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Artist: Matthias Garff
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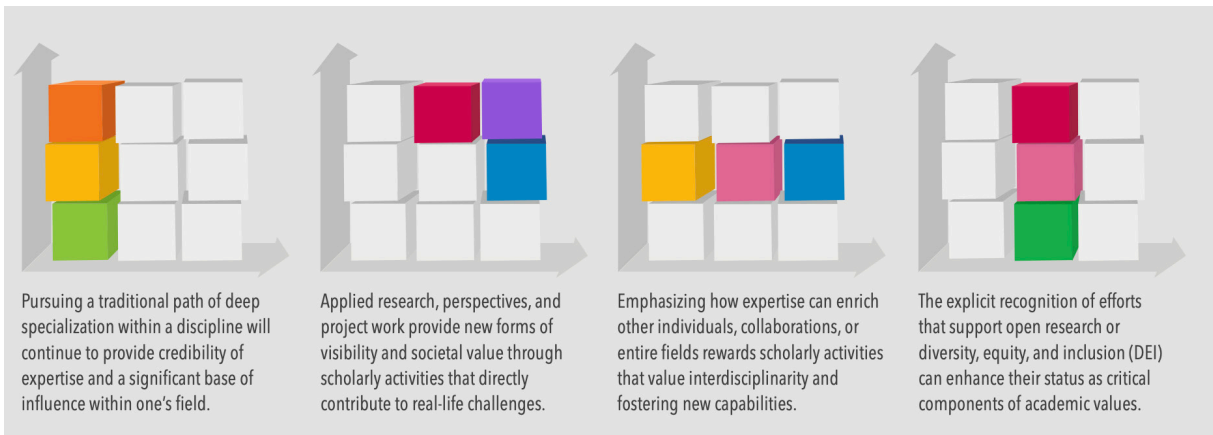
ZQ Launches the Correspondents Program

by Shoshanah Jacobs

Working at the intersection of biology, design, technology, and art is exciting. For us, the primary driver of that excitement is having a front-row seat to remarkable people having remarkable ideas. Whether they are building nature-inspired prototypes, grappling with the complexities of commercialization, or asking questions that traditional disciplines rarely make space for, documenting these stories and lessons learned is what brings us together.

Over the years, ZQ has grown into a community of thinkers, makers, artists, educators, engineers, and biomimetic practitioners who share a fascination with the natural world. We encounter emerging voices with compelling ideas and diverse perspectives, though they may not readily identify as ‘writers’.

We have an idea to help change that.



The ZQ Correspondents Program is designed to encourage and graduate and undergraduate students interested in sharing their ideas related to bio-inspired design, nature-inspired solutions, and transdisciplinary creativity. The program offers

↑ Schmidt, R. (2022) Rethinking Research Assessment: Building Blocks for Impact. DORA. CC 4.0

mentorship and editorial guidance to help correspondents develop a short, online article for publication in ZQ.

Writing for more diverse audiences is an important skill and is increasingly valued by academia and industry. We were inspired by the DORA initiative,* a global push to improve how research and researchers are assessed. The DORA framework recognizes and values communication contributions that reach audiences outside of the academy.

* <https://sfidora.org>

↓ Schmidt, R. (2022) Rethinking Research Assessment: Building Blocks for Impact. DORA. CC 4.0

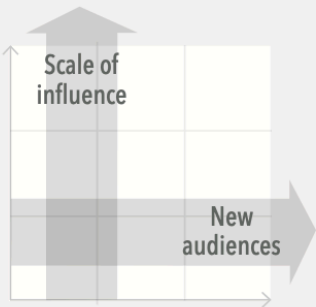


The SCRIBE Program* at the University of Guelph provided an excellent framework to get us started on designing the Correspondents Program. SCRIBE stands for Students Communicating Research in Biology Education, and it is intended to support early-career researchers (in this case, graduate students) in developing their communication skills to diverse audiences. We were inspired!

* <https://www.uoguelph.ca/cbs/graduate/scribe-program>

Our intention is to create a space for students to gain experience in non-academic publishing. We hope that this program helps new voices feel welcome within the growing global conversation surrounding bio-inspired design. Some correspondents may publish with us once, others may choose to return, becoming long-term contributors. Either way, we are excited to create more space for storytelling, emerging perspectives, and new ideas.

Two dimensions to illustrate “impact”
Broadening the definition of scholarly “impact” against two dimensions—the **scale of contributions’ influence** and **new types of audiences**—can help institutions recognize and reward a wider variety of academic achievements and outcomes.



ZQ Correspondent Program

The ZQ Correspondent Program is a mentorship and publishing initiative developed by *Zygoté Quarterly* (ZQ) to highlight emerging voices in biomimetics, bio-inspired design, art, engineering, and science communication. Designed for students, the program offers participants the opportunity to develop a short-form feature article for publication in ZQ under an editor's guidance. Through structured mentorship, correspondents gain experience translating complex

↑ Schmidt, R. (2022) Rethinking Research Assessment: Building Blocks for Impact. DORA. CC 4.0

ideas into compelling stories for broad audiences while contributing to the growing global conversation surrounding biomimicry and nature-inspired innovation.

Program Overview

For each issue, one ZQ Correspondent will be selected to develop an original online feature article focused on either a technology of design spotlight or an artist, designer, or practitioner profile related to biomimetics, bio-inspired design, or related forms of nature-inspired innovation. Articles will typically be between 500 and 700 words and will be written for an interdisciplinary readership spanning science, engineering, design, technology, and art.

The program is intended not only to support emerging writers but also to cultivate future contributors and long-term members of the ZQ creative and editorial community. Successful correspondents will have access to one-on-one mentorship from a member of the ZQ editorial team, professional editorial guidance throughout the writing process, and publication in *Zygote Quarterly* with full authorship credit.

Who Should Apply

Applications to the program are open to students in engineering, art, design, biomimetics, science communication, and interdisciplinary studies who are interested in public-facing storytelling. Prior publishing experience is not required; however, applicants should demonstrate curiosity, potential for communication, and enthusiasm for bio-inspired design and interdisciplinary communication.

Applicants will be asked to submit a short statement of interest, a proposed article topic, and (if available) a brief writing sample or portfolio excerpt. Applications will be reviewed by the ZQ editorial team, and one correspondent will be selected per issue. All applications will remain on file and may be chosen for a later issue.

Mentorship and Editorial Training

Once selected, the correspondent will participate in an introductory mentorship meeting with a ZQ editor. This session will introduce the participant to ZQ's editorial tone, audience, workflow, and approach to interdisciplinary communication. The meeting will also provide guidance on structuring short-form feature articles, conducting interviews, and communicating technical or creative ideas clearly and accessibly for non-specialist audiences.

The assigned editor will continue to serve as a mentor throughout the writing and revision process, providing structured editorial support and professional feedback.

Developing the Article

During the development stage, correspondents will research, draft, and refine their article in collaboration with their editor. The mentorship process is intended to support participants in strengthening narrative structure, improving clarity and accessibility, and learning how to communicate across disciplinary boundaries. Particular emphasis will be placed on connecting science, engineering, design, and creativity in ways that reflect *Zygote Quarterly's* spirit and mission.

Publication and Recognition

Accepted articles will be published online through *Zygote Quarterly* with full authorship credit and promoted through ZQ communication channels. Correspondents will receive a \$100 CDN honorarium upon publication and will join the broader ZQ contributor network, creating opportunities for future collaboration and continued engagement with the publication.

If you are interested, please see [Correspondents](#) on our main page and complete the proposal form.

↓ Shoshanah Jacobs is a Professor in the Department of Integrative Biology at the University of Guelph. Their transdisciplinary research spans biology, education, biomimetics, and the intersections of science, technology, art, and society. They are a co-editor of *Zygote Quarterly* and lead the Manufactured Ecosystems research program.





A portfolio by Matthias Garff

Matthias Garff (b. 1986, Switzerland) is a German sculptor and visual artist based in Leipzig. He creates sculptures and videos from found objects and everyday materials, exploring the often-overlooked presence of animals in urban environments. Birds, insects, and other species living alongside humans are recurring subjects in his work.

↑ Studio Leipzig, 2024

Working with discarded materials, Garff combines familiar objects into animal forms that retain traces of their previous use. Encounters with urban wildlife and observations made in daily life often serve as the starting point for his projects.

He studied Fine Arts at the University of Fine Arts Dresden. His work has been exhibited at institutions including the Museum of Fine Arts Leipzig, the Staatsgalerie Stuttgart, and the Drents Museum in Assen, as well as in exhibitions

throughout Europe, Asia, and the United States.

Garff has participated in international residencies, including the International Studio & Curatorial Program (ISCP) in New York. His interest in birds and wildlife has led to collaborations with naturalists, birding groups, and local communities. He regularly organizes bird walks and guided tours that combine wildlife observation and encounters with his sculptures.

Could you tell us about how you are inspired by nature?

Nature is my main source of inspiration. What inspires me most is experiencing nature within urban surroundings. I have always lived in cities, and I truly admire all those non-human creatures living among us, especially birds and insects.

Encounters in my daily life are often the starting point for new sculptures. My studio in Leipzig is located in a former industrial area with abandoned buildings and vacant lots. It is a very special environment for me because I regularly encounter raccoons, foxes, mice, and many birds. The area is very close to the city center, which makes these experiences even more remarkable.

In these abandoned spaces you can observe how nature slowly takes over again. Plants grow through walls, animals find places to live, and insects return. In my work, I am always searching for the connection between the built and the natural world. I like that the boundaries between both are often blurry.

What kind of techniques do you use for your work?

