BIODESIGN TOOLKIT

EMPOWERING DESIGNERS IN THE BIOECONOMY

- SECOND EDITION -

Toolkit Objectives

The biodesign Toolkit supports the sustainable professionalization of this emerging field.

This Toolkit serves three key purposes:

1. **Informing designers** about the biodesign process and all the elements it involves.
2. **Inspiring designers** about biodesign through thought-provoking questions, practical examples, example case studies, etc.
3. **Activate designers** to start applying biodesign in their projects or businesses.

Toolkit Use

- This toolkit does not intend to restrict or force you in a specific design process, but rather acts as a support, just like a sparring partner.
- If you want to take record of the cards used in your biodesign process, then you can note down the unique card numbers on the top-left corner of each card.
- Note that not all cards will be immediately applicable in your biodesign process.
- Note that cards may recur in different cycles in your biodesign process.
- TIP: Check the toolkit regularly
- Next is a manual that shows a possible way to kick start your biodesign process, but feel free to adapt along the way.

Manual 1/5

How to start out

1. Identify your motivation

- You have a design challenge and you think nature could give an answer.
- You have a material or process of biological origin and you want to explore its valorization into our human world.

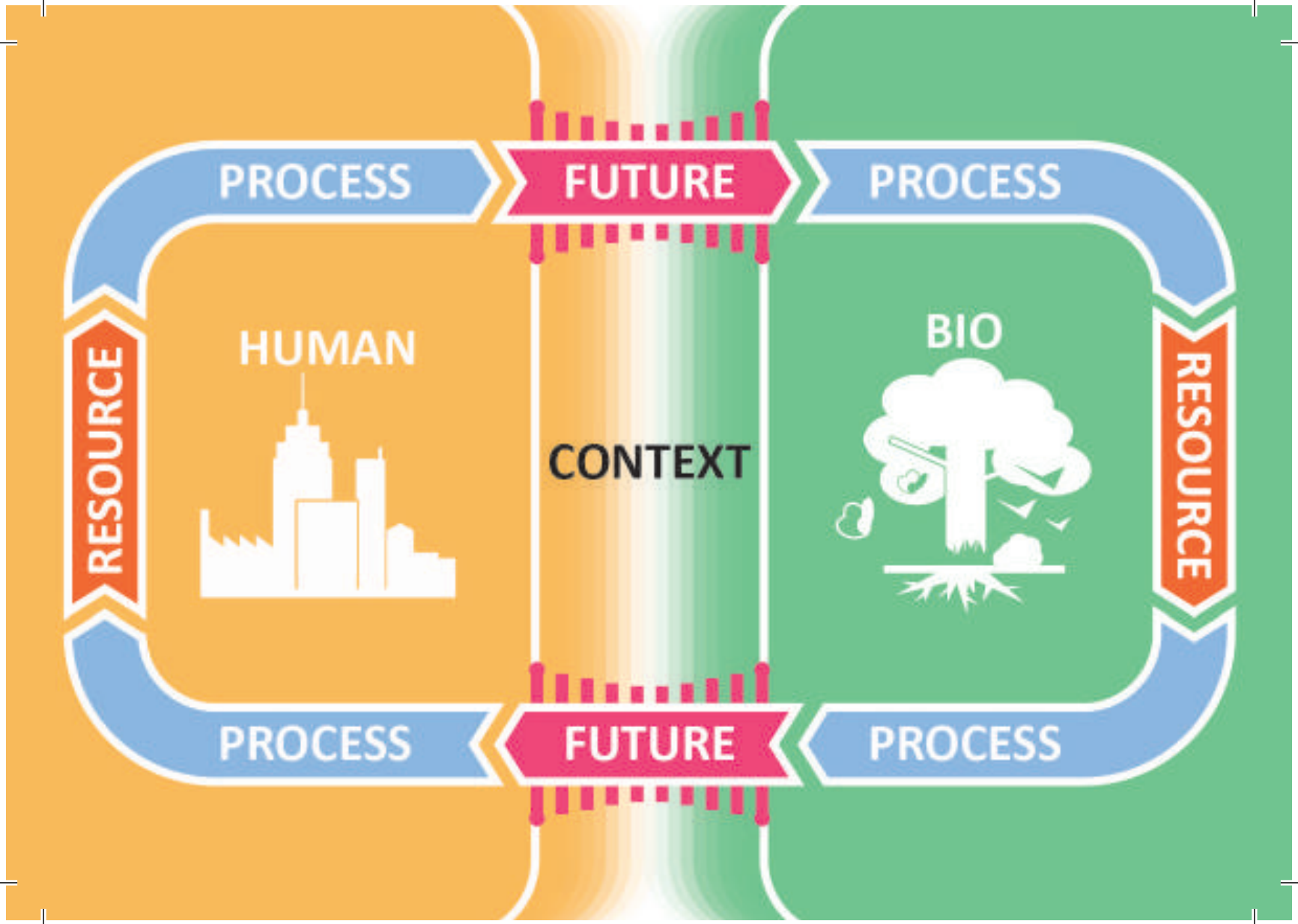
2. Orient yourself in the process

Use the **Process Map** on next card

- If you start from a design challenge, start in the **Human** perspective on the left.
- If you start from a bioprocess/material, start in the natural **Bio** perspective on the right.

3. Define the context of your biodesign project

Use the **Context** cards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Manual 3/5

How to start out

4. **Start cycling back and forth** between the human- and the bio-perspectives of your process, using the Process cards.
   The aim here is to seamlessly blur our human and natural world into one unity, as showcased with the fading colors.

5. **Every time you arrive in one of the two perspectives,** you explore its accompanying cards; Mindset and Materials.

6. **Every time you bridge the two perspectives,** reflect on the future steps by using Future cards

7. **Use Resource cards along the way.**

8. **Use Tip & Tricks cards when referred to on other cards.**

Manual 4/5

Note ...

- This open-ended toolkit serves as a versatile sparring partner, intended for various uses like reflection, activation, communication, and process guidance, but does not guarantee immediate fully biobased results or project success.
- Understanding this process and being aware of its concepts inherently makes you become a better biodesigner.
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Manual 5/5

How to start out

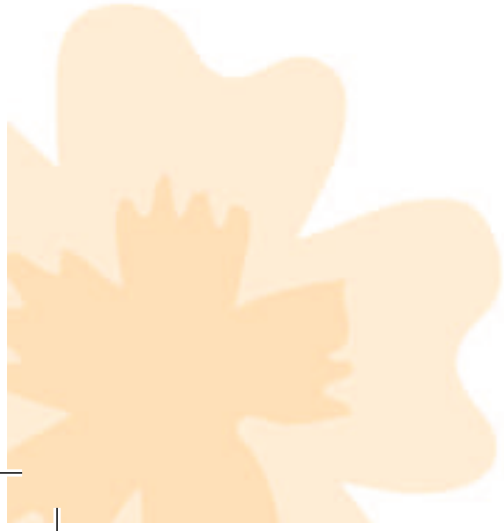
Next to this card deck does the biodesign toolkit also provide digital support through web-based tools. Such as, but not limited to:

- The latest version of the biodesign toolkit.
- New toolkit additions
- Fully worked out case studies with the toolkit.
- A glossary which sets the right terminology.
- Many more tools to follow, suggestions are always welcome.

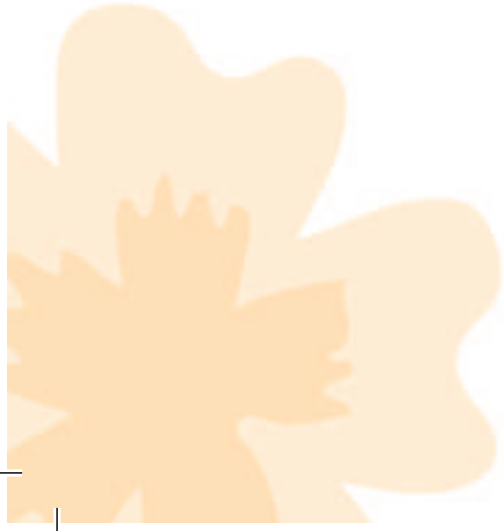
Our website

biodesigntoolkit.com

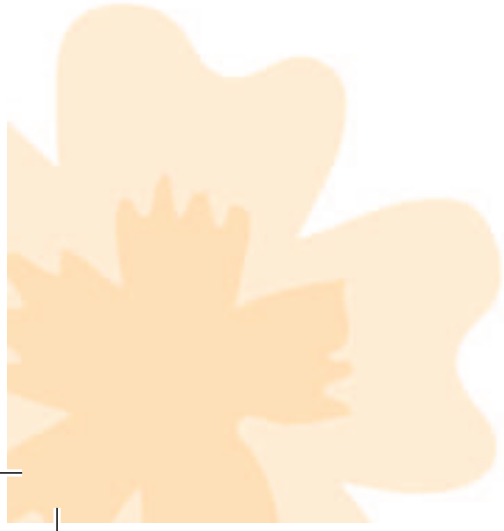




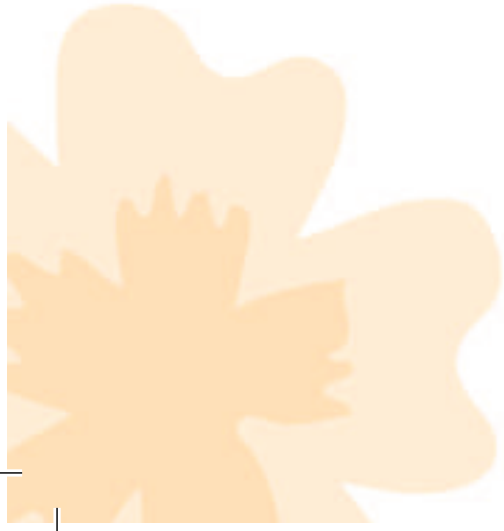












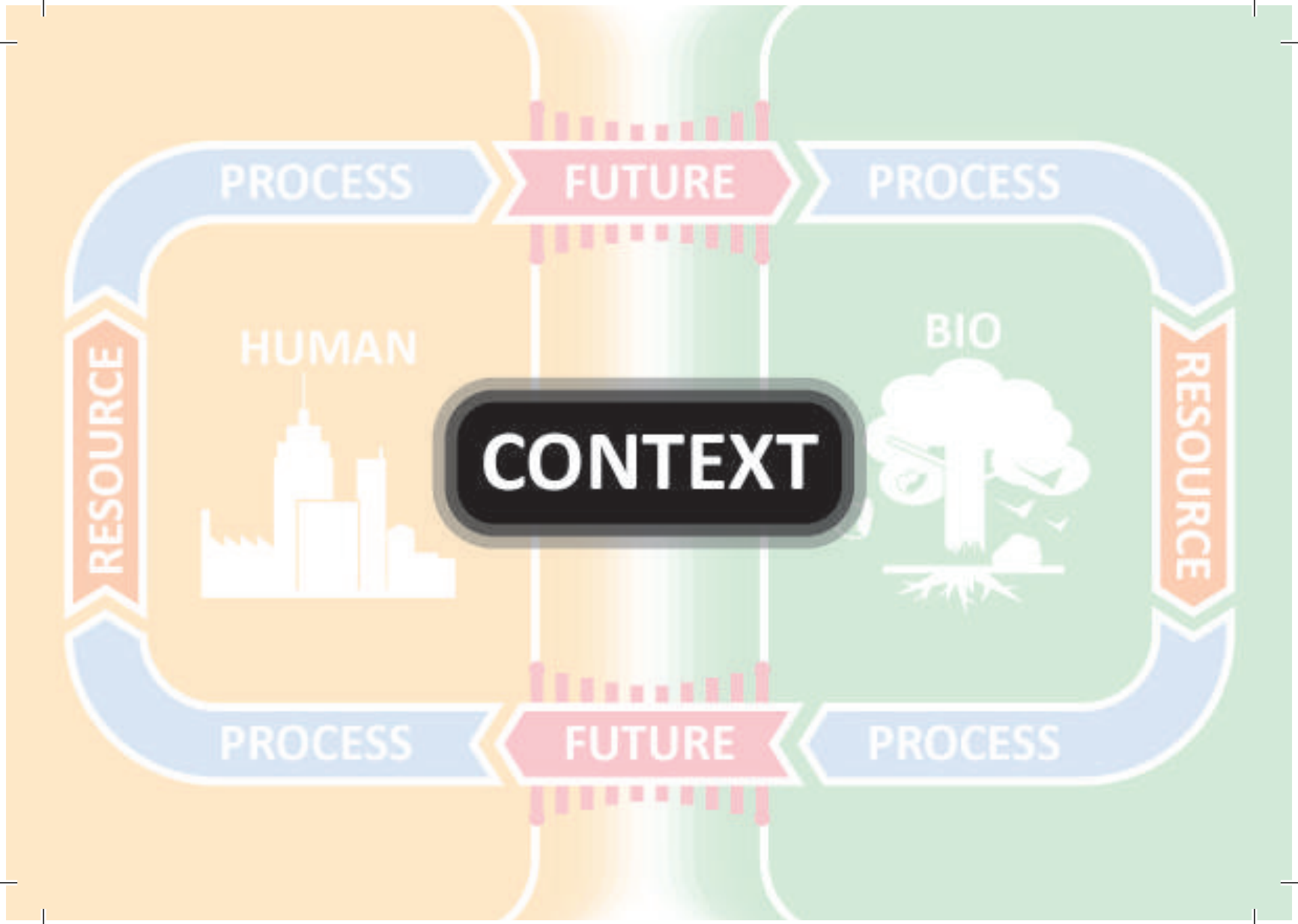








CONTEXTS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Biosphere

CO1

This card helps you understand and integrate the renewable, biobased, and biodegradable resources of the biosphere into your designs.

