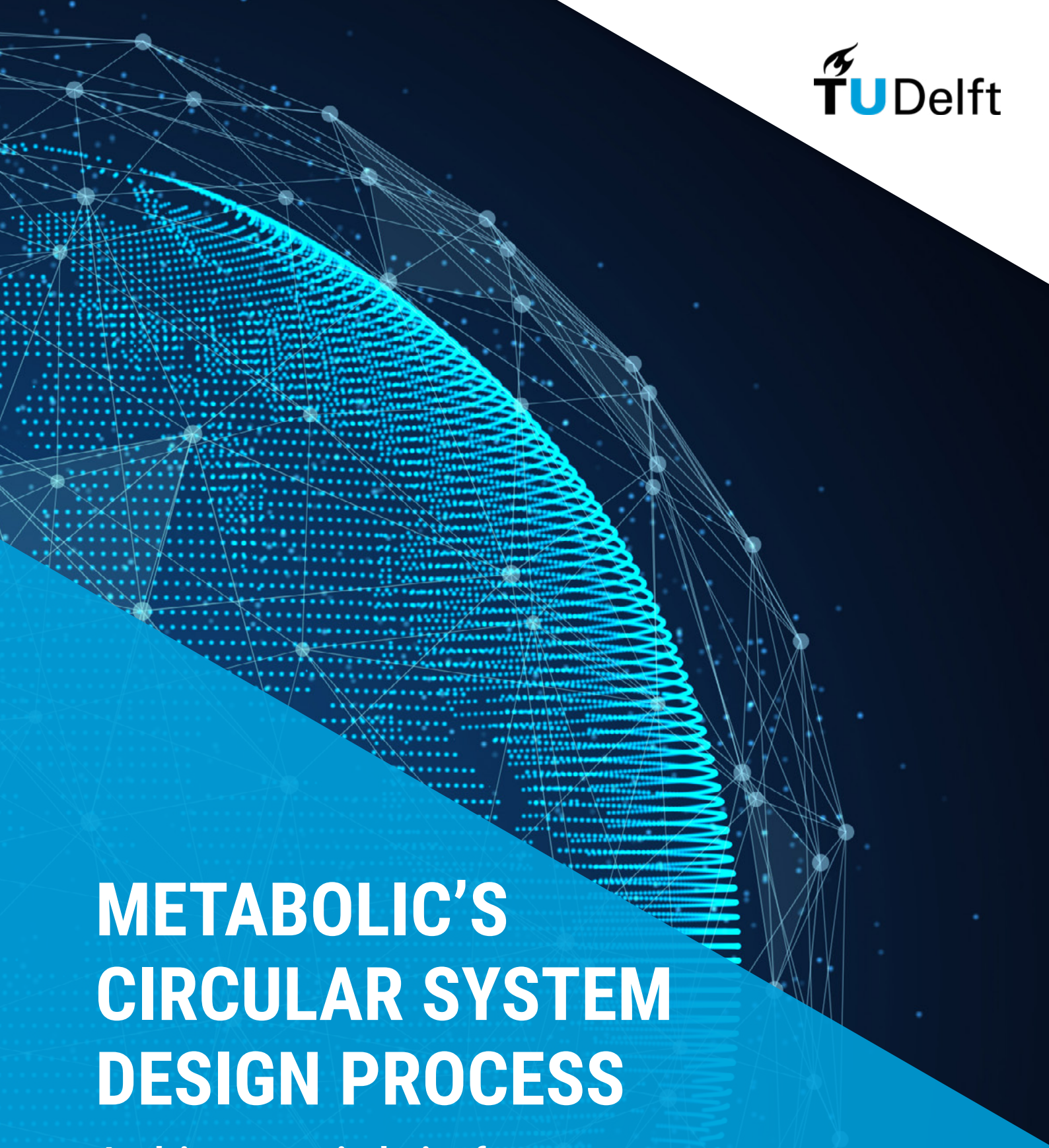

METABOLIC'S CIRCULAR SYSTEM DESIGN PROCESS

Applying systemic design for co-creating circular economy solutions

October 2021

MASTER GRADUATION THESIS

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MSc. Strategic Product Design
Faculty of Industrial Design Engineering Delft University of Technology

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IN COLLABORATION WITH METABOLIC

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GRATITUDE

This graduation thesis is the final deliverable of the Master program Strategic Product Design at the faculty of Industrial Design Engineering, TU Delft University. It also marks the end of a challenging ride of researching and designing the Circular System Design process together with Metabolic.

I would like to thank my supervisory team, Jeremy and Sine. Thank you for your dedication to coaching. Your feedback and suggestions helped me fix the weak parts of my works and gave me the confidence to accomplish this project.

I would like to thank all the Metabolic members that I had talked to. All the formal interviews and informal chats about my projects provided precious information for the research and inspired design ideas.