I work mainly with found materials and all kinds of objects that I collect in my surroundings. My process is based on assemblage. I screw objects



↑ Raccoon, 2021
Champagne cooler, aluminum pot, bicycle saddle, broom bristles, faux fur
85 × 40 × 40 cm

together, bend them, cut them, and often paint certain elements. Besides screws, I often use rivets, hot glue, wire and welding.

The materials come from the streets, flea markets, recycling yards, and from friends who save interesting objects for me. I like working with used things that carry traces of human life and their own history.

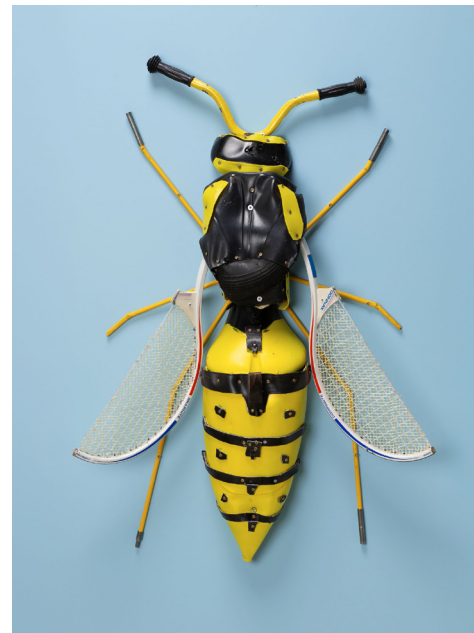
My goal is always that viewers recognize both the animal and the materials it is made from. The objects should remain visible and keep their identity while becoming part of a new creature. Many sculptures contain movable elements such as wings, heads, or tails, which allows me to animate them later in photographs or short videos.

Who/what inspires you creatively? What do you ‘feed’ on the most?

Besides the natural world and encounters with animals, it is often the materials themselves that inspire me and set my imagination in motion. I have a huge collection of all kinds of objects and materials in my studio, and I love playing with the endless possibilities of combining them.

Usually, I already know what kind of animal I want to build. The search for the right objects is one of the most exciting parts of the process. The shape of an old bucket, a shoe, or a tennis racket can suddenly become an important element of a sculpture. I enjoy looking at these objects beyond their original function and imagining what role they might play.

Searching for the right materials is incredibly inspiring because I never know where it will lead me. The final appearance of a sculpture develops through this process of finding, combining, and making decisions. I think it is this openness and sense of discovery that feeds me the most creatively.



↑ Wasp, 2024
Aluminum bowl, tennis racket,
handlebar, tent poles, bicycle saddle,
tire
120 × 75 × 17 cm

What are you working on right now? Any exciting projects you want to tell us about?

At the moment I am working on a new series of sculptures for a solo exhibition in Ulm, Germany, opening in July. The gallery is located on a small island surrounded by a river, and I decided to focus on this particular environment. The exhibition is called *Am Fluss (At the River)*.

The show will include sculptures of frogs, dragonflies, mallards, kingfishers, and other animals connected to river habitats. I am interested in playing with different scales and ways of presenting this waterside environment.

The frog, for example, will be almost two meters high. Next to it, I will place an oversized dragonfly inside an object frame. The frog will appear more like a visitor to the gallery than an artwork itself. It looks at the dragonfly with excitement, as if it is about to buy it.

I enjoy creating these small narratives and shifting the relationship between humans, animals, and objects.



↑ Eisvogel (Kingfisher), 2020
Copper hot water bottle, flour scoop,
straps, paint
42 × 55 × 20 cm

What is the last book you enjoyed?

I'm currently reading *With a Bird – A Reader on Avian Kinship*, published by Onomatopoe. It is a beautiful collection of texts about our relationship with birds.

I especially remember an essay by Daniel Godínez Nivón, who writes about our dreams and about swallows carrying tiny mineral particles in their heads that allow them to follow magnetic fields and resonate with mountains. I was fascinated by this idea because it suggests forms of connection that remain invisible to us. It reminds me that the world is woven together in ways we often do not perceive, and that animals experience their surroundings very differently from us.

What's your favourite motto or quotation?

Three years ago, I worked on a book* project, *Tönende Tiere*,* together with Dominik Eulberg, who is both a biologist and a techno producer and is deeply involved in nature conservation projects. I really appreciate his approach, which is to make people aware of the beauty of nature and inspire a sense of wonder.

* <https://vogelbuero-eulberg.de/products/toenende-tiere-buch-signiert>

* <https://toenende-tiere.de>

He often says: “Der Mensch schützt nur, was er auch schätzt.” A possible English translation would be: “People only protect what they value.”

I think this idea is very true. Creating fascination and curiosity about animals may be one of the most effective ways to encourage people to care about them. In my own work, I do not want to illustrate environmental problems directly. Instead, I hope that encounters with these sculptures can create a sense of wonder and make people look differently at the animals living around us.

↓ Matthias Garff at a recent exhibition *Constructed Nature*, Bad Ischl, Austria
Photo: © Michael Maritsch, 2026





Buchfink (Chaffinch), 2019
Bamboo, wood, plastic bin, aluminum,
carpet, wax
265 x 130 x 130 cm



Buchfink (Chaffinch)
Portrait, 2019
60 x 60 cm



Goldammer (Yellowhammer), 2019
Wood, bamboo, metal, papier-mâché,
reflectors
225 x 205 x 240 cm



Rotkehlchen (European robin), 2019
Wood, car roof box, doormat, bicycle bell
170 x 80 x 230 cm



Blaumeise (Eurasian blue tit), 2020
Rubber boots, enamel bucket, plane, faux fur
145 x 60 x 50 cm



Blaumeise (Eurasian blue tit)
Portrait, 2019
60 x 60 cm



Night Heron, 2024
Rain barrel, exhaust pipes, sickles, buoy,
street lamp
230 x 120 x 210 cm



Kohlmeise (Great tit), 2019
Bamboo, blinds, beer crates, mattress,
bitumen tape
240 x 160 x 180 cm



GARDEN BIRDS, 2021
MdBK Leipzig
Photo: © dotgain



Kohlmeise (Great tit)
Portrait, 2019
60 x 60 cm



Biology and the Cognitive Economics of Engineering Design

by Ben Millen

Our best bio-inspired thinking on a project began two days before that project died. We were trying to fit a linear actuator behind the ear – a tiny and variable space, and we could not compromise on the force. Every conventional mechanism was too big to fit or too heavy to wear on the ear. With the deadline approaching and the budget exhausted, we did what engineering teams do when they get desperate. We piled everyone available into a room and brainstormed; textbooks came out, someone started looking into how biology moves things in small spaces, and for a couple of glorious but stressful days we had interesting discussions about muscles and swim bladders. In the end, these approaches were deemed too risky,

↑ Marek Kupiec, 2022 | Pexels cc

and the team concluded there was “no obvious solution”. We returned to more conventional approaches, found none that worked, and the sponsor pulled the project.

While tragic, this outcome is familiar in my world. Bio-inspired designs or concepts rarely advance to detailed design and production, yet the field’s effort continues to be focused on providing engineers with better methods. The sentiment seems to be that if only they had the right procedure, the right standard, the right process diagram, biology would find its rightful place in design.

The field appears to have concentrated on improving methodology while giving less attention to the economic realities that haunt concept generation and selection in practice. Engineers don’t suffer from lack of process. They respond, rationally, to the incentives before them when confronted with a design challenge. Until you understand those incentives, no methodology or ideological position will be successful in promoting biology as a design solution.

Plenty has been written about the engineering design process and as a necessary part, how concept generation unfolds. Most of it does an excellent job at describing how concepts should be selected, but few acknowledge the question of where ideas come from. The assumption is that engineers systematically explore the solution space, but Cross observes that experienced designers tend to begin with previous designs rather than searching from first principles.

“In most cases, for instance, the designer is asked to design something similar to that which he or she has designed before, and therefore there is a stock of previous design ideas on which to draw. In some cases, only minor modifications are required to a previous design.”¹

My experience in consulting is that this observation can be extended. Prior designs have priority

1 Nigel Cross, *Engineering Design Methods: Strategies for Product Design*, 4th ed. (Chichester: John Wiley & Sons, 2008), 9.

because of their availability. Once these have been exhausted, the engineer doesn't resort to an exploration of all possibilities, but rather proceeds to gather solutions through reliable next-best channels.

In a commercial setting, project deadlines and budget pressures are real and acute. These conditions are antithetical to creative thinking, and a design engineer is often running a risk calculation behind the concept exploration. The lower the risk and the greater chance of success with less time invested in exploring and testing, the better. The designer will tend to first index on what is familiar and lower risk: what is familiar and has shown itself to work in the past in a similar context will always be the most likely solution presented and selected.

The steps that follow can be thought of as a ladder, climbed one rung at a time, only as far as necessary to find a satisfactory solution. After familiar solutions, next likely are solutions they might have seen implemented recently, seem interesting, and offer an opportunity to explore. Collaboration is next, where other engineers with experience in an adjacent domain are drawn in to expand the locus of familiar and low risk solutions. After that, one draws on more distant memory and esoteric knowledge ("I read an article..." "A colleague told me about..."). Finally, novel solutions, which are often hybrids or combinations of disparate ideas, start to be introduced. When these are exhausted, as an absolute last resort, a designer might defer to textbooks or sourcebooks.

This is not laziness or cynicism, but a question of cognitive economics and self-preservation when living under the pressure of a project. Unknown and novel solutions are risky. The sooner the concept can be established and the project moved into more comfortable detailed design activities the better. A solution you find in a paper that requires testing, adapting, iterating, and refining

defers the next phase and invites the inevitable wrath of your project manager to whom you now must explain the project delays.