- Will the materials used in your product be sourced sustainably and responsibly without depleting natural resources or harming ecosystems?
- How will your product interact with local ecosystems? Could it introduce any invasive species or disrupt existing flora and fauna?
- What are the potential longterm environmental impacts of widespread adoption of my product and how can I ensure it contributes positively to the biosphere over time?

All around you

The plants in your living room, the spiders in your house, the ants in your lawn, the birds nesting under your roof overhang, the weeds growing in your yard, the bees swarming in your flowerpots, the toads living in the ditches, the microbiom living inside you, the mycelia meshing through the soil, etc.

Actions

- Identify renewable materials from the biosphere that can help you tackle your design challenge.
- Ensure your design supports and harmonizes with local ecosystems rather than disrupting them.

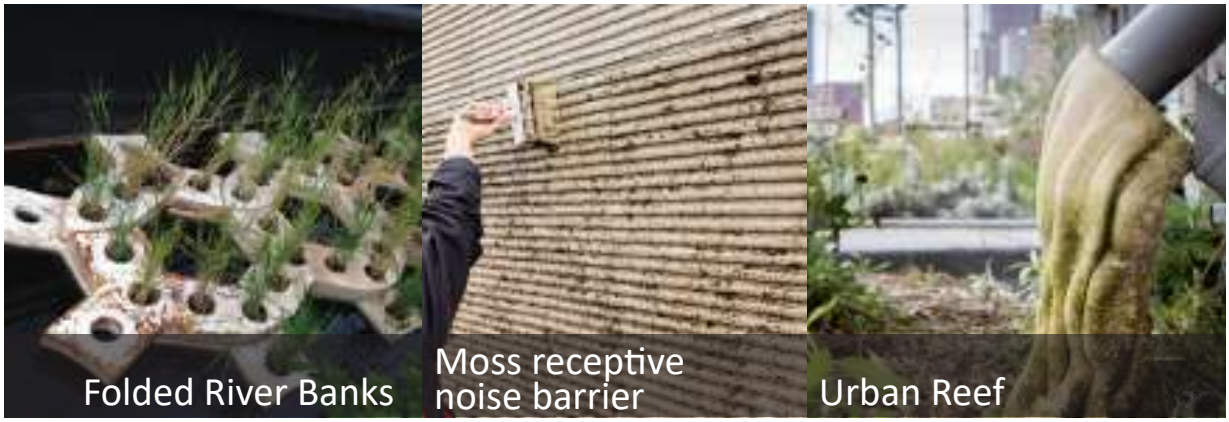
Biodesign

CO2

This card helps you get in touch for the first time with biodesign; designing 'of', 'with' and 'for' biology.

- How well do you understand the biological systems or organisms you will work with?
- How will you facilitate a collaborative relationship between human and non-human biological agents in this design?
- How will you balance control, irregularity and unpredictability in the design process?
- How will you leverage insights from other disciplines, such as biology, biochemistry, to enrich your biodesign project?

Of, With and For Bio



These three projects highlight the different facets of biodesign. On the left, design of biology uses mycelium structures to create new riverbanks. In the middle, design with biology applies moss to noise barriers, improving sound dampening and carbon sequestration. On the right, design for biology creates a biobased, artificial habitat in urban settings, where rainwater is effectively drained away.

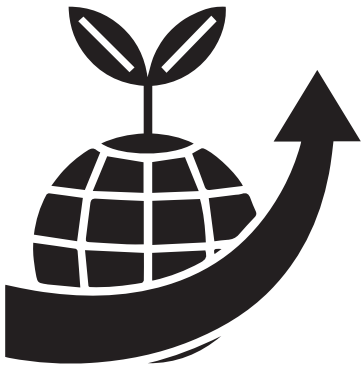
Actions

- Identify your starting point; a design brief for which you want to consult nature for solutions, or a biological material stream to valorize in our human world.
- Experiment with balancing human control and the natural unpredictability of biological materials.

Operating scale

CO3

This card helps you explore the different scales at which your biodesign project can operate, from biothinkerspace, to biomakerspace, to biofactory.



- What specific resources are accessible in your current workspace and how do they influence your design choices?
- As your biodesign project grows, what considerations should you make for transitioning to a larger operating scale?
- How does the operating space influence the level of collaboration and access to expertise?

Different scales


Prototyping Circulair

Biodesign projects typically progress through three operating scales. They often begin in small, domestic lab environments, known as the **biothinkerspace**, where proof of concepts are tested. As the projects grow, they move into more specialized labs, called **biomakerspaces**. Finally, for commercialization, they scale up to larger production plants, known as **biofactories**. Ideally, this final stage is decentralized, utilizing local resources to benefit the local economy.

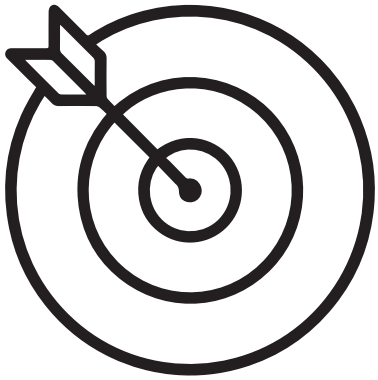
Actions

- Match the operating scales with the current stage of your biodesign project.
- Assess the resources and expertise available in your current operating space.
- Plan for scalability, consider how your project can transition from one scale to the other.

Biodesign Ambitions

CO4

This card helps you define your biodesign ambitions by establishing your desired Technology Readiness Level (TRL), which in turn sets the project's constraints.



- How far are you willing to go in terms of technological maturity—do you aim for early exploration or real-world application?
- To what extent do you want your project to challenge current industry norms or integrate within them?
- How will your ambition influence the materials, partners, and tools you choose to work with?

Define your ambition

Setting your ambitions in a biodesign project is important because it defines how far you want to go —whether you're exploring ideas or aiming for real-world impact. It helps you make clear choices about materials, tools, collaborators, and your project's scale. By doing so, you stay realistic, focused, and aligned with your resources and goals. Similar to Ghent University's Biocomposites courses, where students designed demonstrator TRL fully biobased birdnests using local habitat resources.

Actions

- Define the impact you want your biodesign project to have in the real world.
- Choose the tools and collaborators that match your desired level of technological maturity.
- Align your materials and methods with how far you’re willing to go in scaling or challenging industry norms.

Material VS Product Design?

CO5

This card helps you decide whether to design a new material and explore its potential application area, or to develop a functional product using existing, ready-to-apply resources.

- Could your goals be achieved more effectively by using an existing biobased material?
- Are you more driven to invent new materials or to apply existing ones in meaningful, functional products?
- How will your choice between material and product design influence your prototyping process and timelines?
- Who do you need to collaborate with depending on your focus—material scientists, product engineers, or both?

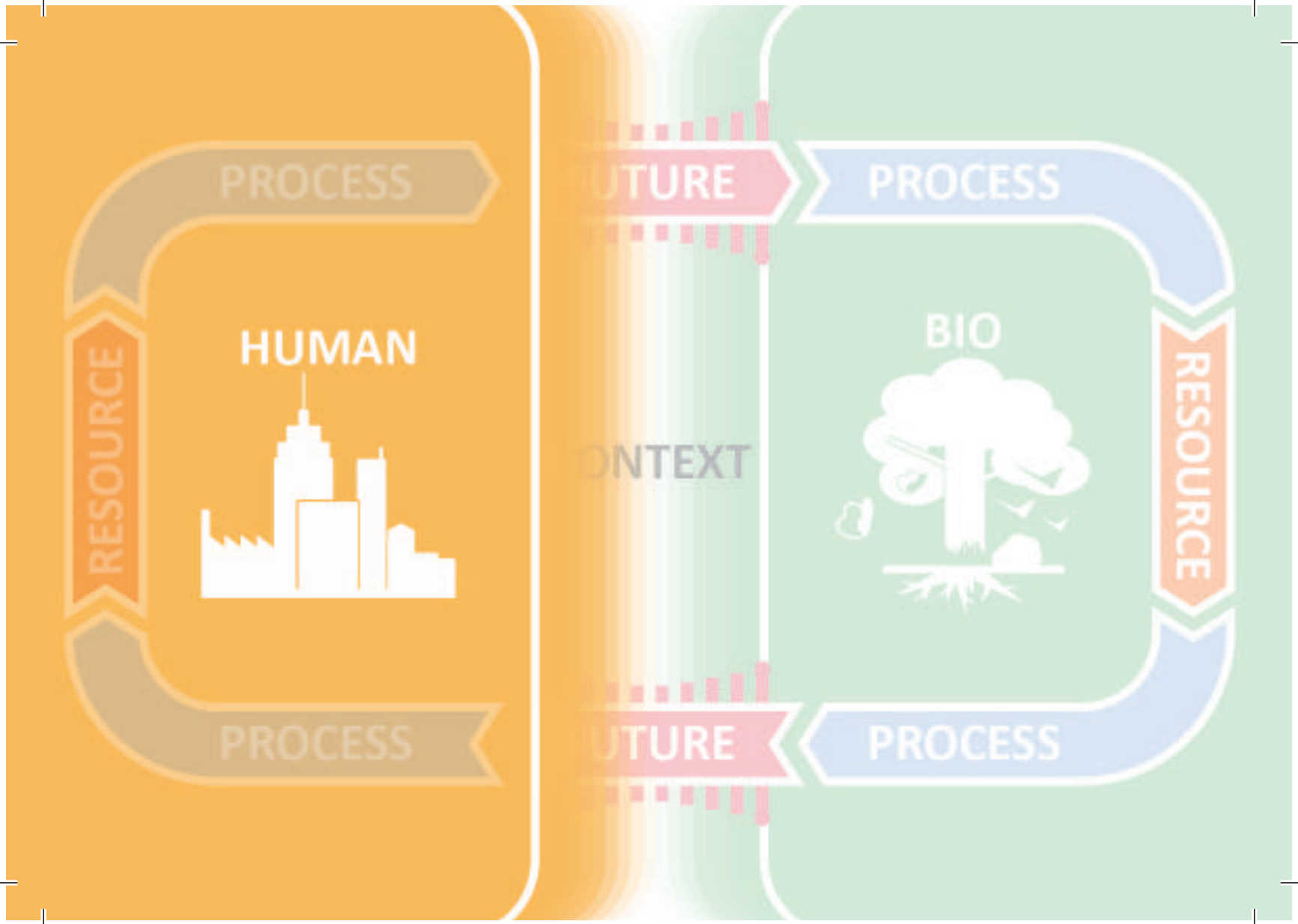
Material OR Product?