I would like to thank all the friends who participated in the testing of my work. Your time invested and comments helped improve the work, which can't be done without your contribution.

Finally, I would like to thank my Metabolic mentor, James. Thank you for giving me the chance to work on my thesis topic with Metabolic. Thank you for sharing your knowledge and practical experiences about the circular economy transition, system thinking, Metabolic's methodology, and more. This knowledge helped me build the project's foundation and made me become a person with a 'systemic circular economy' mindset. Last but not least, thanks for brainstorming with me along the project to fix any problems faced and generate ideas for the design works. This project could not have been done without your support.

I am super glad to be part of the circular economy transition and hope to see my work being iterated and applied to make a real impact in the world.

EXECUTIVE SUMMARY

The current 'take, make, waste' linear economy has caused many ecological and social problems; that's why the circular economy aims to close the loop so businesses can thrive while natural resources sustain and regenerate. Metabolic, a sustainability consultancy that helps clients transition towards the circular economy, recognizes that a circular product can only exist within a properly functioning circular system. Therefore, they adopt system thinking, a thinking skill that perceives parts of a more extensive system as intertwined components rather than independent entities (da Costa Junior et al. 2019), with science-based analysis in their project work.

However, collaborations between stakeholders are essential to achieve systemic changes since they might all hold different values, interests, and world views on a system. Metabolic's current 'science-based system thinking' methods can be improved by engaging and building upon those collaborations. Systemic design provides frameworks and methods to create a shared understanding that mutual agreement can emerge among actions to be taken. Besides, designers' ability and methods to synthesize, visualize, and create can complement system thinking in co-creating circular economy solutions among stakeholders. Therefore, this graduation project explores how systemic design and other design methods could help improve Metabolic's circular system design process.

The outcome of this project is a Circular system design process with multiple sessions, activities, and tools developed for Metabolic to apply in their future projects. Additionally, a guidebook (Ch. 5) was written for Metabolic members to learn and get the essential preparation for adopting the tools.

CHAPTER 00

PROJECT CONTEXT

0.1 PROJECT SCOPE

The original motivation for this project was to explore how systemic design could benefit the circular economy transition. Systemic design, an emerging design discipline that integrates systems thinking with design, is considered to help deal with complex challenges. The circular economy transition is about redesigning our current take-make-dispose linear economy systems into waste-free and regenerative systems. This transition often involves systemic changes. Though, as the project ultimately collaborated with Metabolic, the scope was shaped more specifically.

Metabolic is an ecosystem of multiple institutions aiming to transit the global economy into a fundamentally sustainable state. Metabolic's Circular System Design (CSD) process, previously known as the Circular Design Bootcamp (the Bootcamp), is a service that Metabolic offers to facilitate clients to redesign their products and services to become systemically circular. Since the Bootcamp assisted corporations in redesigning their products and services into a more circular state, it was considered to be a good fit for this project. Therefore, the project scope was reformulated as 'how systemic design and other design methods could benefit Metabolic's Circular Design Bootcamp.'

0.2 METABOLIC'S MOTIVATION AND PROBLEM STATEMENT

Metabolic is a sustainability consultancy based in the Netherlands, with a mission to transition the global economy to a fundamentally sustainable state. This mission was driven by the urgency that many essential sustainability indicators are under exponential growth and close to reaching the planetary boundaries. Therefore, Metabolic aims to help cities, NGOs, and corporates develop clear, impactful strategies for circular and sustainable operations.

Metabolic's Circular Products and Services cluster, which sits within the Industries consulting team, primarily works with clients who produce commodities (e.g., batteries, medical equipment, and consumer goods.) Their work includes mapping the impacts of production systems, designing circular product-service systems with stakeholders across production value chains, and identifying opportunities to shift linear production systems towards circular interventions such as reuse, repair, and remanufacturing. In the past, most clients asked Metabolic to give a big picture for sustainability transition and provide advice on the operational level instead of redesigning and implementing sustainable products or services.

Therefore, Metabolic has tried to prompt clients to do more redesign and implementation work, and one of the means was the Bootcamp. Metabolic invited different stakeholders of the projects to the Bootcamp and took them on a journey towards initiating the pilots for circular products or services. Metabolic has held a long-term goal to empower clients to become impact champions through the Bootcamp to start more circular products or services redesign within the industries.

The Circular Products and Services cluster is looking to optimize the Bootcamp design and rebrand it as the Circular System Design (CSD) process. Considering the Bootcamp's goals made it suitable for this project to study how systemic design and other design methods and tools could benefit circular transition challenges.

0.3 PROJECT GOAL

The project aims to explore how systemic design and other design methods and tools could benefit and optimize Metabolic's Circular Design Bootcamp.

It is speculated to result in the new CSD process, including a new framework, sessions, and tools, to help companies redesign and implement their product and service into a more circular state.