In this context, any rational actor living with budget and schedule constraints starts at the bottom of this ladder with familiar and predictable solutions to the problem at hand. Pretending otherwise, that a different type of solution can be inserted upstream, is how the biomimetics literature appears to be divorced from the reality of design engineering practice.

Acknowledging this reality, the inevitable question follows: where on this ladder does biology sit? On the final rungs, where the designer makes the effort only under duress. Bio-inspired ideas live among half remembered esoterica (“I read an article in school...”) and the novel hybrids. These are the second-to-last things a designer reaches for, with only the textbook remaining, opened in outright surrender. The irony is that this is where the field appears to have been most diligent – cataloging biology into searchable databases and filing the material into a sourcebook, the one designers turn to only when all else has failed. Biological solutions do not lose because they are inferior, they lose because they arrive late.

↓ Ludvig Hedenborg, 2020 | Pexels cc



This is the challenge of bio-inspired design adoption in practice laid bare. It is not a question of process or relevant case studies, but rather one of position and cognitive availability. The intervention is not glamorous. You need biology to be there at the decision point, at the second or third rung where earnest search for viable options happens and implementation still feels low risk.

To get there requires upstream work and looks less like a process or a framework and more like an engineer who has spent time looking at how a particular mechanism appears and functions in an insect so when a matching problem appears on their desk the idea is available – easy to retrieve and arriving as an answer to the problem independent of an agenda to implement it. It may also look like a colleague who is perennially interested in how nature does things and won't stop talking about planthopper gears, so the information is already in the air before there is a project that needs it.

The intervention required isn't more process or procedure imposed on the project but rather exposure to the person before the problem appears. This makes biological solutions available on the lower rungs before the project begins. Executed correctly, it should feel less like consulting biology and more like reaching for known mechanisms as unglamorous as springs or helical gears. I think of this as cognitive pre-loading, which is not a romantic way to get biology into a project, but is by far the most effective way for anything to influence design in a project context.

An alternate approach to process frameworks that might force biology into the design process is the belief that biology might enter through a "biology push". In these scenarios, someone might identify a mechanism in a lab or research context, and this gives way to a new innovation that is subsequently commercialized. While this does happen, it is subject to the same pitfalls as other,



non-biological technologies that emerge from research environments. Lasers were an elegant solution to a problem that didn't exist for twenty or thirty years, until they found a home in barcode scanners and measuring devices. The adhesives used in Post-it® notes were considered a research failure until they found an application.

↑ Pyae Phyo Aung, 2021 | Pexels cc

Both are thin examples of success and tell a better story of institutional tenacity and serendipity than focused development. The biology push approach inherits the challenges of research-driven innovation with the added complexity of translating biology itself. To make matters worse, the labs and institutions where this type of work was allowed to happen have mostly been shut down and when they appear anew, have a half-life too short to properly incubate and commercialize these ideas.

Julian Vincent, who has given this much thought, argues that biology only becomes useful to engineers when it arrives on their own terms rather



than grafted on as a separate step. He notes that a promising idea from biology tends to be "discarded with the comment that it's unrelated and irrelevant: 'Interesting but trivial!'" The engineers "continue as engineers, steering the project down paths familiar to them."² This is the ladder, observed through the biologist's lens, and it points to what success may look like.

If we return to the "behind the ear" linear actuator problem from the introduction, the project did not die because biology had nothing to offer; rather it died because biological solutions arrived too late, and were too unfamiliar to survive a risk calculation the team had already made. If the same ideas were within reach when the early concepts and prototypes were created, then they become candidates to shape a solution. In my experience this is where the opportunities for biology to influence design exist: less as a mechanism borrowed literally from an organism, but rather a different lens on a stalled problem. The resulting work often looks conventional and the biological influence almost undetectable. It shows up in our industrial design work, where a shell or

↑ Raimundo Robas, 2021 | Pexels cc

2 Julian F. V. Vincent, "How to Tame Analogies for Use in Biomimetics," in *Biomimicry: A Functional Approach*, ed. Vincent Bels, Stanislav N. Gorb, and Roi Gurka, Biologically-Inspired Systems 20 (Cham: Springer, 2026), https://doi.org/10.1007/978-3-032-11949-0_11.



an overlapping plate arrives and nobody thinks to call it biology. The biology provides influence and framing, and it leaves little in the way of witness marks. Good solutions from biology, as from other fields, become invisible because the work is good enough to reset expectations and does not draw attention to itself.

Like so much important work, there is little glory in this. Wins like these don't play well in journals or on presentation slides as there is nothing to point at, and no clear way to prove biology was the solution. I am not sure it's my place to say what the field should do with this. The fixes are multivariate and entangled with engineering practice in a way that makes them difficult to parse. Incentives, training, culture, mentorship, disposition and what someone was curious about prior to being hired all have a role to play. But I can say what I see from inside a project: biology doesn't lose on merit, it loses on timing. The genius of nature argument, however true, works against that. It asks an engineer to adopt a cause under duress, and a cause that is not part of the spec will be the first thing abandoned in a project. What survives is already at hand because it costs nothing to reach for.

↑ Maximilian Orlowsky, 2012 | Pexels cc

↓ Ben Millen is VP of Design & Product at Tangent Design Engineering, a Canadian consultancy building medical and industrial products. Trained as a systems engineer and an industrial designer, he works across both sides of the business. He writes about design practice and the commercial and cultural forces that shape how we work and what we end up making. <https://euclidian.substack.com/>





Ducks aren't oily, and bones aren't hollow: Lorna Gibson's *Birds Up Close*

a review by Richard James MacCowan

"You're not going to believe this," is how Lorna Gibson says she opened every conversation with her MIT colleagues while she was writing this book.

↑ Caio, 2022 | A mallard duck | Pexels cc

Go and stand beside a pond on a cold morning. Watch a duck haul itself out onto the bank and shake. The water comes off in sheets, and within seconds the bird is dry.

Why?

If you thought of the preen gland and its oils, you are in good company, and you are very much wrong. It is one of those explanations/legends in biology that has been repeated so often nobody thinks to check it. Feathers keep their water repellency after the oils and waxes have been cleaned off. They keep it even when the preen



Moussa Idrissi, 2025
Pexels cc

gland has been removed at hatching. Whatever is going on, oil is not the mechanism.

That gap, between what we can watch and what we can actually account for, is where Lorna Gibson has chosen to work. For me, this is extremely important as I seem to spend much of my time separating myths of nature from actual facts that biologists have identified. The bird aspect takes me back to my summers on the west coast of Scotland, learning about plants and animals along the Loch Fyne coastline with my grandfather. I still have a fascination with cormorants to this day!

Gibson taught materials science and engineering at MIT for nearly forty years. She is also a life-long birder, and in the epilogue explains what started the book. Browsing the science and nature shelves over many years, she found plenty of popular titles by biologists, by mathematicians, by physicists, and almost none by engineers. Birds seemed a reasonable way to close that gap.

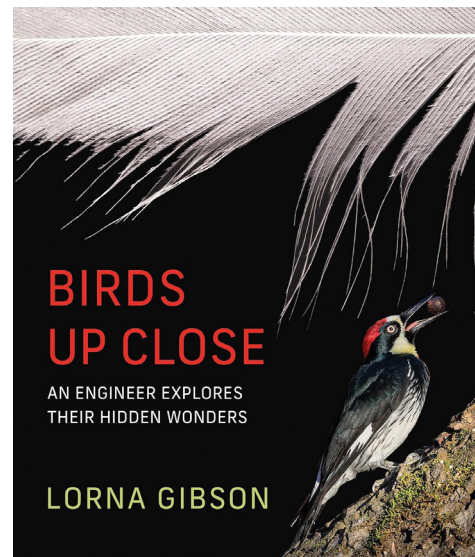
Her method comes from the overlap between her two habits. Birders raise binoculars to look closely at the outside of a bird so they can tell one species from another. Materials scientists put a sample under a microscope to look closely at the inside of a material so they can work out why it behaves as it does. Both are acts of close looking. Gibson simply points the second kind of attention at the subject of the first.

Birds up Close is seven chapters, organised by system rather than by species. Here is what she does with them.

Feathers

Two chapters, and she splits them by problem rather than by anatomy.

The first deals with colour and sound. It opens with a male broad-tailed hummingbird's courtship dive, in which he synchronises the flash of his



↑ Gibson, L. J. (2026). *Birds Up Close: An Engineer Explores Their Hidden Wonders*. MIT Press. <https://mitpress.mit.edu/9780262049894/birds-up-close/>



iridescent throat with the buzz of his tail feathers to within 300 milliseconds. Pigmentary colour from melanins and carotenoids is kept separate from structural colour, which comes from thin-film interference in barbule nanostructure at scales below a micron-levels. Owl silence gets taken apart into three distinct mechanisms rather than treated as one: leading-edge serrations, a velvet surface, and trailing fringes. The facial ruff is handled separately again, as an acoustic collection problem rather than a noise suppression one.

↑ David Dibert, 2022 | Ruby-throated hummingbird. | Pexels cc

The second chapter comes back to the duck. The repellency turns out to be a matter of surface energy and surface geometry, and Gibson makes it quantitative. Water sits on glass at a contact angle of about 7 degrees, on paraffin wax at about 109 degrees, and on the keratin of a Canada goose feather shaft at about 102 degrees. She then explains surface energy through the bonding asymmetry of atoms sitting at a free surface, which is the actual physics rather than a picture of it. The preen gland, incidentally, does have a job. It keeps keratin from drying out and going brittle, and it holds down bacteria and fungi. It just isn't the one we credit it with.

Bones

This is where the materials scientist is most visible, and it contains the book's second good demolition.