Defining whether you focus on material or product design is crucial because it shapes your entire biodesign process. Designing a new material often requires more biodesign cycles, time, lab access, and expertise, while product design using existing materials allows for faster development and market testing. This choice affects your timeline, tools, needed collaborators, and the scale and ambition of your project. Being clear on this from the start helps keep your biodesign process realistic and focused.

Actions

- Define whether your focus is on inventing a material or designing a product.
- From now on, match your collaborators and tools to your chosen focus.
- Adjust your timeline and prototyping approach based on material or product goals.

BIODESIGN MINDSET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Improve project sustainability

MI1

This card helps you make your project more sustainable by triggering you to collaborate with nature.

- How will you collaborate with nature instead of treating it as a resource?
- How will your project adapt to environmental changes, just like nature does?
- Does your project support a long- term, regenerative vision of sustainability and how so?

Full Grown

Full Grown

Full Grown collaborates with nature by growing trees into furniture shapes rather than cutting down established forests. This approach eliminates traditional manufacturing waste, supports ecosystem regeneration, and creates a closed-loop process where trees continue growing after harvest. Each piece represents years of patient cultivation rather than resource extraction.

Actions

- Find interfaces between nature and your project that you can interact with.
- Map how actions between those interfaces can enhance your project sustainability.
- Tips&Tricks: TT2, TT7

Changing mindset

MI2

This card helps you shift your mindset by using materials with ecosystem considerations, collaborating with nature, and fostering curiosity and critical thinking.

- Does working with nature challenge your traditional design thinking and how so?
- Will you collaborate with living systems instead of controlling natural resources in your designs?
- What new curiosities about nature are you exploring through your biodesign project?
- Are you prioritizing some materials for their ecosystem health and regeneration?

Flower Matter


Flower Matter

The company Flower Matter transforms flower waste into flower bouquet packaging. The founder says that biodesign shifted her focus to materials' life cycles and deepened her understanding beyond environmental impact. As a product designer, she used to demand rigid standards. Now, she values flexibility, adapting designs to natural material properties.

Actions

- Think of yourself as part of nature and not as a species that has distanced itself from nature.
- See imperfections, irregularities and unpredictability as a logical evolution of your design, just like in nature is entropy a certainty.
- Tips&Tricks: TT8

Intrigue & Motivation

MI3

This card helps you feel more intrigued and motivated by exploring biodesign as a new process, observing nature, and drawing inspiration from traditional crafts.

- Does biodesign inspire you differently than your previous design experiences?
- Has a natural phenomenon sparked a significant idea in your design work?
- How have ancient cultural traditions and crafts through biodesign shaped your appreciation of design's past and future?
- Where in nature will you draw your inspiration from?

Seagrass Thatching

Studio Kathryn Larsen explored how seagrass as regional natural resource could be used in the ancient construction roofing system called seagrass thatching. The founder Kathryn says that her motivation often lays in solutions that are deeply rooted in traditions and culture, such as seagrass and thatching in Denmark.

Actions

- Think of natural phenomena that intrigue you to explore its unique properties in product design.
- Explore the ways how some traditional material use or crafts have been used in ancient times.
- Tips&Tricks: TT8

Broader view

MI4

This card helps you expand your perspective from a narrow focus to a more holistic understanding of systems in biodesign.

- Have you shifted your understanding of design from creating isolated objects to influencing complex, interconnected systems?
- How do the complex, interconnected (eco-) systems related with your project look like?
- Viewing your work within a larger ecological and cultural context, how does this influence your design process?

Devel'UP

Bert Vuylsteke - Devel'UP

Devel'UP explored how domestic and industrially generated fruit- and vegetable waste could be valorized into fully biobased temporary signage. A complete system had been worked out to co-create value in many places along the value chain of this system, amongst which the creation of human value and the regeneration of nature.

Actions

- Map the systems in which your project will thrive.
- What will be the project boundary in the system?
- Tips&Tricks: TT2, TT8

Connection with nature

MI5

This card helps you retrieve your connection with nature.

- Has your role as a designer evolved as you see yourself as part of a larger natural ecosystem?
- Does understanding the interconnectedness between human and non-human agents shape your approach to sustainability in design?
- How will you balance your creative vision with the natural behaviors of organisms or materials?
- How will you integrate the rhythms and cycles of nature into your design process?

Tree House

Tree houses not only connect human life with nature and the trees themselves, but they also create a symbiotic relationship between people and trees. When the load, tilt angle, and supporting components are balanced and non-intrusive, trees can embrace and support human life with ease. In turn, they grow stronger, reinforcing the built environment and providing shelter.

Actions

- Observe for various time frames if there are natural rythms or cycles in your biodesign project.
- Look at your biodesign project's lifecycle and try to connect it to nature.
- Tips&Tricks: TT1, TT2, TT3

Curiosity

MI6

This card helps you spark your curiosity through biodesign.

- Has curiosity in your biodesign work led you to unexpected discoveries that shaped your project?
- Does the unpredictability of nature in biodesign inspire you to learn and experiment?
- Are you curious about the inner workings of natural phenomenon and about the why's and how's of its natural occurrence?

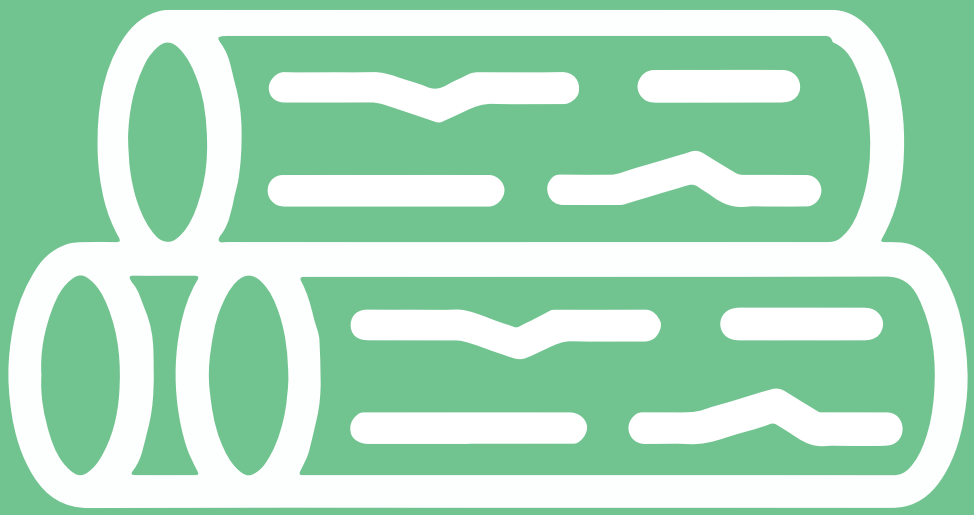
Colorifix

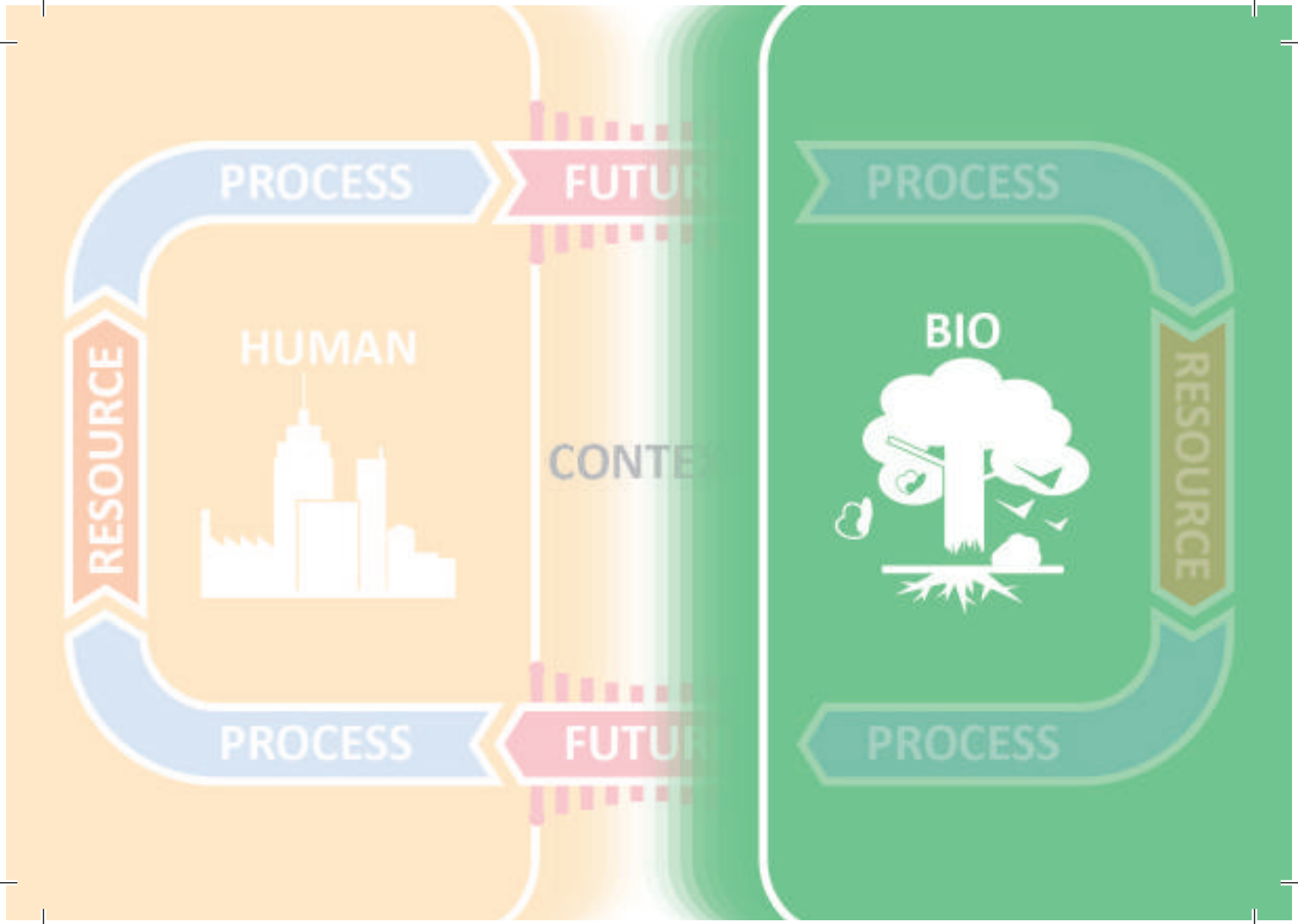
Colorifix is a company focused on creating fully biobased colors and dyes for the textile industry. Their curiosity about the rhythms of life led them to explore why certain organisms— such as flowers, bacteria, fungi, etc.— can generate specific colors. They now cultivate these living organisms to intentionally produce those natural vibrant dyes.

Actions

- Think of natural systems and their unique properties and wonder why and how they work as they do.
- Ask yourself if these properties are changing over time, and why they do so.
- Tips&Tricks: TT3, TT9

BIODESIGN MATERIALS

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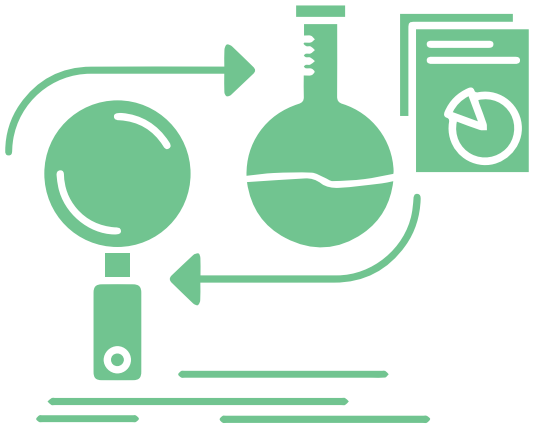
Material application

MA1

This card helps you focus on applying materials in ways that suit their properties, avoiding unrealistic expectations that can stall prototyping.



