 'inspiration', 'imitation', and 'integration' and the conceptual distinction between nature as a normative principle and nature as a technical model as conceptual guiding axes, the framework allows the construction of a typology of biomimetic design that covers a continuum from (degrees of) technical normativity to (degrees of) ecological normativity (65, fn. 4).

The framework provides the first steps towards what I propose to call 'eco-normative profiling' of eco- and biomimetic technology and design (and potentially all types of technology). This means, on the one hand, assessing the ecological and environmental impact of technology and design and, on the other hand, identifying and discerning the wide range of normative and ideological dimensions and effects at different levels that are involved in the planning, development, and administrative incorporation of products, technologies, and infrastructures in relation to the overarching and meta-normative principle of avoiding the path to climate and biodiversity catastrophe. While the first task is carried out by empirical environmental research, the second task can be conceived as the job of applied ethics and philosophy. As I have said, the typology of six types of biomimetic design, the focus on normative implications and dimensions of these approaches, and the distinction between technical and ecological normativity can be thought of as initial elements of the evaluative and critical approach of eco-normative profiling. However, as the authors themselves acknowledge, 'biomimicry comprises multiple levels of "normativity"' (65, fn. 4), and further research and reflection on this is needed.

In the following, I would like to inspire further development of the normative evaluation and critical appraisal of eco- and biomimetic technology and design *in light of the Anthropocene*. For this, I draw on the approach of a 'moral profile of a technology and its competitors', as introduced by Eugen Octav Popa, Vincent Blok, Georgios Katsoukis, and Cornelius Schubert (Popa et al., 2023, p. 3; emphasis in original) and present an outline of a more comprehensive normative analysis, including multiple levels of normativity and normative efficacy. Let us start with Popa et al.'s approach of drawing a 'moral profile' of a technology under consideration. Popa et al. base their approach on Langdon Winner's famous insight that technologies and artefacts 'have politics'; that is, technologies and artefacts represent amalgams of value and idea-driven choices that translate into inclusive and exclusive mechanisms, contributing powerfully to the maintenance or reshaping of social, socio-economic and political orders (1). Thus, artefacts, technologies (and I would add, design decisions and forms of infrastructure) 'are embodied moral choices between values, choices that promote one image of the good life while demoting others' (3). Consequently, the 'moral profile' of a technology/artefact/design can be heuristically conceived as ‘an overview of how a certain technology impacts our moral universe, the values it serves and those it ignores or disserves, all this in relationship to alternative technologies that have their own moral profile’ (3).

The account of moral profiling appears quite useful. However, I suggest that (at least) two extensions are necessary to achieve a comprehensive account of normative profiling. The first aims to broaden the scope of normativity; the second proposes to add the meta-normative category of ecological sustainability to the framework. As to the extension in terms of normativity, it should be acknowledged that not only moral or ethical values but also ideas, concepts, and norms are involved in technology. My suggestion therefore is to expand the account of ‘moral profiles’ to the scope of ‘normative profiles’, including technical, epistemic, moral, social, and political values and (imaginaries of) norms, as well as ideas and discourses of social and political order and progress. Furthermore, as argued before, today’s technology and design decisions ought to be made in relation to the historical situation of the Anthropocene, in which an undesirable future for ecosystems and human well-being looms large. This is why I propose to add ecological sustainability – or with Gerola et al. (2023) ‘ecological appropriateness’ – to the normative evaluation (what I call ‘profiling’), thus extending the normative profile to an ‘eco-normative’ profile, assigning it an inherent normative drive towards ecological sustainability. As a contribution to drawing an ‘eco-normative profile,’ the normative evaluation of a biomimetic (or non-biomimetic) technology and design would investigate:

- the impact on existing moral and ethical values
- the impact on the discursive realm, ideas, and concepts of the good life and the desirable future of society
- the impact on the landscape of socio-material practices, including technical normativity, that are afforded, enabled or prohibited by a technology or design (see for this in particular Mathews, 2019)
- the impact on ecosystems and environmental processes.

In this way, elements of Popa et al.’s and Gerola et al.’s accounts of normative reflection on technologies and design are taken up and pushed a little further.

Finally, this leads me to a more general normative question. Given the historical situation of the Anthropocene and the trajectories of rapid climate change and biodiversity decline, is technological development (and design and innovation) that does not relate to the socio-ecological context still socially and morally justified at all and what would be reasonable exceptions?

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