Birds do not have hollow bones. Most bird bones are filled with marrow, for the straightforward reason that marrow is where blood cells are made. Only some of them are hollow and connected to the respiratory air sacs, chiefly the humeri, certain neck vertebrae and the sternum. What actually characterises bird long bones is that the cortical wall is unusually thin relative to the diameter. We all know now!!!

The flatter bones do something more interesting. The carpometacarpus is built as a sandwich section, with solid cortical skins either side of a porous core. Anyone who has specified aerospace panels will recognise it immediately, because it is the standard engineering answer to getting bending stiffness at low mass. Gibson traces the observation back to D'Arcy Thompson's 1917 drawing of a vulture's metacarpal and forward into her own research career.

Biology, then mechanism, then engineering principle. She does not skip the middle step, and the middle step is what most writing in our field leaves out.

Bills

Gibson opens this one at the Wild Centre in the Adirondacks, standing in front of a twice-life-size wooden pileated woodpecker mounted on a tree trunk, with a giant Swiss Army knife opened up against the same trunk. Birds gave up their hands to build wings, so the bill must do the handiwork.

She then sensibly abandons any attempt at a taxonomy and gives us three cases instead. Woodpeckers and impact tolerance, through the hyoid apparatus, the offset between upper and lower bill tips, and the foam-like interior of the skull.



Calidris sandpipers detecting buried prey without touching it, using Herbst corpuscles to read pressure differences in saturated sand. Phalaropes spinning on the surface and then walking droplets of plankton-laden water up the bill on surface tension alone.

↑ Dmytro Koplyk, 2026 | Pileated Woodpecker | Pexels cc

None of those is a shape. All of them are mechanisms.

Eggs

Four questions, worked through in order, on how an egg is assembled along the oviduct. What produces the colours and patterns, and why cavity nesters lay white while ground nesters lay speckled. Why shapes run from nearly spherical to sharply asymmetric, which turns out to track flight ability and body form rather than nesting habit alone. And how a shell manages the awkward trick of bearing an incubating parent while staying

breakable from the inside.

The shell is a thin-walled pressure vessel with a deliberate directional weakness. It is a nice piece of engineering, and Gibson treats it as one.

Flight

Two chapters, split along the force balance, which is the right way to do it.

The first deals with weight and upward force. Birds typically weigh a third to a half of a mammal of comparable length, and she gives the comparisons directly: a house sparrow against an eastern chipmunk, a rock pigeon against a grey squirrel, an American crow against a cottontail rabbit. All three ratios land between a third and a half.

The second chapter handles drag and thrust. Three sources of drag separated properly: V formation flight supported with the pelican heart rate work and the GPS-tracked ibis study. Soaring split into thermal and dynamic. A closing run

↓ Veronika Andrews, 2025 | Crow | Pexels
cc



through hovering, underwater flight in alcids and penguins, and the local rules that generate startling murmurations.

So can you build from it?

Well... not yet. And this is the part worth being clear about.

Gibson explains mechanisms. She does not specify them. You finish the bones chapter understanding why a sandwich section resists bending efficiently. You do not have the relative density relationships that would let you size one. You finish the feathers chapter knowing that contact angle and surface geometry govern repellency. You do not have the roughness parameters or the wetting-regime criteria that decide whether a given surface will behave that way in practice. For those in biomimetics, this is helpful.

That is not a fault. She states her constraints openly before the first chapter: no scientific background assumed, calculations confined to boxes you can skip, mathematics held to arithmetic and exponents. Those were the right calls for the audience she chose. But they place the book at a particular point in the chain that runs from biological observation to working technology. It clears the first step properly and then stops.

For those of us working in biomimetics, that needs saying plainly. This is an excellent entry point and an unreliable endpoint. On its own, it will get you as far as recognising the mechanism and framing the problem. It will not get you to transfer. Treat it as a source for design decisions rather than as a route into the literature, and you will find yourself working from qualitative description where you need quantitative constraint.

The references are the real prize

Which brings me to the feature that is easiest to overlook and hardest to overvalue.

There are roughly 165 references, sitting at the

end of each chapter and subdivided by section topic. Separate lists for feather colour, for creating sound, for suppressing sound, for collecting sound, for water repellency, for thermal insulation, and on down the book. They are overwhelmingly primary peer-reviewed literature. *Journal of Experimental Biology*. *Proceedings of the Royal Society*. *Nature Communications*. *Journal of Anatomy*. *Journal of the Royal Society Interface*. Prum and colleagues on structural colour. Bachmann and Wagner on barn owl wing morphometry. Clark, Elias and Prum on aeroelastic flutter.

One pairing makes the whole point. The preface cites her own 2006 *Journal of Zoology* paper on woodpecker impact, and it cites *Cellular Solids*, written with Michael Ashby, which is where the quantitative mechanics of foams and honeycombs actually live. Chapter 3 describes trabecular bone in prose. *Cellular Solids*, flagged two pages into the book, gives you the scaling laws. The distance between those two texts is exactly the distance between reading about a mechanism and being able to use one.

This approach to the book is unusually generous and unusually well organised. Enter at any section, take the mechanism as your search term, and you are straight into the primary sources. Read it that way, as an annotated route into six separate research literatures assembled by somebody who has actually read them, and it is worth a good deal more than its page count suggests.

One last thing, and it may frustrate some readers. Gibson makes almost no claim to biomimetics at all. The terms appear in her reference lists and essentially nowhere in her body text. She is explaining how birds work, not proposing what we should build from them. I take that as restraint, and I prefer it. There is more than enough writing in circulation that runs the other way, starting from the application and reasoning backwards to a biological story that supports it.



Worth your time?

Yes, with a condition attached.

Birds Up Close is the most mechanistically serious popular book on biological materials I have read in a long while. It explains rather than gestures. It kills off at least two claims that should have died decades ago. And it is honest about being a starting point rather than a manual.

Read it for the mechanism recognition, which sits well above the standard of most comparable writing. Then read the references, because that is where the transferable content is. The book will not do the second job for you, and it never pretends it will.

So here is my question to you. How many books in our field explain the mechanism properly and then hand you the primary literature to go further? I can think of very few. Professor Gibson has taken how she teaches and opens up curiosity of both materials and birding. This book is more like a seminar with a world-renowned materials scientist than a standalone book. Use it as one.

Epilogue - Sanctuary and solace

Gibson had a complete draft by the spring of 2019. That April her wife Jeannie was diagnosed with glioblastoma. The epilogue is an account of Jeanie's life, her illness and her death, and of what birding meant during it. It is written with restraint and without a shred of sentimentality.

It also reframes everything before it. Those chapters on feather microstructure turn out to be, among other things, a record of sustained attention during a period when attention must have been very hard to sustain. The dedication only makes sense once you have read it.

↓ Richard James MacCowan is a researcher and R&D advisor specialising in biomimetics and complexity science. He is the founder of Biomimicry Innovation Lab, which applies evidence-based scientific principles to manufacturing, agrifood, and urban systems, and provides technical advisory support for organisations developing nature-inspired technologies. His work spans collaborations across North America, Europe, Africa, and Asia, focusing on translating biological mechanisms into deployable technologies, materials, and decision frameworks. Richard also serves as CEO of Smart Stable Ltd, an equine technology company. Alongside his consulting and technology scouting for deeptech and nature-inspired ventures, he is a jury member for the European Innovation Council (EIC), assessing frontier technologies and startups. His research on the state, constraints, and future of nature-inspired engineering is captured in *The State of Nature-Inspired Innovation* series: [https:// www.biomimicryinnovationlab.com/research](https://www.biomimicryinnovationlab.com/research).





Eliot Graeff

Interviewed by Shoshanah Jacobs

It's been quite a while since Eliot Graeff and I talked about biomimicry. If I remember correctly, the last time was in a restaurant in Paris, savoury crepes, served to perfection, passionate people talking about speculative pathways for a more sustainable future. And now, suddenly, it's ten years later, and I'm wondering how things are going in France. There is no better person to reach out to. Eliot's passion has not faded. He and his colleagues have built a community of biomimicry practitioners and thinkers, and I've realized that ten years is just too long to wait between conversations.

↑ Seahorse via <https://asteria.life>

What are your impressions of the current state of biomimicry or bio-inspired design?

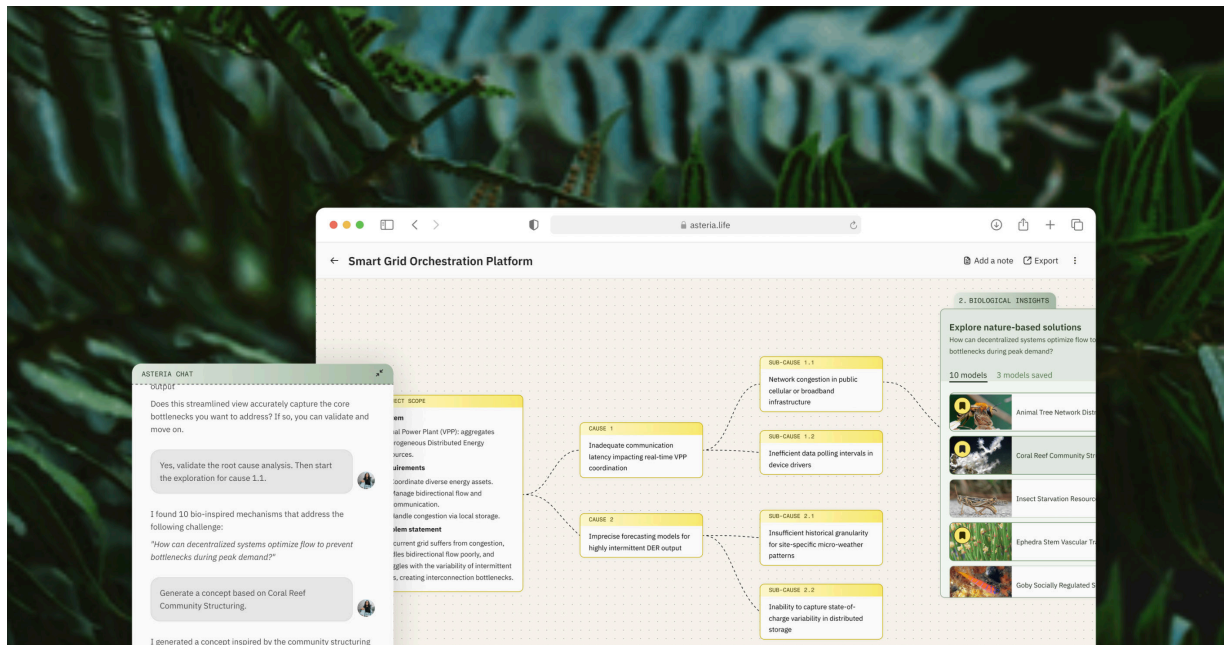
I think we're evolving from artisanal biomimicry to industrial biomimicry, with all the ethical and technical challenges it implies. From my perspective in France, after a foundational first wave grounded in external expertise, the field's maturity and the emergence of new tools allow organizations to integrate biomimicry into their practices as a means to a sustainable competitiveness goal.