- How will you manage your expectations when working with new or living materials, ensuring that your prototypes remain realistic, achievable and scalable?
- In what ways will a deeper understanding of material properties help you overcome prototyping challenges in your project?

Mogu

Mogu

Mogu was founded on the belief that Nature's intelligence can transform everyday product design, balancing the human-made with the rhythm of natural ecosystems. The company, known for products like flooring tiles, matches expectations with reality by for example choosing an 87% biobased resin to ensure durability in diverse settings. Therefore, They disclose this choice, avoiding greenwashing and maintaining transparency.

Actions

- Align material properties with practical use by testing prototypes under real conditions.
- Set realistic expectations for durability and performance to avoid stalling during prototyping.
- See **Biocomposites Database** on **Biodesigntoolkit.com**
- Tips&Tricks: TT3, TT9

Susceptibility

MA2

This card helps you account for how external factors like contamination, temperature, humidity, micro-organisms may affect your biodesign project.

- What strategies will you use to minimize the risk of contamination or environmental degradation in your biodesign project and during the product life- cycle?
- How will you balance the unpredictability of natural factors with the need for control and consistency in your biodesign process?
- In what ways will the vulnerabilities of living or natural materials influence the way you design and experiment with them?

Blooming Tiles

Blooming Tiles

Blooming Tiles repurposes excavated soil and sewage sludge into biodegradable tiles for temporary outdoor events. These tiles prevent event attendees from walking in mud and, after use, they naturally biodegrade, allowing the flower seeds embedded in them to sprout and create vibrant flower beds — showcasing how designing with natural susceptibilities can add both function and environmental harmony.

Actions

- Adapt your design to account for changes in environmental conditions over the product's lifecycle.
- Explore ways to use the natural breakdown / wear of materials as a functional or aesthetic feature.
- See **Biocomposites Database** on **Biodesigntoolkit.com**
- Tips&Tricks: TT1, TT2, TT3

Terminology

MA3

This card helps you use clear and consistent terminology in biodesign, avoiding misunderstandings due to ambiguous terms like "biomaterial."

- How will you ensure uniform terminology usage in communication within you biodesign project?
- In what ways will you take up new vocabulary to be able to understand and communicate in transdisciplinary teams on an equal level?
- What terminology can you align with and do you plan on using for clear communication in and about your biodesign project?

Future Materials Bank

Future Materials Bank

The Future Materials Bank is a web platform featuring a database of biobased materials, detailing their composition and properties. What sets it apart is its dedicated lexicon page, which defines commonly used terms to foster a shared understanding. They also acknowledge that these definitions may evolve over time and will be updated accordingly.

Actions

- Align terminology across your biodesign project and team to ensure clear and consistent communication.
- Familiarize yourself with relevant biodesign vocabulary to collaborate effectively in transdisciplinary teams.
- Check out our website glossary page.

Biodegradability

MA4

This card helps you consider how biodegradability affects your biodesign project, balancing environmental benefits with practical limitations.

- In what ways will the goal of biodegradability constrain your design, and how will you creatively navigate those limitations?
- How will you approach the trade-offs between biodegradability and other performance factors, such as functionality, lifespan, etc.?
- How will you communicate the potential limitations of fully biodegradable materials to clients or stakeholders while emphasizing the environmental benefits?

Loop Living Cocoon

Loop Biotech is a company creating fully bio-degradable coffins called the"Loop Living Cocoon™". Their motto is "Feed the Earth and become a source for new life with the world's first mushroom coffin". They explicitly use the unique properties of mycelium to develop for biodegradability at a specific time in the product life cycle.

Actions

- Balance biodegradability with essential performance needs in your design.
- Identify where biodegradability adds value to your project’s lifecycle and communicate this impact clearly to stakeholders.
- Tips&Tricks: TT3, TT4

Cultural History

MA5

This card helps you recognize and explore the cultural history and heritage behind the materials you use, including nearly lost knowledge and practices.

- What is the cultural history or heritage of the materials you will use?
- In what ways will you incorporate traditional knowledge and practices into your biodesign projects?
- How do you balance the preservation of traditional material practices with the need for technological advancement?
- Will you work with local artisans to learn the cultural history of your materials?

Gutta Percha


Shahar Livne

Designer Shahar Livne incorporated gutta percha, an ancient, fully biobased latex-like material, into one of her projects. This material holds a rich cultural history, especially prominent before the 1900s as one of the first globaly used fully biobased plastics.

Actions

- Identify if there is cultural heritage to the materials you will be using, and what you can learn from that for application today.
- Connect with local artisans to deepen your understanding of traditional material use.
- See **Biocomposites Database** on **Biodesigntoolkit.com**

Connection with nature

MA6

This card helps you reconnect with nature by recognizing the origins of materials and products in your biodesign work.

- How will your biodesign project help bridge the gap between humanity and nature, and how will you aim to restore this lost connection?
- How will you balance modern design needs with a desire to reintroduce natural products and processes into people's daily lives?
- How will you communicate the value of nature-based products to a society that may have grown accustomed to synthetic or massproduced goods?

Rootfull

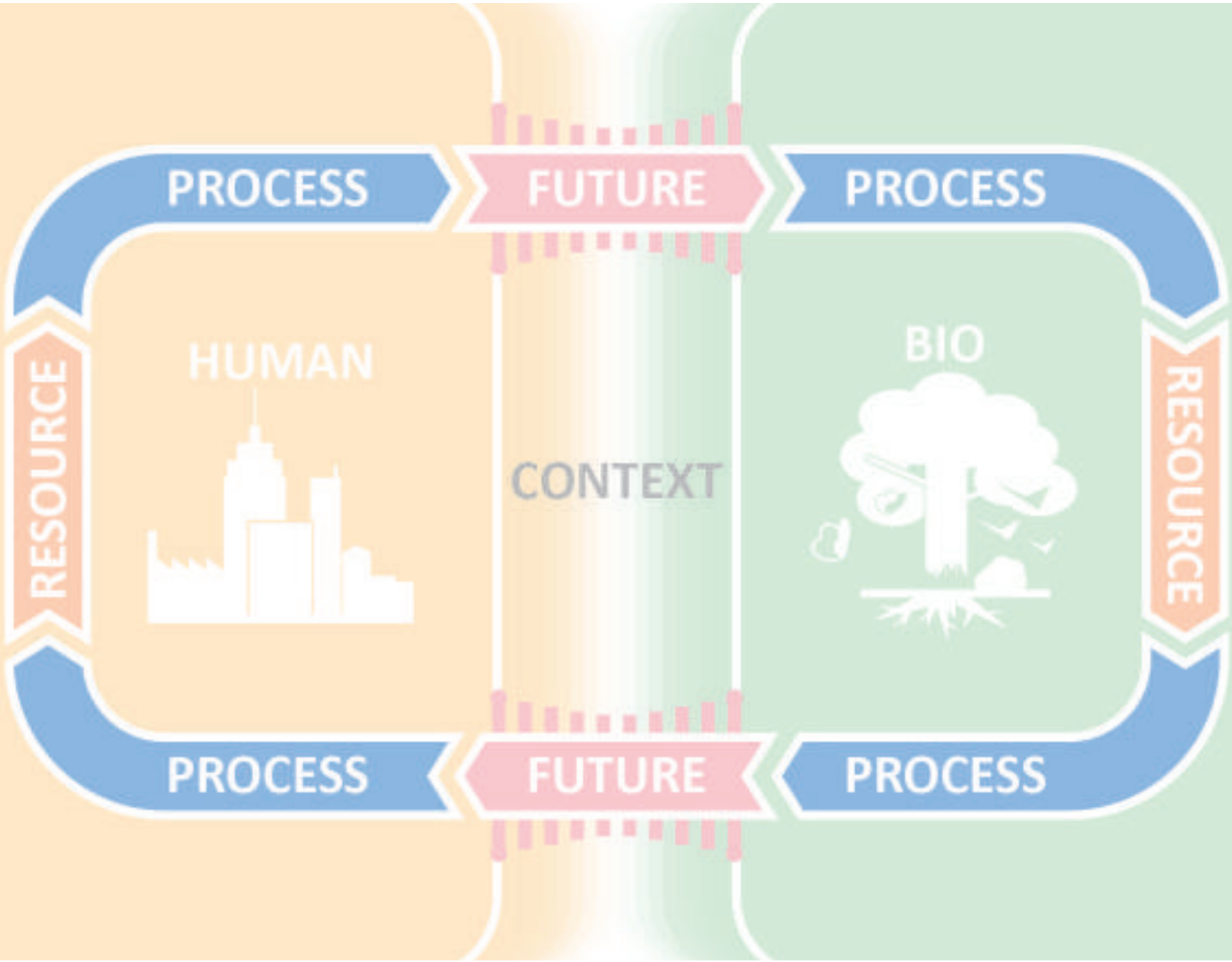

Rootfull - Zena Holloway - www.rootfull.com

Designer Zena Holloway's project, Root, creates fabrics entirely from grass roots. By growing grass on substrates that guide the roots into intricate, natural weaving patterns, she transforms the root structures into durable, natural fabrics once the grass is cut and dried. Through this process, Zena beautifully reconnects with the natural world, harnessing nature's ingenious growth processes to craft materials for human use.

Actions

- Explore ways to integrate the natural origins of materials into your projects.
- Communicate the origins and values of nature-based materials to reconnect people with their natural roots.
- See **Biocomposites Database** on **Biodesigntoolkit.com**
- Tips&Tricks: TT2

BIODESIGN PROCESS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Experimentation & Learning through doing

PR1

This card encourages you to experiment, using failures as valuable feedback and learning through hands-on experience.

- Do you use feedback from failed experiments to improve your biodesign project?
- Does hands-on experimentation help you better understand the behaviors of living materials?
- Has a failure in your biodesign work ever led to an important breakthrough?

Mycelium


North Spore

Many companies across various industries — such as fashion, food, construction, packaging, and consumer goods— are exploring the use of mycelium, the vegetative part of fungi, for its fully biobased nature, high strength-to-weight ratio, and biodegradability. However, mycelium is sensitive to contamination and environmental changes during its growth, making an understanding of its behavior crucial for success in these industries.

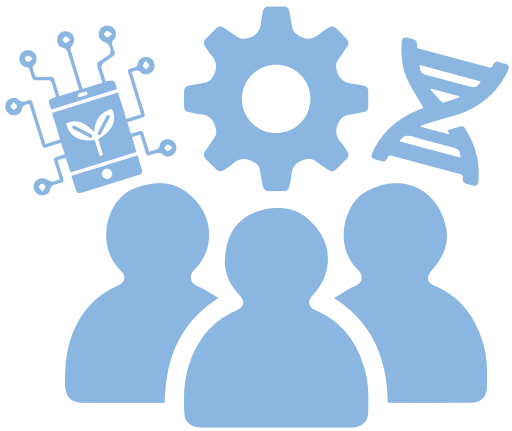
Actions

- Experiment in a hands-on, iterative, fast-paced manner, but observe and study in a slow-paced, procedural manner to learn the behavior of materials under different or changing conditions.
- Tips&Tricks: TT1, TT2, TT3, TT9

Transdisciplinary Collaboration

PR2

This card helps you embrace a transdisciplinary approach by combining design, engineering, biology, and life sciences.



- How does biodesign's transdisciplinary nature challenge you to think beyond traditional design boundaries?
- Do you plan to work in a transdisciplinary biodesign environment to expand your own expertise and skillset?
- What expertise do you lack to be able to make progress in you biodesign project and who might have this knowledge?

CHEMARTS

CHEMARTS

CHEMARTS is a joint minor program between Aalto University's School of Art, Design, and Architecture (ARTS) and the School of Chemical Engineering (CHEM). It serves as a great example of transdisciplinary collaboration, where design, engineering, and biochemistry come together to tackle biodesign projects, each discipline enhancing the other with its unique expertise.