There is enormous enthusiasm for biomimicry today, and that momentum is a real asset. Many organizations and individuals are driven by passion, the common good, and a desire to spread biomimicry as a model for a more desirable future, and that conviction is what has carried the field this far. The next challenge, and the real opportunity, is to match this enthusiasm with industrial credibility. The technical, philosophical, and cultural paradigm shift that biomimicry represents remains the absolute objective, and giving it the industrial rigour to scale is how we make sure this vision actually lasts.

What excites me is that the expertise and commitment of this first wave of pioneers led to the emergence of a new generation of organizations and tools. This new wave is filled with energy and a deep willingness to tackle the massive industrial challenges ahead. The same is true in research. Young researchers entering the field today may reach professional maturity just as society becomes ready for the kinds of solutions biomimicry can offer.

Asteria* is the perfect example of that transition. It started as a four-year research project at Cee-bios (the French biomimicry network) and has now become an independent company focusing on AI-supported approaches that empower companies to become active practitioners of biomimicry and reintegrate biology into their daily practice. This transition isn't without challenges, but it feels

* <https://asteria.life>



↑ Asteria Platform | <https://asteria.life>

like a period of infinite potential. New industrial constraints, changing regulations, international competition, supply chain pressures, and increasing environmental demands are creating conditions in which biomimicry isn't simply interesting anymore, it may become necessary since standard approaches fail.

Overall, I'm deeply optimistic. The field is changing rapidly, and while every phase of adaptation brings some friction, I believe these changes are precisely what moves us forward.

What do you see as the biggest challenges in the field?

Our biggest challenge is finding a balance between meeting people where they are and staying true to the spirit of biomimicry.

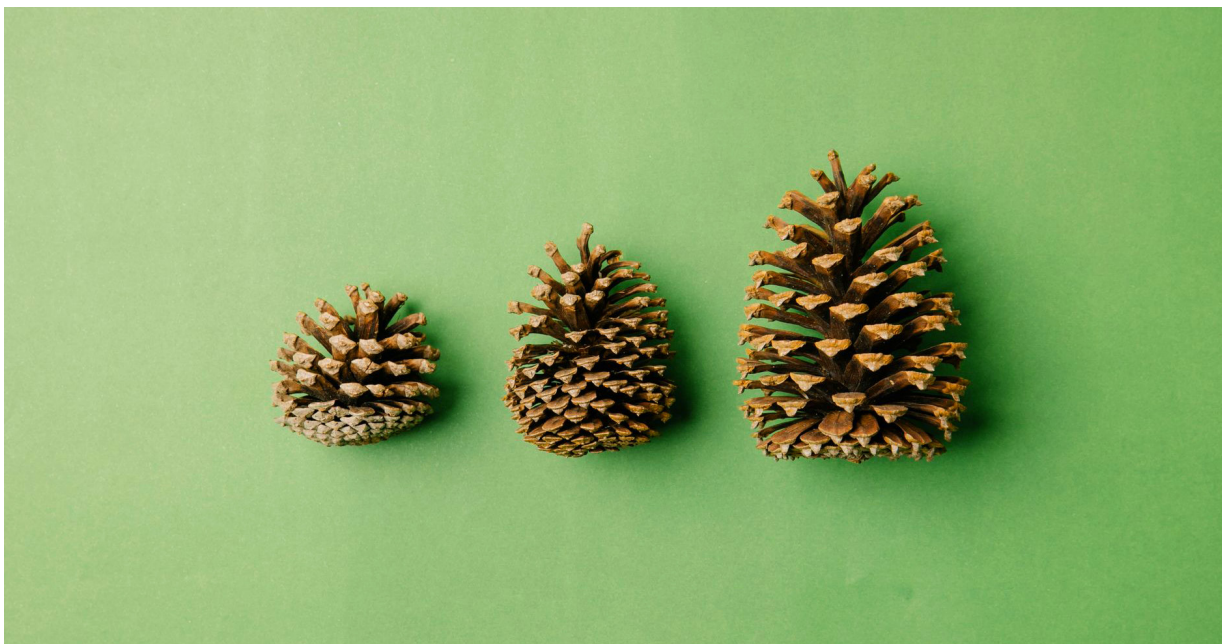
If we remain purely in the long-term paradigm-change space without solving short-term real problems, we remain an academic concept, and nothing changes in practice. But if we focus only on engineering performance or short-term

commercial success, we risk drifting away from the discipline's deeper purpose.

If we aim for widespread transversal adoption, biomimicry needs to be bottom-up, used imperfectly by many, rather than mastered only by a few experts. We need to start with the day-to-day challenges people face, then gradually explore how biomimicry can drive a true paradigm shift. That requires patience and careful balance.

We experience this exact tension in Asteria's development. Some users tell us they only want the engineering mechanisms or the physical principles behind a biological strategy. They don't feel they need the biology itself. I completely understand that perspective because the value lies in transferring functional principles and that principle of transfer is exactly what we've built Asteria around. At the same time, one of our missions is to change the way we think about innovation and the future, and we are convinced that reconnecting people with nature is one of the keys to doing so. When an engineer learns how a pine cone regulates moisture at work and then points out that same mechanism to their child on a weekend walk, a

↓ Laura James, 2020 | Pexels cc



quiet cultural shift occurs. They stop viewing nature just as a resource to exploit and start seeing it as a partner to respect. That is my personal driver.

As entrepreneurs and practitioners, we constantly have to balance what users want with the mission we believe in. I think that challenge defines this new wave of biomimicry practice.

What areas should we focus on to advance biomimetics?

One of the biggest priorities is strengthening the evidence that biomimicry actually delivers superior sustainability outcomes. Many of us intuitively trust that learning from the living naturally leads to better environmental outcomes, and for perfectly good cultural and theoretical reasons as I've just explained. Building the evidence base that confirms this at industrial scale is the natural next step in the field's maturity. That means showing why and when biomimetic products are actually more sustainable, starting with a careful look at the whole life-cycle, including materials and manufacturing processes. The real opportunity is to manufacture in ways that reflect the efficiencies of living systems and to choose sustainable materials, so the sustainability gains are real rather than moving the problems somewhere else in the chain.

I also think we need much stronger collaboration with the well-established ecodesign, LCAs, low-tech, and circular design community. So much of the expertise there complements biomimicry. Rather than working in parallel, we could be producing many more collaborative studies that connect biomimetic approaches with measurable sustainability outcomes.

The goal is to move beyond assumptions and build a body of reproducible evidence that demonstrates where biomimicry delivers meaningful



environmental benefits, and maybe even more importantly, where it doesn't.

↑ Bejan Adrian, 2026 | Pexels cc

That is precisely where AI-native software holds such great promise: it allows us to analyze, test, and validate these complex cross-disciplinary variables at scale before a single prototype is even manufactured.

What is your best definition of what we do?

I often think about it this way: mathematics, physics, and chemistry describe the fundamental laws of the universe. They explain why things happen, the cause not the objective, and frame the scope of what's scientifically possible.

Biology shows us how those laws are leveraged by living organisms to survive, adapt and thrive on Earth over billions of years. So basically biology defines what's scientifically desirable to thrive. And beyond those abstract laws, we can observe

millions of proven, functional embodiments to learn from.

Biomimicry is about learning from this priceless map so that our human societies can thrive on Earth as well.

By what metric should we judge the work?

I look at this through two main axes, the result, and the process. In my opinion both matter because they both create distinct externalities.

On the result axis you have to consider both the overall externalities of a design on the environment and its ability to create real value. A product with wonderful environmental externalities but no value, because it's inefficient, too costly, or poorly designed, won't make a real-world difference. It remains an investment of time, money, and environmental resources with no return. From an evolutionary standpoint, if it can't survive in the market, it isn't fit enough to be selected. And I intentionally say "value" and not "profit" because I don't think a good biomimetic project has to necessarily be a profit-based project, it just has to deliver real utility.

On the process axis, good biomimicry requires understanding and transferring the underlying scientific principles that make a biological strategy work. The real challenge is identifying and applying those mechanisms and scientific laws while ensuring they remain functional when translated into a different context or at a different scale. That scientific fidelity is what distinguishes biomimicry, in a biomimetics sense, from aesthetic bio-inspired design. Inspiration can certainly lead to interesting ideas, but biomimicry depends on faithfully transferring the principles that have been selected through evolution. Beyond the technical rigor, this step-by-step discovery process is what builds a lasting human connection. Uncovering how a mechanism actually works

creates a powerful bond grounded in curiosity and fascination for nature's ingenuity.

And this brings me to what I find to be the single most delicate challenge in building an AI-native tool like Asteria. There is a profound cognitive difference between analyzing, understanding, and learning how to transfer a biological insight yourself versus simply having a pre-formulated solution handed to you on a silver platter.

If an AI tool just delivers a ready-made answer, you solve the short-term tension, the immediate engineering problem, you optimize the time sensitive innovation process, but you completely miss the human impact. You lose the transformative journey, that moment of awe when you finally realize how nature solved a problem, which is what actually rebuilds the human-nature connection.

So the ultimate design challenge for Asteria isn't just making biological data searchable. It's designing an experience that doesn't bypass human curiosity, but ignites it, a tool that guides engineers through the logic of living systems so they don't just consume the answer, but truly internalize the intelligence behind it.

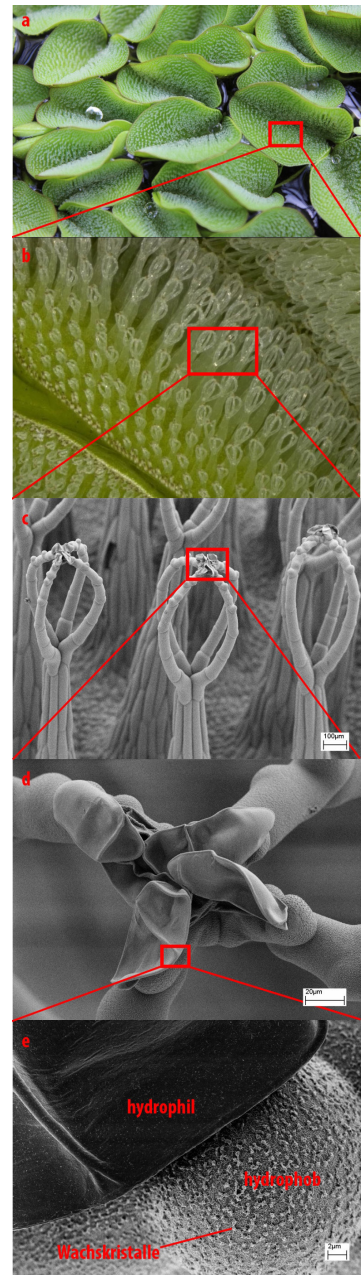
Spoiler alert: it's hard! And if any of your readers have ideas to help us solve this puzzle, I'd be more than happy to connect.

When we combine those transferable principles with value and genuine positive impact, we create designs that honour the science, solve real problems, and fulfill the intent of biomimicry.

That's fascinating. What's your favourite biomimetic example of all time?

I'd have to say the *Salvinia* effect, the way the *Salvinia* floating fern traps air underwater. I first came across it during my PhD while researching superhydrophobic surfaces. At first, I thought I

↓ Issempa, 2013 | Images of *Salvinia molesta* at various magnifications. In the SEM image (d), the hydrophobic wax crystals and the wax-free (hydrophilic) cells at the tips of the hairs are clearly visible. | Wikimedia Commons

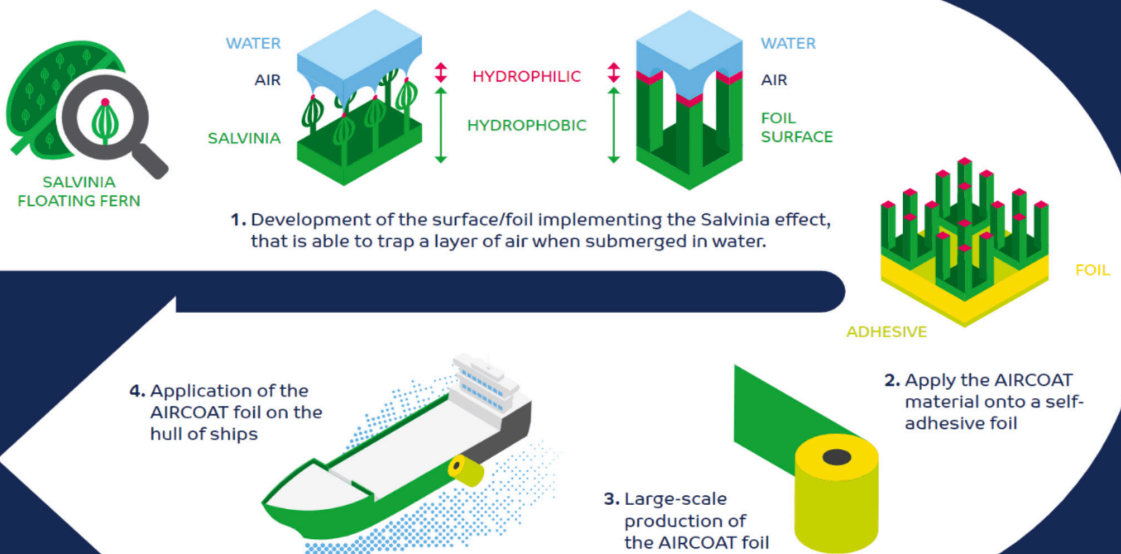


understood exactly what was going on. I thought it was just like the famous Lotus effect, a simple story of water-repellency and self-cleaning, but after spending time with it, I realized I had completely misunderstood the biological function, and I had to confront the complexity of the abstraction.

That was a really humbling experience. The plant was actually solving a much more complex problem involving buoyancy and gas exchange. The more I looked, the more levels of design I discovered, from the microscopic surface structures to the way groups of structures work together, and even the flexibility of the system itself.

Since then, I've tried applying it in a few industrial projects, kept a close eye on initiatives like the EU AIRCOAT project for ship hulls, and I even built my TEDx talk around it to share that sense of wonder with a broader audience.

↓ Johannes Oeffner, Jukka-Pekka Jalkanen, Stefan Walheim, Thomas Schimmel. From nature to green shipping: Assessing the economic and environmental potential of AIRCOAT on low-draught ships. *Proceedings of 8th Transport Research Arena TRA 2020*, April 27-30, 2020, Helsinki, Finland. <https://aircoat.eu>





I still love it because it reminds me that biology often has much richer explanations than our first engineering interpretation. It's a wonderful example of how nature can surprise you, even when you think you already know the answer.

↑ <https://asteria.life/use-cases/low-energy-high-density-data-storage>

What's the last book you enjoyed?

I recently finished *Les Furtifs* by the French science-fiction author Alain Damasio. Much of Damasio's work explores societies shaped by technologies that have gone a little too far, almost like *Black Mirror*. In *Les Furtifs*, the story imagines a new species living alongside humans that moves so quickly we can't perceive it. The fascinating question is what it would mean, in a world where we believe technology lets us control everything, to discover another species that has been living among us all along, and what we might learn from it. I thought it was magnificent.

Who do you admire, and why?

Rather than naming one person, I admire the generation of pioneers that has spent the last twenty years building the foundations of biomimicry.

They knew they probably wouldn't see the field fully mature during their own careers, yet they kept doing the work anyway. They built the



knowledge, the tools, and the community so that others could continue from where they left off.

↑ Nicolas Leo Moreira and OpenAI. 2023. DALL.E. Feb/March 24 versions

All of us young biomimicry professionals today stand on their shoulders and for me, that's one of the most inspiring aspects of biomimicry. It encourages us to think beyond our own careers and to work for future generations. I feel a responsibility to make sure the work they've done continues to grow.

What's your idea of perfect happiness?

For me, perfect happiness is something very simple: a bit of sunshine near a river, sharing a drink in a beautiful place with close friends and the person you love. I don't think it needs to be any more complicated than that.

If you weren't scientist, what would you be?

I'd probably be a science-fiction writer. I love



imagining possible futures and asking "what if?" questions. Science fiction creates a space where you can explore new technologies, new societies, new cultures, new philosophies, and different ways of living without being constrained by today's assumptions. In many ways, sci-fi and biomimicry share the same core engine: reimagining what is possible. In fact, I've been thinking about a sci-fi novel set in a fully biomimetic world for a while now... so who knows, maybe that's next!

↑ <https://asteria.life/use-cases/nature-inspired-pigment-free-lipsticks>

↓ CEO and co-founder of Asteria, Eliot is a life science engineer and holds a PhD in biomimetics. Passionate about understanding, teaching, and applying bio-inspiration, he coordinated the biomimetic methodology department at Ceebios until 2024 and served as a scientific advisory member of the European Nature4Nature program. Today, he drives Asteria's mission as a committed, science-driven company delivering concrete solutions to support ecological transition and foster a desirable future.

Is there anything else you'd like to add?

If constraints drive innovation, then given the global challenges ahead, we are about to witness an unprecedented wave of human creativity. Our community has a massive role to play in building viable, inspiring alternatives to the standard industrial narrative. Now it's up to us to adapt, innovate, and make those alternatives a reality.

Let's build them, or fail trying.





Sustainable Design: From Vision to Action, edited by Jeremy Faludi

A review by Randall Anway

At 444 pages, *Sustainable Design* is a substantial read. Reflecting on it during a walk in the woods near my home, I considered how 'sustainability' encompasses a complex mix of standards and concepts, centered around an intangible purpose reminiscent of the vision for "A Common Ground for Learning From Nature" over a decade ago.¹⁰

The promise of biomimicry and associated practices like bio-inspired design and biophilia holds significant potential, including improved interdisciplinary collaboration and credibility for biology-grounded systems practices. Despite evolution in these fields since 2013, the idea of a common ground remains aspirational, situating

↑ Lorenzo Manera, 2024 | Pexels cc

¹⁰ Hoeller, N., Goel, A., Freixas, C., Anway, R., Upward, A., Salustri, F., et al. (2013) Developing a Common Ground for Learning from Nature. *Zygote Quarterly*, issue 7, pages 134-145

sustainability within a wider frame of people's relationship with nature.