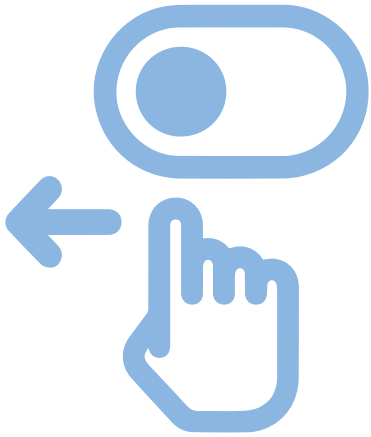
Actions

- Identify the expertise you lack and potential collaborators who possess it.
- Present your idea to relevant disciplines, highlighting how their contributions can benefit both the project and them.

Letting partially go of control

PR3

This card encourages embracing adaptability and evolution by partially letting go of control in the biodesign process.



- What are the controllable and the uncontrollable factors in your biodesign project?
- How will you make the uncontrollable factors measurable and observable over time?
- How are you planning to design around or with the uncontrollable factors?

Silk Pavilion


MIT Media Lab

Silk Pavilion is a project at MIT Media Lab's Mediated Matter group, where at first a manmade structure of silk thread was created, after on which 6.500 silk worms where released. These worms naturally generated silk threads, reinforcing the overall manmade threaded structure. In their pupation stage, the worms had been removed, because the resulting moths would have produced 1,5 million eggs, enough to generate 250 more such structures.

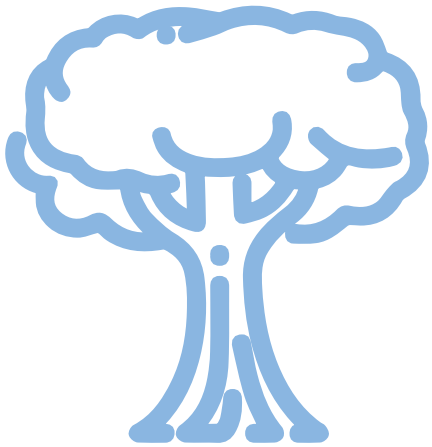
Actions

- Identify uncontrollable changes early on and determine how to make them observable.
- Brainstorm ways these uncontrollable factors can add value to your biodesign project.
- Tips&Tricks: TT1, TT5, TT9

Starting from a natural feedstock

PR4

This card encourages you to start your design process with natural materials.



- What are the unique properties of your natural material and how do they guide your design choices?
- Can the characteristics of your natural feedstock lead you to unexpected design solutions?
- How does the variability and complexity of natural materials shape your design process and decisions?

Peelsphere

Peelsphere

Peelsphere is a company dedicated to valorizing fruit peels into halffabricates. They are using the unique properties of these natural biobased waste streams to their advantage. They explicitly highlight the unique properties of their halffabricates onto their website (i.e. biobased, biodegradable, water repellent, fully circular, low energy consuming, strong, flexible, unique texture, etc.).

Actions

- Identify the unique properties of your natural feedstock and explore how they can guide your design.
- In what human domains can these unique properties serve their role?
- See **Biocomposites Database** on **Biodesigntoolkit.com**

Material properties that guide

PR5

This card helps you let material properties guide your design process.

- In what ways will you allow the natural characteristics of your materials to lead your creative process, rather than imposing a predetermined design?
- How will you balance your design intentions with the limitations and potential of your materials?
- How will you actively collaborate by listening to and observing your materials as active participants in the design process and product life-cycle?

Carpentry

Every carpenter working with natural wood understands its "living" qualities and how it responds to changes in the environment. Shifts in humidity or light can cause wood to expand, contract, warp, or change color. To create a stable product, a carpenter must anticipate these reactions and collaborate in harmony with wood's natural properties.

Actions

- Adjust your design to work with, not against, the material's unique behaviors.
- Identify how the material behaves in different environments and over various time frames.
- See **Biocomposites Database** on **Biodesigntoolkit.com**
- Tips&Tricks: TT1, TT2, TT3, TT9

Widening your know-how

PR6

This card encourages you to expand both your theoretical and practical knowledge.

- How will you expand both your design and biology knowledge in your biodesign process?
- In what ways do you plan to learn new hands-on skills to work with living materials in your design?
- How will you overcome the challenge of obtaining new transdisciplinary knowledge?

Notpla

Notpla

Notpla is a company dedicated to creating disappearing packaging, meaning it is fully biodegradable and non- toxic for any living matter. This company depends as much on biochemists, biotechnologists for their theoretical know-how, as it depends on designers for their expertise and hands-on approach to finding application areas.

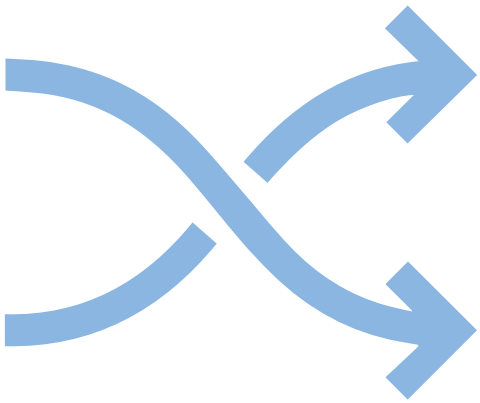
Actions

- Identify key knowledge areas in biology or design that you might lack to make progress.
- Practice hands-on skills by experimenting with the materials to better understand the lab-equipment and procedures, as well as the material behavior.

Unpredictability

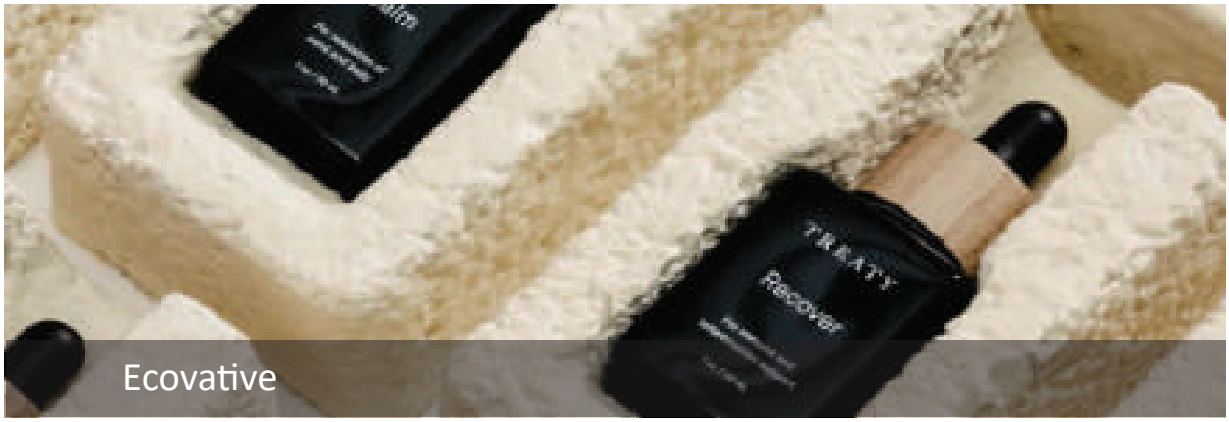
PR7

This card helps you embrace unpredictability as a natural part of the biodesign process.



- How will you plan and execute your design project, knowing that unpredictability will challenge your plans?
- What possible risks are related with the unpredictability of your biodesign project?
- What role might unpredictability play in fostering a deeper connection between your design work and the natural systems you engage with?

Mushroom Packaging



Ecovative

Ecovative is a company harnessing the unique properties of fungi to create sustainable alternatives across various products, from food substitutes to packaging, leather alternatives, and construction insulation blocks. They have successfully adapted their production processes to accommodate the unpredictability of mycelium growth, ensuring it aligns with their diverse applications.

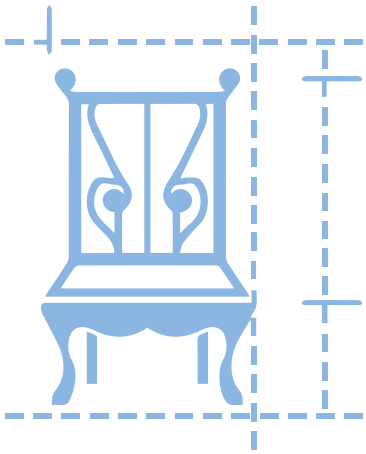
Actions

- Map the potential risks related to the unpredictability of the material or production process.
- Identify and accept the potential benefits of unpredictability to strengthen your connection with natural systems.
- Tips&Tricks: TT1, TT3, TT5

Hands-on Craftsmanship

PR8

This card helps you embrace craftsmanship and hands-on experience in biodesign, valuing practical skill and the tangible process



- How will hands-on experience with biodesign materials deepen your understanding of their properties and potential?
- Since biodesign is often related to tradition in crafts, how will craftsmanship support your biodesign process?
- How does the act of crafting with living materials influence your relationship with the natural world and the sustainability of your designs?