The original vision was motivated by a lack of standardization in research and evaluation, which could undermine credibility. Since then, frameworks like the Planetary Boundaries and Sustainable Development Goals have advanced sustainability thinking, particularly in managing tradeoffs and impacts on human development.⁵

While these frameworks are becoming more widely recognized, translating them to practice and operationalizing them remains a struggle.⁸ Research suggests that sustainability transitions in industry are in an extended conceptual stage, challenged by tensions between driving macro trends, internal transformation processes, and the role of design in systemic change.² Now, as when the 2013 article was written, there is a continuing call for clarity on the concept of sustainability, and for grounding action in Earth's wisdom.

Initial Expectations

Given the title and authors' backgrounds, I anticipated a comprehensive framework to guide industrial designers in contributing meaningfully to sustainability transitions. This aligns with Wilde's vision for design education, where addressing sustainability is an intricate design problem requiring educators to position it as both background and foreground for every design action.²³

However, I'm aware that integrating sustainable transitions into design education can be uncomfortable and fraught with challenges, such as creating common ground between biomimicry (B3D), Sustainable Design, and Design for Sustainable Transitions. One key characteristic—transdisciplinarity—highlights the increasingly difficult choices educators face, as narrow focuses on employability often neglect critical eco-social challenges.⁴ More broadly, common ground engagement draws on critical thinking, judgment, and discovery

5 Chan KMA, Boyd DR, Gould RK, Jetzkowitz J, Liu J, Muraca B, et al (2020). Levers and leverage points for pathways to sustainability. *People and Nature*, 2:693–717. DOI: 10.1002/pan3.10124

8 Geels, F. W. (2026). Why sustainability transitions are starting to accelerate via technical innovations but not through social innovations: five reasons and some critiques of transformations research. *Global Sustainability*, 9, e13, 1–8. <https://doi.org/10.1017/sus.2026.10054>

2 Berger, E., Goutagny, P., and Nowacki, C. (2024) Framing Transitions: Scenarios and Design for the Strategic Redirection of Companies within Planetary Boundaries, in Gray, C., Ciliotta Chehade, E., Hekkert, P., Forlano, L., Ciuccarelli, P., Lloyd, P. (eds.), *DRS2024*: Boston, 23–28 June, Boston, USA. <https://doi.org/10.21606/drs.2024.934>

23 Wilde, D. (2020). Design Research Education and Global Concerns. she ji The Journal of Design, *Economics, and Innovation* Vol. 6, No. 2, Summer 2020.

4 Boehnert, J.; Sinclair, M.; Dewberry, E. Sustainable and Responsible Design Education: Tensions in Transitions. *Sustainability* 2022, 14, 6397. <https://doi.org/10.3390/su14116397>



skills for the deep research required to 'cut cubes out of the fog'.²² These capabilities are essential for designers seeking solutions that can address complexity across multiple levels of concern.

Reflecting on our current planetary crises and the hopeful vision of common ground, I wondered what a textbook like *Sustainable Design* could offer: a reflection of current practice or an advancement towards new solutions? I had high expectations for a visionary approach to industrial design education that could help navigate the unsustainable state of 'sustainable' design. As Stuart Walker suggests, imagining our way out of this crisis requires speculation, exploration, and a profound respect for the natural world.²¹

Summary of the book and how it challenged my expectations

Sustainable Design is a textbook for Industrial

↑ Sonny Vermeer, 2023 | Pexels cc

22 Whitney, P., Nogueira, A. (2020). Cutting Cubes Out of Fog: The Whole View of Design. she ji *The Journal of Design, Economics, and Innovation* Vol. 6, No. 2, Summer 2020.

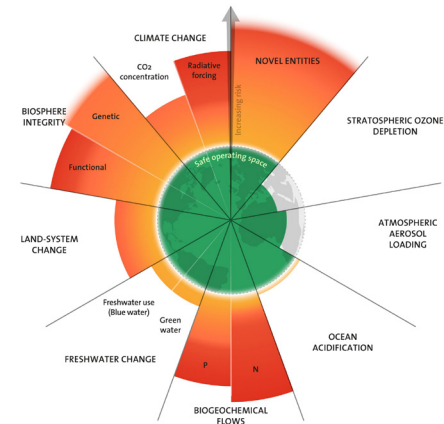
21 Walker, S., (2023). Design is ... Lost, *The Design Journal*, 26:1, 4-6, DOI:10.1080/14606925.2022.2154962

Design students, covering a range of design strategies and practices through sections on vision and action. The "vision" section includes chapters on higher-level topics such as Sustainable Development Goals, Planetary Boundaries, Ecodesign, and systems modeling, providing a holistic perspective on sustainability. The "action" section offers a concept-rich overview of discretionary design actions related to materials, recycling, energy, business models, biomimicry, relational ethics, and communication.

However, upon closer review, I found the book's approach to be narrowly scoped from a common ground perspective. It seems more focused on industrial design tools with a material management slant rather than a thoughtful vision for sustainable design informed by nature's principles. The book's emphasis on practicality through toolkits and checklists prioritizes incremental improvements over non-linear developments. For instance, the focus on energy efficiency and impact reduction prioritizes incremental changes, while the emphasis on materials and recycling encourages a focus on traditional materials and manufacturing processes.

Furthermore, the book's techno-centric, managerial approach to design overlooks more nature-aligned pathways and expansive vocabularies of complexity. The modest assumptions about what constitutes sustainable outcomes leave little room to empower industrial design education in the numerous ways design could matter to industry in sustainability transitions.

The book's limitations are particularly evident in its approach to addressing the complex challenges facing industrial design education. The emphasis on closed-loop systems and industrial metabolism, while useful, depends on a brittle metaphor¹⁹ that distances sustainable design from what it could become: a primary driver for translating insights from natural systems into sustainable



↑ Planetary Boundaries, 2025 | Azote for Stockholm Resilience Centre, based on analysis in Sakschewski and Caesar et al. 2025 | CC BY-NC-ND 3.0

19 Smit JP (2025). (De)naturalizing knowledge ecosystems: on the use of ecological metaphors in STS and innovation studies. *Science as Culture*, 34:3, 355-383, <https://doi.org/10.1080/09505431.2025.2457731>



planetary outcomes. This approach also underplays the importance of educating design students to be attuned to shifting boundaries and conceptualizing actions through ecological and sustainability literacy, the future of work, or theory of change, for instance.¹¹

While the book conveys a sense of urgency, it doesn't really advance any coherent approach to realizing a 'safe operating space' for humanity at an industrial level.³ The authors' approach – adding analytical complexity and metrics to design proposals in an effort to steer toward closed material systems – seems oriented towards incremental wins rather than transformative change. However, the book does contribute to the noble enterprise of educating our way out of some sustainability challenges, and the authors' efforts widen the circle of researchers and educators seeking clarity and agency.

Opportunities for improvement

While the book is well-intentioned, it falls short of transforming design education and practice. I had expected a broader recognition of the larger context for design, acknowledging the gulf between scientific understanding and entrenched industrial practices. Instead, the focus seems narrow, focusing on incremental improvements through product analytics and product-service model innovation.

The authors underestimate the value of testing assumptions and the empathic agency of designers in recalibrating interactivity between people and nature at an industrial scale. By prioritizing practicality over more expansive and relational approaches, the book misses opportunities for design to drive sustainable transitions, for instance, by better understanding the subjective experiences around current, transitional, or niche innovations.²⁰

The authors could have advocated for a more expansive role for industrial designers in

11 Irwin T (2015). Transition Design: A Proposal for a New Area of Design Practice, Study, and Research, *Design and Culture*, 7:2, 229–246, DOI:10.1080/17547075.2015.1051829

3 Biermann, F., and Kim R. E. (2020). The Boundaries of the Planetary Boundary Framework: A Critical Appraisal of Approaches to Define a “Safe Operating Space” for Humanity. *Annu. Rev. Environ. Resour.* 45:497–521

20 Valor C, Martino J, Ruiz L (2023). Blends of emotions and innovation (Non)adoption: A focus on green energy innovations. *Environmental Innovation and Societal Transitions* 48 (2023) 100759. <https://doi.org/10.1016/j.eist.2023.100759>

sustainability transitions by considering business models with nature as a stakeholder and evaluating industrial ecologies against planetary boundaries. A notable exception is a paragraph that brings together sustainable development and planetary boundaries, but it ultimately engages in a scarcity argument about renewable energy technology rather than exploring the broader applications of design in a planetary context.

However, I believe that the book's limitations are more profound. Recognizing the limitations of design as problem-solving, and framing design – especially industrial design – as intentional transformation and transition, is crucial for creating a more sustainable future. This requires designers to become more capable of acting with wisdom,¹⁵ rather than just relying on technical skills or knowledge.

The book's focus on practical tools and incremental improvements may perpetuate conceptual inertia, where legacy products and design methods are erroneously seen as assurances of a stable world. This can limit designers' ability to think differently and adapt to new challenges. As sustainable transitions build on new knowledge but also new ways of knowing, the book's approach may not enable the fundamental reframing and unlearning of unsustainable norms necessary in the context of systemic change.^{7,17,19}

The distinction between "knowing how" and "how to know" is crucial in this context.¹ Designers need to move beyond just knowing how to design sustainable products or systems, and instead develop a deeper understanding of how to approach complex problems and systems. To put it more plainly, framing and engagement skills are critical. This requires a willingness to question assumptions, challenge existing norms, and explore new ways of thinking and doing. Beyond what is offered directly in the book, that could mean contesting the provenance and meaning of industrial design;

15 Maxwell N (2007). *From Knowledge to Wisdom: A Revolution for Science and the Humanities*. Pentire Press, London.

7 Fazey I, Schöpke N, Caniglia G, Hodgson A, Kendrick I, Lyon C, et al (2020). Transforming knowledge systems for life on Earth: Visions of future systems and how to get there. *Energy Research & Social Science* 70, 101724 <https://doi.org/10.1016/j.erss.2020.101724>

17 Peeters, A.L., Tromp, N., & Hekkert, P. (2025). Transformative design frames: A transdisciplinary model to support designing for sustainability transitions. Contexts—The *Systemic Design Journal*, 3. <https://doi.org/10.58279/v3001>

19 Smit JP (2025). (De)naturalizing knowledge ecosystems: on the use of ecological metaphors in STS and innovation studies. *Science as Culture*, 34:3, 355–383, <https://doi.org/10.1080/09505431.2025.2457731>

1 Abson DJ, Fischer J, Leventon J, Newig J, Schomerus T, Vilsmaier U, et al (2017). Leverage points for sustainability transformation. *Ambio* 2017, 46:30–39 DOI 10.1007/s13280-016-0800-y



considering business models with nature as a stakeholder; or evaluating industrial ecologies against planetary boundaries using a broader palette of available concepts.^{6,13,14}

By recognizing the limitations of design as problem-solving and framing design as intentional transformation and transition, we can create a more nuanced and effective approach to sustainable design. This involves acknowledging the complexities and uncertainties of the real world, and developing a more relational and contextual understanding of design's role in shaping the future.

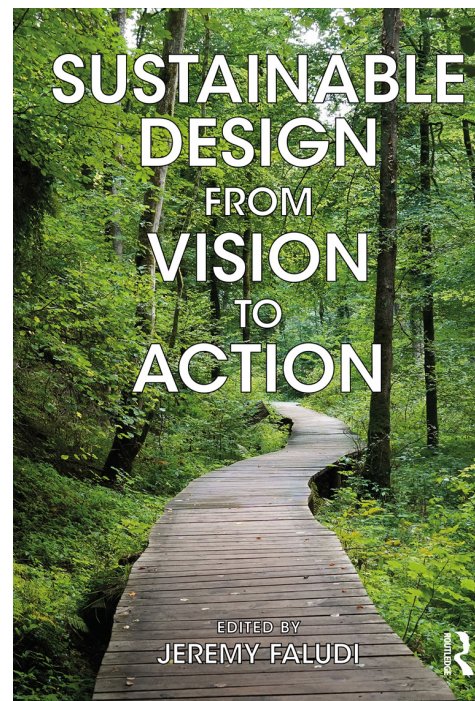
The implications of how we think about and communicate through design are under-appreciated. Rather than fixating only on impacts, developmental design can play a paradigm-shifting role in reconciling sustainable development and planetary boundary work, by recognizing the limitations of design as problem-solving, and framing design - especially industrial design - as intentional transformation and transition.

Transitioning to more sustainable life ways means acknowledging that sustainability is not just a technical challenge, but a paradigm shift involving a reorientation in what it means to live well, to be successful and to thrive, and to participate in similar reorientations with others. In this endeavor designers meet their vulnerabilities, engage in self-reflection, re-imagine their own role and agency in relationship with the natural world, and seek to open up new possibilities allied with life and to flourish. But the arc of that journey gets lost in a fog of methods, metrics, and indicators.

Suggestions for the next edition

This textbook on industrial design for the circular economy provides a practical, introductory overview of design competencies that can help shape product and service design pedagogy. This is a valuable contribution, as it offers design students

- 6 De Vere, I; Fennessy, L (2019). Redefining Industrial Design: Responding to Emerging Modes of Practice. *International Conference on Engineering and Product Design Education*, 12-13 September 2019, Department of Design, Manufacturing, and Engineering Management, University of Strathclyde, United Kingdom.
- 13 Konietzko, J; Das, A; Bocken, N (2023). Towards regenerative business models: A necessary shift? *Sustainable Production and Consumption* 38 (2023) 372–388. <https://doi.org/10.1016/j.spc.2023.04.014>
- 14 Martín-Gómez, A.M.; Ávila-Gutiérrez, M.J.; Lama-Ruiz, J.R.; Aguayo-González, F. (2024) Industrial Metabolism: A Multilevel Characterization for Designing Sustainable Manufacturing Systems. *Machines*, 12, 16. <https://doi.org/10.3390/machines12010016>



- ↑ Faludi, J. (Ed.). (2025). *Sustainable Design from Vision to Action*. Routledge. <https://www.routledge.com/Sustainable-Design-from-Vision-to-Action/Faludi/p/book/9781032824741c>



a starting point for exploring sustainable design principles and practices.

↑ Matthias Groeneveld, 2023 | Pexels cc

One of the key strengths of the book is its acknowledgment of the role of empathy, societal goals and social inquiry, and learning from nature in sustainable design. By highlighting the need for designers to work collaboratively with stakeholders and consider the social and environmental impacts of their designs, the book encourages readers to think more broadly about the role of design in creating a more sustainable future.

However, there are also areas where the book could be improved. Some potential limitations and suggestions for future development are discussed below.

In terms of the book's approach to sustainable design, it may be helpful to more emphatically consider a broader perspective that acknowledges

both the strengths and weaknesses of different design modalities. For example, while product design methods can be necessary and useful tools for managing product-service model innovation and environmental impacts, they may not be sufficient on their own to robustly support sustainability transitions and development.

I suspect that the book's audience could benefit from a less circumspect approach to industrial transformation:¹⁸ by examining in greater detail how to know over 'knowing how', designers will have a better sense of when design for growth or transition (unstable state) can be succeeded by design for renewal (stable state). Such an approach could more explicitly integrate system modeling, post-normal science, plural knowledge systems, and design frames.⁹ In addition to practical guidance on circular design methods, the book could more fully explore means of working with transformation, including normative, critical, dialogic, and interpretive approaches.

This could involve designers working collaboratively with stakeholders (including nature) to articulate mindsets and postures, theories of change, and new ways of designing, as well as becoming unstuck from ingrained approaches to industrial design. To support designers in creating more sustainable systems, it may be helpful to provide more relatable guidance on how to integrate sustainable design principles into their daily practice. This could range from exploring leverage points for transformation (what to reconfigure), to self-awareness and active learning (inner preconditions for innovation), and transdisciplinary collaboration (social synthesis).^{1,12,16}

Ultimately, the book provides a useful foundation for exploring sustainable design principles and practices, but may benefit from further development and refinement to more fully support designers in helping navigate sustainability transitions and industrial transformation. By

- 18 Prendeville S, Koria M, (2022). Design Discourses of Transformation. she ji *The Journal of Design, Economics, and Innovation* Vol. 8, No. 1, Spring. <https://doi.org/10.1016/j.sheji.2022.01.002>
- 9 Goss HM, Tromp N, Schifferstein HNJ, (2025). Framing System Dynamics for Designers Innovating in Transitions. *International Journal of Design*, Vol. 19 No. 1. <https://doi.org/10.57698/v19i1.05>
- 1 Abson DJ, Fischer J, Leventon J, Newig J, Schomerus T, Vilsmaier U, et al (2017). Leverage points for sustainability transformation. *Ambio* 2017, 46:30–39 DOI 10.1007/s13280-016-0800-y
- 12 Ives CD, Freeth R, Fischer J (2020). Inside-out sustainability: The neglect of inner worlds. *Ambio* 2020, 49:208–217 <https://doi.org/10.1007/s13280-019-01187-w>
- 16 Mejía GM, Henriksen D, Xie Y, García-Topetec A, Malinac RF, Junga K, (2022). From researching to making futures: a design mindset for transdisciplinary collaboration. *Interdisciplinary Science Reviews*. <https://doi.org/10.1080/03080188.2022.2131086>



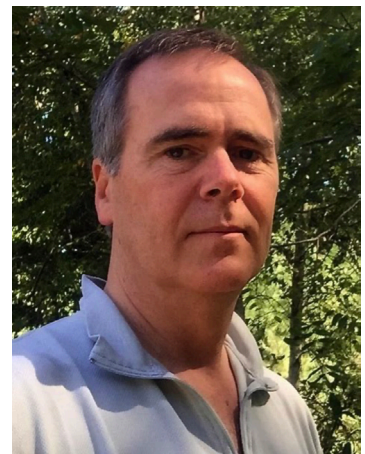
acknowledging both the strengths and weaknesses of different design approaches and providing more guidance on actively becoming sustainable in principled ways, the book could become an even more valuable resource for designers seeking to engage in positive change.

↑ Matthias Groeneveld, 2025 | Pexels cc

Here are some potential areas for improvement:

- Appreciate and illuminate the vulnerabilities of industrial activities with respect to Planetary Boundaries
- Emphasize framing and grounding sustainability transitions in natural systems, as an Industrial Design problem
- More fully integrate the means of working through transformation, such as with interpretive, dialogic, and critical approaches
- Be mindful of the drivers and limits of 'inner transitions' (e.g., at individual, organizational, and social levels), recognizing that sustainable transformation requires not only individual change but also systemic and structural transformations.

↓ With over 30 years of diverse experience in academic, corporate, non-profit, and research settings, Randall Anway brings a unique perspective to design research, helping bridge gaps in our understanding of nature's expressions, human design imperatives, and socio-technical systems. Through his ongoing work, he hopes to inspire support for a new generation of designers, engineers, and researchers adopting a relatable, forward looking, systems-appreciative approach to tackling complex sustainability challenges and creating innovative solutions that begin to actively address the emerging understanding of planetary boundaries for the human-managed environment.



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