Kanshitsu

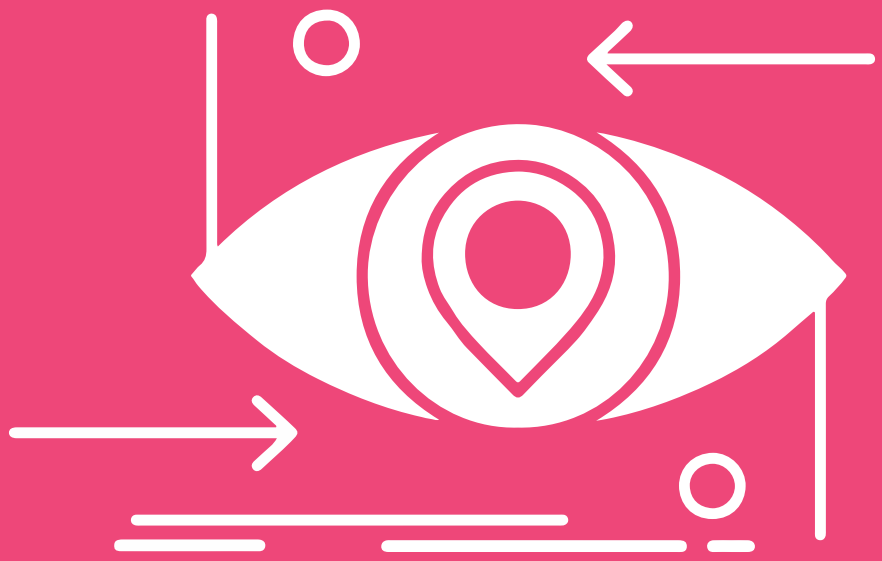

Kenji Toki Lab

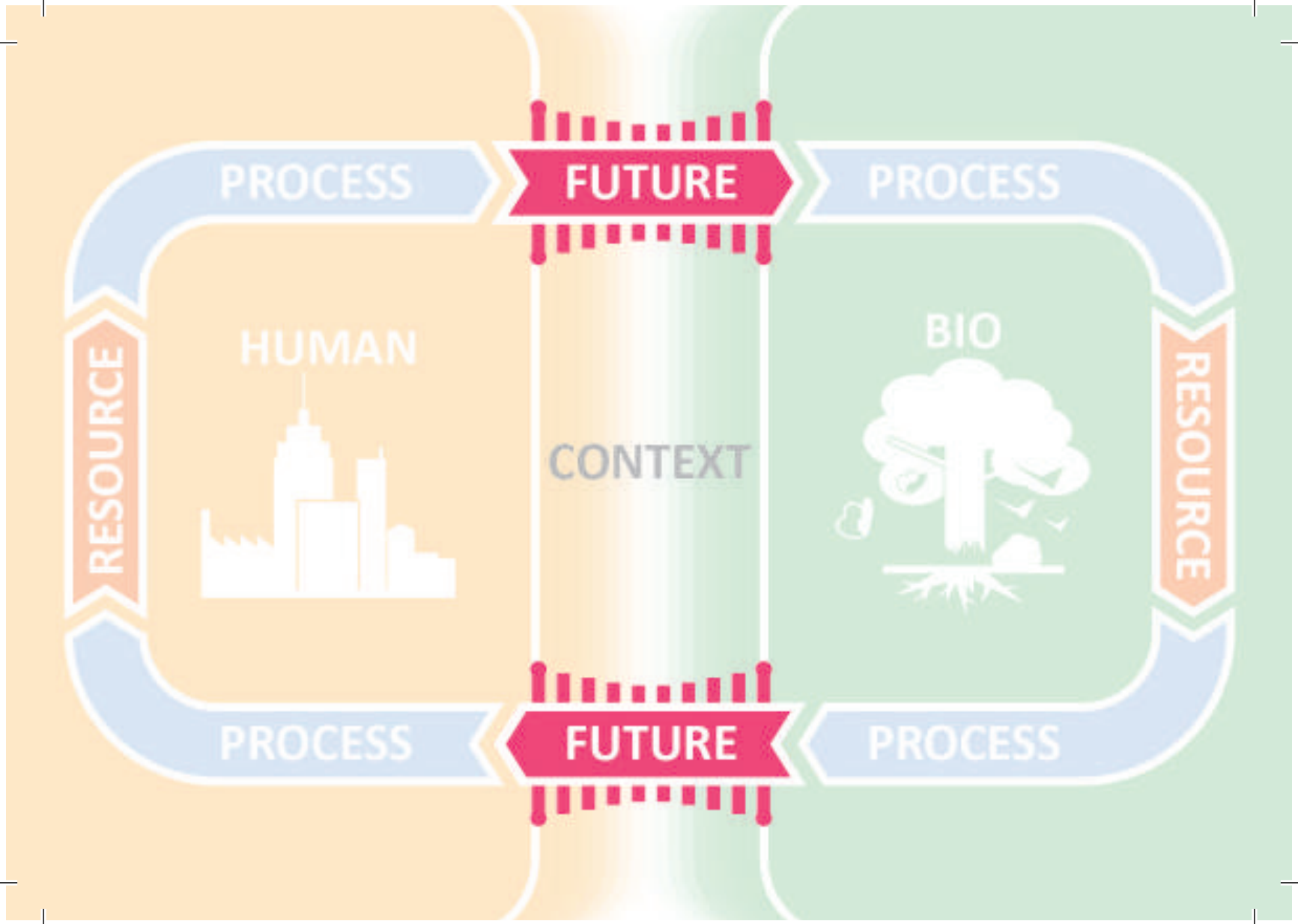
Kenji Toki Lab revived an ancient Japanese craft technique, called Kanshitsu. By using Urushi lacquer, a fully biobased natural sap, they bind natural fibers and coat surfaces. When exposed to air, this sap spontaneously oxidizes and hardens, turning into a dark brown, almost black hue, biocomposite.

Actions

- Look-up the traditional uses of your natural materials stream in ancient times.
- Explore traditional craftsmanship techniques to inspire your biodesign process.
- Tips&Tricks: TT6

BIODESIGN FUTURE

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Scaling

FU1

This card helps you address the challenges of scaling your project from prototype to commercial or industrial production.

- What key factors will you consider to determine if your biodesign concept is ready for industrial or commercial production?
- How will you maintain the values of sustainability and innovation as you transition from a small-scale experiment to a larger commercial model?
- What will be the biggest risks or challenges you anticipate when scaling your biodesign project, and how do you plan to address them?

Kaffeeform

Kaffeeform - Max Manavi-Huber

Kaffeeform is a company that produces coffee cups entirely from biobased resources, with coffee grounds as the primary material. Coffee grounds are a waste byproduct of brewing coffee. As the company grew and demand for their cups increased, they faced the challenge of sourcing sufficient coffee grounds to meet production needs. This demand cannot exceed the available waste stream, as relying on virgin materials would compromise their original sustainable concept.

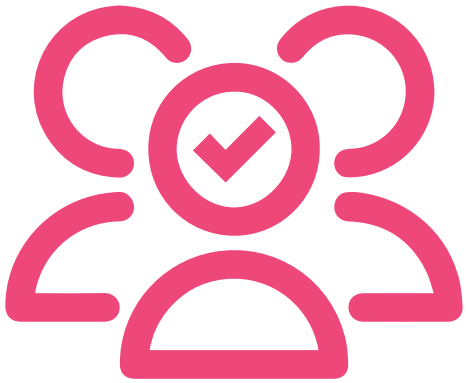
Actions

- Explore and tackle the critical stages in your biodesign project to be able to scale.
- Identify and address production risks while maintaining alignment with your sustainable biodesign principles.
- Tips&Tricks: TT3, TT7

Social acceptance

FU2

This card helps you identify and address social acceptance challenges in your biodesign project, such as material choices or breaking traditional benchmarks.



- How will you approach the challenge of making biodesign materials and concepts more socially acceptable, particularly when they deviate from conventional norms and challenge established industrial benchmarks or standards?
- How will you educate and communicate with stakeholders (e.g., consumers, clients, or regulators) about the value and potential of biodesign innovations, overcoming skepticism?

Mycoworks - Hermès


Mycoworks - Hermès

MycoWorks, a biotech company, developed the "Fine Mycelium Platform," a technology that produces strong, flexible, drapable, and textured materials entirely from mycelium. Collaborating with the renowned fashion brand Hermès, they designed a fully biobased vegan purse. By mimicking the look and feel of leather, MycoWorks addressed potential social acceptance challenges surrounding the use of fungi in fashion.

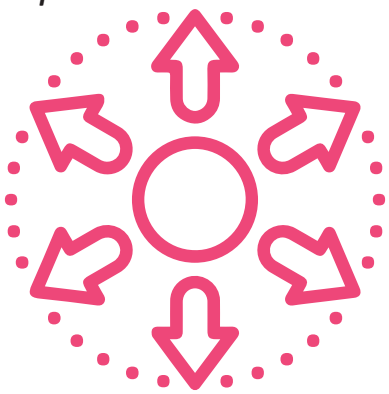
Actions

- Educate stakeholders early about the benefits and potential of your biodesign innovations.
- Anticipate skepticism and try to find ways to align with societal expectations, like adapting to established norms.

Decentralized systems

FU3

This card helps you explore decentralized systems for scaling biodesign, combining global knowledge with local materials and craftsmanship.



- How will you design biodesign products that are flexible and adaptable to different regional resources and conditions, facilitating decentralized production?
- What challenges will you foresee in establishing a network of decentralized biofactories?
- What role might decentralized biodesign production play in empowering local economies and communities?

Flavia Amadeu


Flavia Amadeu

Flavia Amadeu, the designer behind the "Flavia Amadeu" brand, works with Amazon rainforest communities in Brazil to create fashion items from natural rubber, empowering local communities and boosting the economy. She could expand by sharing her intangible resources (her knowledge) globally and producing locally (with local tangible resources), she embodies the principles of decentralized, sustainable production.

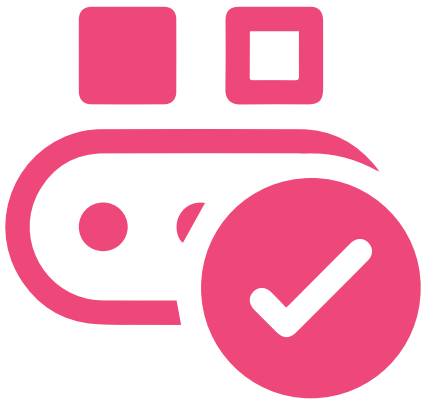
Actions

- Identify ways of sharing your knowledge globally to set up a decentralized production system with local resources.
- Design products adaptable to regional materials and conditions to empower local communities.
- Tips&Tricks: TT5, TT6

Material property control

FU4

This card makes you wonder about the controllability of your material properties that affects the scalability of your biodesign project.



- How will the material properties and its variability and unpredictability you work with, influence your ability to scale up?
- How will you maintain the unique qualities of your biodesign materials while making them suitable for upscaling?
- How could collaborating with scientists or material experts help you understand your control over the material properties regrading upscaling?

MyForest Foods


Ecovative

Ecovative is a company harnessing the unique properties of fungi to create sustainable alternatives across various products, from food substitutes to packaging, leather alternatives, and construction insulation blocks. They have successfully adapted and scaled their production processes to accommodate the unpredictability of mycelium growth and its properties, ensuring it aligns with their diverse applications.

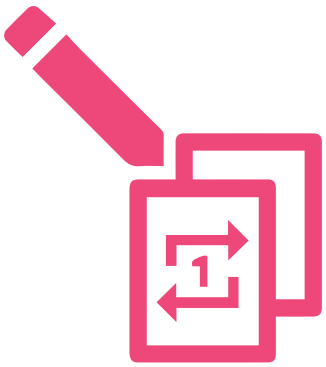
Actions

- Experiment with material properties to understand their scalability potential.
- Collaborate with experts to refine controllable and anticipate uncontrollable material properties for upscaling.
- See **Biocomposites Database** on **Biodesigntoolkit.com**
- Tips&Tricks: TT1, TT5, TT9

Design for one

FU5

This card helps you focus on creating biodesign solutions that prioritize uniqueness and small, local production, rather than aiming for mass, global-scale designs.



- In what ways will the intimate, localized nature of your biodesign project conflict with the principles of mass production, and how will you navigate this tension?
- How will you ensure that the values of sustainability, locality, and craftsmanship are maintained as you consider scaling up your biodesign projects?

StudioCork


StudioCork

StudioCork is a company that produces handbags using cork from local farms, crafted by artisans with over 30 years of expertise in the cork industry. They prioritize on the unique qualities of cork and focus on small-scale, local production, in contrast to larger fashion brands. Despite this, their goal is to promote cork globally as a sustainable alternative to genuine leather.

Actions

- Consider how to scale your project into small production, while preserving its unique, local, proximal values.
- Tips&Tricks: TT5, TT6

Commercialization

FU6

This card helps you explore opportunities to bridge the gap between conceptual biodesign and its professional, commercial, and industrial application.

- How do you envision translating the innovative ideas in your biodesign work into commercially viable products or solutions?
- How do you navigate the challenge of commercializing biodesign innovations while ensuring they remain environmentally and ethically sustainable?
- In what ways will you design a sustainable system in which your biodesign product will flourish?

Biomason


Biomason

Biomason is addressing one of the cement industry's most significant challenges: its massive carbon emissions. By concentrating on just one biodesign feature that sequesters carbon rather than emitting it, Biomason developed an enzymatic process where micro-organisms produce cement for commercial applications while also storing carbon in the process.

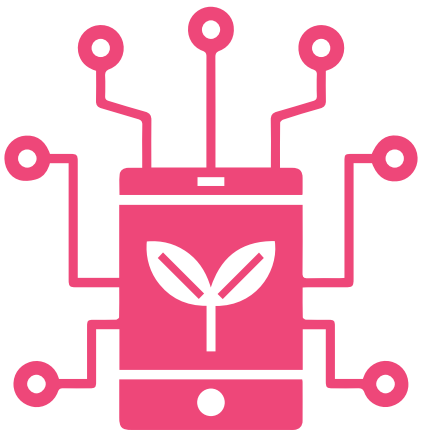
Actions

- Identify and start from the biodesign innovations in your project that are most easily commercialized.
- Identify potential for your biodesign project to generate various types of value (economic, ecologic, societal) during its whole product life- cycle.
- Tips&Tricks: TT4, TT8

Technology

FU7

This card helps you determine technological challenges in scaling and producing biodesign solutions.



- How might current technological limitations in biodesign industrialization impact your ability to scale your projects from prototype to production?
- How will you collaborate with engineers, scientists, or technologists to solve the technical issues that arise when scaling your biodesign work?

Spiber

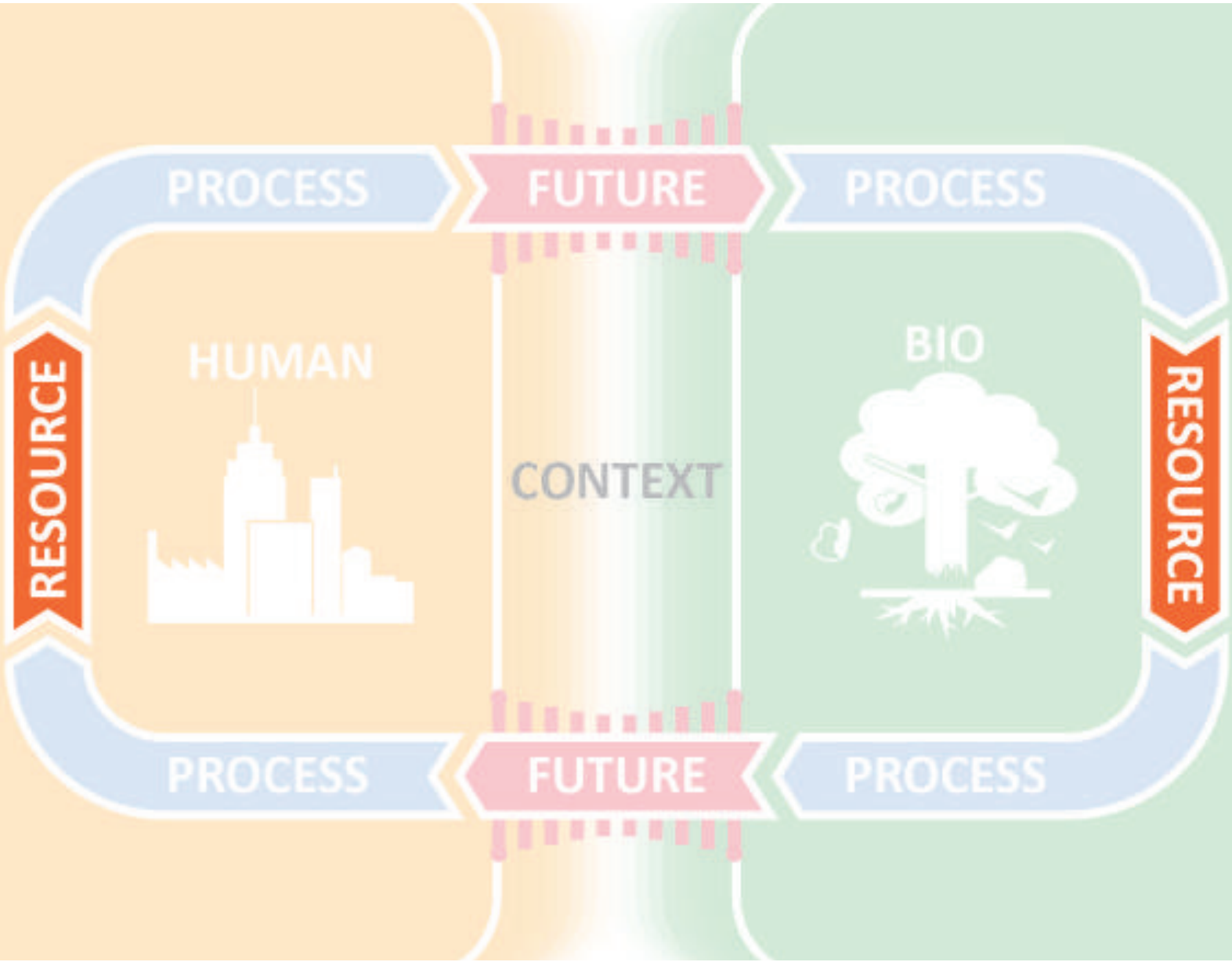

Spiber

Spiber is a company that produces protein-based polymers, which are spun into yarns and woven into fabrics with a wide range of textures. This fully biobased technology became a reality through the collaboration of experts from diverse fields, following years of dedicated research to make this technology platform both feasible and applicable.

Actions

- Determine early what the technological feasibility will be of your concept today, looking at benchmarks, technology readiness, similar processes.
- Identify the experts that might be able to help you overcome the technological issues.

BIODESIGN RESOURCES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Lab equipment & Machinery

RE1

This card helps understand your need for specialized lab equipment or machinery.

- How much will access to specialized lab equipment and machinery expand your ability to experiment and innovate in biodesign?
- What equipment do you need in your current biodesign stage and scale?
- In what ways will learning to operate certain lab equipment and machinery expand your knowledge and skillset as a designer and help progress your project?

Moving Pigments

Charlotte Werth, the fashion designer behind the "Moving Pigments" project, developed her own specialized machinery to dye fabrics. The machine rolls the fabric through baths of bacteria, each of which produces a different dye color on the material.

Actions

- Identify the lab equipment or machinery that can enhance your biodesign project progress at its current stage and scale.
- When considering scaling, identify what equipment you currently lack.

Financial resources & Funding

RE2

This card helps you recognize the importance of financial resources and funding to scale your biodesign from prototype to product, especially in a market that values perfection.

- How will your need for financial resources impact your ability to scale your biodesign project from a prototype to a commercially viable product?
- How will you navigate the tension between the commercial demands for perfection and the inherent value of imperfection in biodesign?
- What are the unique values of your biodesign project to communicate to potential investors who may prioritize financial returns over ecological values?

Biodesign Challenge

Biodesign Challenge

The Biodesign Challenge is an organization that invites (student) design teams from around the world to address design challenges by incorporating biological components. Its purpose is to encourage designers to explore application areas where biological elements add real value. Participating teams gain significant exposure through the challenge, enhancing their potential for future funding opportunities.

Actions

- Identify potential funding sources and align your biodesign project with their priorities.
- Communicate the unique ecological and innovative value of your biodesign to attract investment.
- Tips&Tricks: TT4

Knowledge fragmentation

RE3

This card helps you recognize that biodesign knowledge is often fragmented and hard to access due to challenges in managing the design process, including transdisciplinarity, finding starting points, iteration, testing, and sharing results.

- How will you navigate the fragmented nature of biodesign knowledge?
- How will you approach documenting your biodesign experiments and results to create a more accessible knowledge base for yourself and others?
- In what ways do you collaborate with or learn from other biodesigners to fill gaps in knowledge and overcome the fragmentation within the discipline?

Materiom

Materiom is a web platform dedicated to gathering and sharing knowledge on materials made entirely from biobased sources. The platform hosts a crowd-sourced database, where each material entry includes a detailed recipe, a list of required tools, and an overview of the material's properties.

Actions

- Document and share your biodesign experiments to contribute to a more accessible knowledge base.
- Connect with other biodesigners to exchange insights and fill knowledge gaps together.
- See **Biocomposites database** on **Biodesigntoolkit.com**
- Tips&Tricks: TT5

Open lab space

RE4

This card helps you access open lab spaces with the right facilities for your biodesign work.

- What type of open lab space matches with the stage and scale of your biodesign project?
- In what ways will access to an open lab environment enable collaboration and knowledge exchange with other designers and researchers?
- How will you adapt your biodesign process when faced with limitations or lack of access to certain lab equipment or facilities?

RISD Nature Lab

RISD Nature Lab

The Rhode Island School of Design's (RISD) Nature Lab hosts a student accessible lab space, the "Biodesign Makerspace". This space serves students to scale up their initial biodesign ideas and perform experiments in a transdisciplinary and inspiring setting.

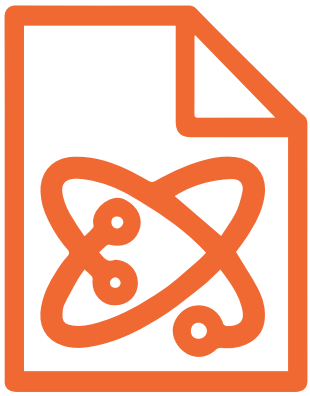
Actions

- Identify lab spaces that support collaboration and provide the tools you need for your current project stage and scale.
- Explore ways to adapt your biodesign process when lab equipment or facilities are limited.

(Non)- academic literature

RE5

This card helps you use academic and non-academic articles to inspire, learn, and assess the innovation of new biodesign concepts



- Will you consult academic and non- academic literature to deepen your understanding of the scientific principles behind biodesign?
- In what ways will academic articles help you measure the novelty or innovation of your biodesign concepts?
- Will you read into biodesign related articles to let you spark new ideas?

Biodesign Academy

Biodesign Academy

The Biodesign Academy is an online platform that supports designers through sharing teaching materials, expert insights, interesting trends, case studies and new innovations in the field.

Actions

- Use academic and non-academic articles to identify scientific principles that can elevate your biodesign project.
- Assess the innovation of your concepts by comparing them with findings in recent biodesign literature.

Tools

RE6

This card helps you explore and choose the tools that support your biodesign work, from creating to sharing and inspiring

- Which tools might be useful to shape your creative process?
- What tools could support your process documentation (such as specific parameters you used, environment conditions, etc.)?
- Which tools might allow you to monitor and assess impact of your biodesign project on its surrounding ecosystems?
- What tools might help you sharing your findings with peer biodesigners?

Prototyping Circulair

Prototyping Circulair

Prototyping Circular is a project that showcases a wide range of biodesign initiatives on its web platform. The platform provides essential information for each project, including required equipment, recipes, instructional videos, course materials, and other valuable online and offline resources, all of which serve as useful tools in the biodesign process.

Actions

- Identify tools to inspire, document, measure and monitor impact, share your biodesign process. Could be as simple as a walk in nature, and as complex as material libraries or recipe platforms)

Biothinkerspace

RE7

This card helps you recognize the value of starting biodesign experiments in a familiar, accessible space like a kitchen or home lab.

- What minimal kitchen or home equipment do you need to start out experimenting in your biodesign project?
- Are the materials you will be using safe to use in a domestic environment?
- In what ways will starting biodesign experiments at home make the process more accessible?

Jess Redgrave

Jess Redgrave

Jess Redgrave is the designer behind the famous fully sunflower-based rain jacket. At first she start out in her own backyard growing sunflowers, as well as performing experiments in her kichenspace to obtain a proof of concept, before scaling up to a biomakerspace.

Actions

- Set up a simple, accessible workspace using minimal equipment to obtain a first proof of concept.
- Ensure that the materials you're using are safe for experimentation in a domestic environment.

TIPS & TRICKS

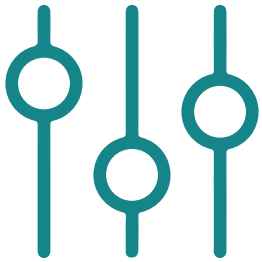
This card deck provides Tips & Tricks and 101's about practically applicable approaches in biodesign.

Some of the Biodesign Toolkit cards from the other decks might refer to one or more of these Tips & Tricks cards.

This Tips & Tricks card deck will expand over time. The most up to date version of the biodesign toolkit, including this Tips & Tricks card deck is available on our website.

Cybernetics

TT1



Cybernetics is the study of systems and how they control themselves, adapt, and communicate. It looks at how things like machines, living organisms, and ecosystems use feedback to stay balanced and work effectively.

In biodesign, you often work with living systems that are complex and self-regulating, like microbes or plants. Cybernetics helps you understand and influence these systems by focusing on feedback loops and interactions.

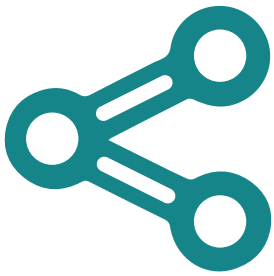
By applying cybernetic principles, you can create more sustainable, adaptable designs that harmonize with nature rather than disrupt it.

Actions

- **Map Feedback Loops in Your System**
  Identify inputs, outputs, and feedback within your biodesign system. For example, observe how changing light or temperature affects microbial growth and adjust accordingly.
- **Monitor and Measure Continuously**
  Set up tools or sensors to track variables in real-time over various timeframes, like pH levels, moisture, or nutrient availability, to ensure your system balance.
- **Design for Adaptability**
  Build flexibility into your design, allowing it to respond to changes in the environment or unexpected conditions, much like natural ecosystems do.
- **Collaborate with the System**
  Treat the biological components of your project as partners. Experiment with different ways to enhance their natural processes rather than forcing them to fit rigid outcomes.
- **Iterate Based on Feedback**
  Use data from your system's responses to improve and refine your design. Cybernetics emphasizes learning and evolving rather than following a fixed path.

System Archetypes

TT2



System archetypes are common patterns in how systems behave. They help us understand why certain problems repeat and how different parts of a system interact. These archetypes can guide us in both diagnosing current issues and anticipating future ones, helping us find sustainable solutions.

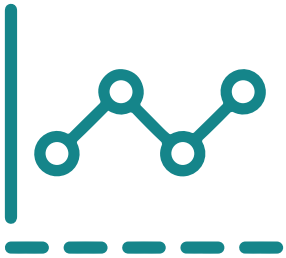
In biodesign, understanding how biological and ecological systems work is essential. System archetypes allow biodesigners to identify recurring challenges like resource limitations, feedback loops, and balancing trade-offs between growth and sustainability. They provide a framework for creating designs that work harmoniously within larger natural systems, ensuring long-term viability and minimizing unintended consequences.

Actions

- **Identify Recurring Patterns in Your System**
  Look for repeating behaviors or challenges in your biodesign project, such as limited growth, resource depletion, or unintended side effects. Match these patterns to known system archetypes.
- **Analyze Feedback Loops**
  Map out the reinforcing (positive) and balancing (negative) feedback loops in your system. Understanding these loops can help you identify which behaviors drive growth or stability and which might cause imbalances.
- **Address Root Causes, Not Just Symptoms**
  Use archetypes like "Fixes that Fail" to pinpoint underlying problems in your system. Design interventions that solve these root issues rather than applying short-term fixes.
- **Design with Long-Term Viability in Mind**
  Consider archetypes like "Tragedy of the Commons" to ensure shared resources are managed responsibly. Create designs that promote cooperation, sustainability, and resilience within the system.

Behavior Over Time Graph (BOTG)

TT3



BOT graphs help biodesigners visualize and understand the change of dynamic systems over time by:

1. **Spotting Trends**: Showing how materials or biological processes behave over time, helping to identify potential problems or opportunities.
2. **Testing Interventions**: Predicting how changes will affect a system, allowing designers to refine their processes.
3. **Evaluating Sustainability**: Tracking long-term outcomes, like whether a material breaks down as expected or if resources are being depleted.

By using BOT graphs, biodesigners can ensure their projects are aligned with the natural rhythms and feedback loops of biological systems.

Actions

- **Identify Key Variables**
  Determine which aspects of your project are most important to monitor over time.
- **Collect and Track Data**
  Gather data on your chosen variables at regular intervals. For example, measure microbial growth daily or track material breakdown weekly to build an accurate timeline.
- **Visualize Patterns and Trends**
  Create BOT graphs to plot the data you collect, making it easier to see trends, fluctuations, or unexpected changes. Use these patterns to better understand how your system behaves over time.
- **Test Hypotheses and Simulate Changes**
  Use BOT graphs to explore "what if" scenarios. For example, predict how altering a variable (e.g., increasing temperature) might affect material performance or biological processes.
- **Refine Your Design Based on Insights**
  Apply the insights from your BOT graphs to adjust your biodesign project. For example, if a graph shows nutrient depletion over time, redesign the system to replenish nutrients sustainably.

Flourishing Business Canvas

TT4

The Flourishing Business Canvas is a strategic tool designed to help businesses integrate sustainability and social responsibility into their operations.

In biodesign, the Flourishing Business Canvas is vital for:

1. **Embedding Sustainability**: It helps designers consider the environmental implications of their materials and processes, ensuring alignment with natural eco-systems.
2. **Value reflection**: It helps designers reflect on the values they will be co-creating, as well as co-destructing in their natural ecosystems.
3. **Long-Term Visioning**: The tool encourages thinking beyond immediate outcomes, supporting projects that benefit the biosphere and future generations.

Actions

- **Map Material Choices to Sustainability Goals**
  Use the canvas to analyze the environmental impact of your materials and ensure they align with the principles of the biosphere.
- **Reflect on Co-Creation and Co-Destruction**
  Identify the positive and negative values your project contributes to ecosystems. Consider unintended environmental or social consequences and adjust designs to minimize harm while maximizing benefits.
- **Engage with Stakeholders for a Broader Perspective**
  Collaborate with environmental scientists, communities, and customers to understand the broader implications of your design choices.
- **Incorporate Long-Term Scenarios**
  Use the canvas to envision how your project could evolve over time. Include scenarios for scaling up, adapting to changing ecosystems, and maintaining sustainability across generations.
- **Iterate with Systems Thinking**
  Regularly revisit and refine the canvas as your project develops.

Open-ended Design (OeD)

TT5

Open-Ended Design (OeD) is an approach that intentionally creates unfinished or adaptable products. It emphasizes flexibility, allowing designs to evolve based on local contexts, user needs, and environmental factors. By embracing imperfection, this method avoids over-designing and encourages participation and re-appropriation from users, who can personalize or modify the design to fit their specific conditions.

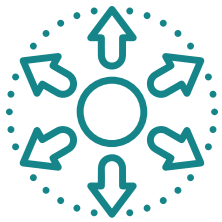
This methodology is crucial for biodesign as it mirrors the non-static, evolving nature of biological systems. By integrating OeD, designers can create solutions that respect both the complexity of natural ecosystems and the diverse needs of human communities.

Actions

- **Design for Adaptability**
  Create a biodesign product that allows for local adaptation and customization. For example, leave room for users to modify its structure or use local materials to meet their specific needs.
- **Embrace Imperfections**
  Incorporate the natural variability of living materials into your design. Accept outcomes like irregular textures or shapes as integral to the final product rather than flaws.
- **Collaborate with Users and Communities**
  Engage with end-users or communities to co-create solutions. This approach ensures the design evolves to align with the users' real-world needs and cultural context.
- **Plan for Ongoing Evolution**
  Design a product or system that can evolve over time, incorporating feedback loops and biological growth.
- **Document and Share Knowledge**
  Share design processes and outcomes openly to encourage re-appropriation and further development by others. This fosters a collaborative network that advances biodesign innovations.

Decentralization

TT6



Biodesign relies heavily on local ecosystems, renewable materials, and community involvement. Scaling up biodesign projects in a centralized manner could deplete resources, damage ecosystems, or compromise the sustainability of the system. Decentralization offers a sustainable way to scale biodesign by:

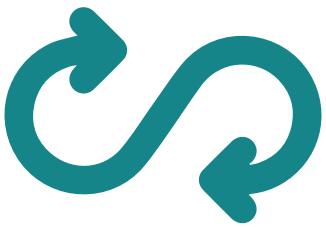
1. **Preserving Local Resources**: Keeping materials and craftsmanship local.
2. **Global Collaboration**: Sharing knowledge and branding across decentralized hubs allows for innovation and growth without overwhelming single ecosystems.
3. **Avoiding Overgrowth**: Nature teaches us that overgrowth can harm systems. For example, when ant colonies grow too large to sustain themselves, they naturally split into smaller colonies. This principle of self-limitation ensures the survival of both the original and new colonies.

Actions

- **Identify Local Resources and Skills**
  Map out local materials, resources, and skilled artisans or craftsmen in your area.
- **Develop Knowledge-Sharing Networks**
  Create or join global networks to share best practices, research, and branding strategies.
- **Design for Regional Adaptability**
  Tailor your biodesign solutions to align with specific local conditions, such as climate, available resources, and community needs, ensuring they are effective and sustainable within each unique ecosystem.
- **Establish Collaborative Hubs**
  Set up decentralized production hubs that operate semi-autonomously, focusing on local materials and production while adhering to shared global branding and ethical guidelines.
- **Implement Sustainable Growth Models**
  Monitor and manage the growth of your biodesign initiative. Avoid overextension by mirroring natural systems, such as splitting operations into new hubs when resources or demand exceed local capacities, ensuring long-term viability.

Life Cycle Assessment (LCA)

TT7



Life Cycle Assessment (LCA) is a method used to evaluate the environmental impact of a product throughout its entire life — from the extraction of raw materials, through production and use, all the way to disposal or recycling. LCA is important because it helps biodesigners:

- **Avoid greenwashing:** Some bio-based materials may still have a high impact when produced or transported.
- **Make informed material choices:** LCA highlights which parts of the design cause the most environmental harm.
- **Improve sustainability:** It guides better decisions by showing where environmental performance can be improved.
- **Support transparency and trust:** LCA provides measurable data that can be shared with stakeholders, regulators, and customers.

Actions

- **Map the full life cycle of your product**
  Identify all stages: raw material sourcing, production, transportation, use, and end-of-life (reuse, composting, recycling, or disposal).
- **Collect data on materials and processes**
  Gather information on energy use, water consumption, emissions, and waste for each stage of the product's life.
- **Choose the right LCA tool or partner**
  Use tools like SimaPro, Granta Edupack, OpenLCA — or collaborate with LCA experts to support your assessment.
- **Compare alternatives**
  Test different materials or processes to see which option has the lowest environmental impact — even between biobased options.
- **Translate insights into design decisions**
  Use LCA results to improve the sustainability of your biodesign — reduce hotspots, shorten transport chains, or redesign for longer product life or easier biodegradation.

Human Centered Design (HCD)

TT8

Human-Centered Design (HCD) is a creative approach to problem-solving that starts with the people you're designing for and ends with solutions tailored to their needs, behaviors, and experiences.

- **Biodesign doesn't only affect nature — it affects people too.** HCD ensures biodesign solutions are not just ecologically sound, but also socially acceptable, desirable, and usable by real people.
- **Bridges the gap between biology and daily life.** It helps designers translate biological principles into human-centered applications that people can relate to, adopt, and trust.
- **Builds empathy and relevance.** HCD invites designers to understand users' values, fears, and habits — which is especially important when introducing new, unfamiliar bio-based materials or living systems.

Actions

- **Conduct Empathy Interviews**
  Talk to potential users and stakeholders to understand their values, needs, fears, and perceptions—especially around new or unfamiliar bio-based materials.
- **Co-Design with Communities**
  Involve local users, artisans, or communities early in the design process to generate ideas, shape decisions, and build ownership of the biodesign solution.
- **Prototype and Test in Context**
  Develop quick, low-risk prototypes using your bio-based material or concept, and test them in real-life environments with actual users for direct feedback.
- **Map the Human Journey**
  Create a user journey map showing how people will interact with the biodesign solution—from discovery to use to end-of-life—and identify moments that need improvement.
- **Balance Desirability, Feasibility, and Viability**
  Continuously evaluate your biodesign solution by asking: Is it desirable for users? Technically feasible to produce? Viable for long-term social and ecological impact?

Research through Design (RtD)

TT9

Research through Design (RtD) is a way of doing research by making things. Instead of starting with a hypothesis and testing it with data like in traditional research, RtD begins with a design challenge. Designers create prototypes—not just to solve a problem, but to test ideas, explore questions, and generate new knowledge. The act of designing becomes a method of inquiry.

Biodesign is full of uncertainties—biological materials behave differently, living organisms grow unpredictably, and environmental factors play a major role. RtD is especially valuable because:

- It embraces experimentation
- It's idea-driven
- It accepts non-linearity
- It's generative

Actions

- **Prototype to Learn**
  Create quick, low-commitment prototypes with biological materials—not to perfect them, but to explore how they behave, grow, or react. Let making guide your thinking.
- **Frame a Research Question**
  Formulate a central question your design explores, e.g., “How can we co-create with living organisms?”. Let this question evolve as you prototype.
- **Document Everything**
  Capture your design process in detail—photos, sketches, notes, failures, unexpected outcomes. This becomes your research data.
- **Reflect Through Making**
  Regularly pause to reflect on what each design iteration teaches you about the biological, social, or material aspects of your question.
- **Share Knowledge Through Design Outputs**
  Turn your prototypes, visuals, or process maps into communicative tools that explain your insights and provoke discussion—beyond just presenting a “final product.”

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