0.4 RESEARCH QUESTIONS AND PROJECT APPROACHES

0.4.1 Research questions

The Bootcamp was embedded in the larger service package that Metabolic offered to clients. Hence, it is critical to understand Metabolic's methodology to ensure the new CSD process can be properly connected with other parts of the project work and create more extensive synergy. Therefore, the first research question is:

Q1: What is Metabolic's methodology? (Ch. 1.1)

Understanding the context of why Metabolic developed the Bootcamp in the first place and the intended goals for it can guide the new design toward the desired direction that Metabolic wishes for. Therefore, the second and third research questions are:

Q2: What was Metabolic's motivation for running the Bootcamp? (Ch. 1.2)
Q3: What goals did Metabolic want to achieve through the Bootcamp? (Ch. 1.3)

After knowing the context of the Bootcamp, the next step is to explore how systemic design and other design methods and tools could benefit it. Therefore, the fourth and fifth research questions are:

Q4: What is Systemic design, and how could it benefit the Bootcamp? (Ch. 2.1)
Q5: What other design methods and tools could benefit the Bootcamp? (Ch. 2.3)

Knowing how the current Bootcamp was constructed and executed helps identify opportunity areas for optimization. Therefore, the sixth research question will be:

Q6: How was the Bootcamp constructed? (Ch. 3.1)

By combining the knowledge from all the research questions, the insights help determine 'What are the opportunity areas for Bootcamp optimization?' and 'How could systemic design and other design methods and tools be applied to address these opportunity areas?

0.4.2 Project approach

The figure below shows the overall approach of this project and the research and design activities performed. Also, the corresponding chapters are noted besides as a reference. The project approach follows the Double Diamond framework; hence there are four stages within this project.

The 'Discover' stage aims to get the necessary data for answering all the research questions. The stage starts with studying internal documents from Metabolic to understand their methodology (Q1). Then we conducted three interviews with Metabolic's CEO (Eva Gladek), Metabolic's Research Director (Liz Corbin), and the team leader of the Circular Products and Services cluster (James Souder) to understand the motivation and expectation of the Bootcamp (Q2, Q3). Then the literature review was performed to study systemic design and other design methods and tools (Q4, Q5). Finally, the Bootcamp material was studied to get insights into how its structure and any shortcomings that have been discovered (Q6).

The 'Define' stage synthesized all the knowledge learned from the 'Discover' stage and identifies opportunity areas for Bootcamp optimization.

The 'Develop' stage developed the design concept for the CSD process and tested and revised it through four iterations. The first two iterations validate the value of the concept through concept testing with Metabolic's colleagues. Then, the concept was tuned according to the test result and further built into a prototype. Finally, the last two iterations focus on usability improvement through usability testing.

The 'Deliver' stage finalized the CSD process design and developed necessary documents that help deliver the work to Metabolic. Also, we will reflect on and evaluate the final work at the end of this project.

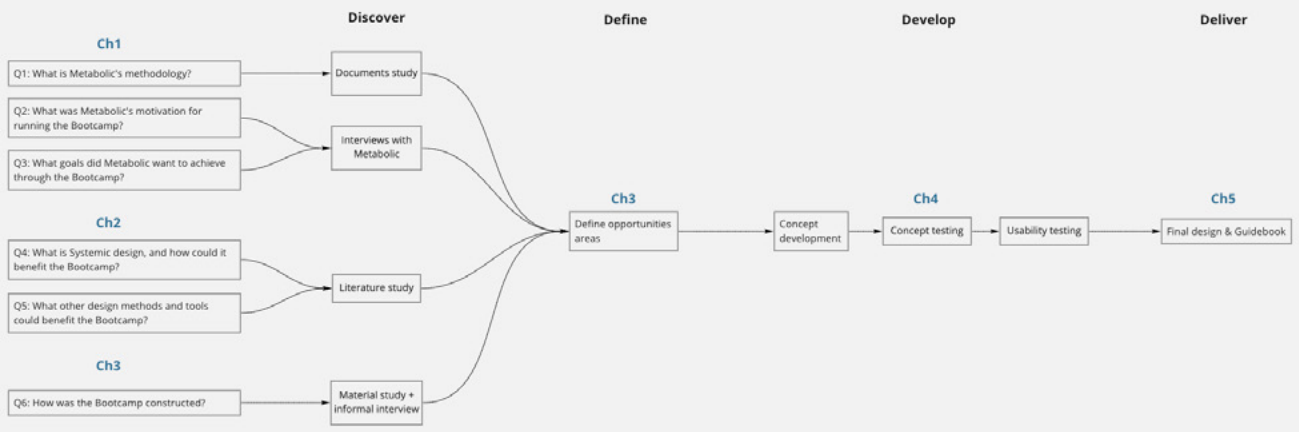
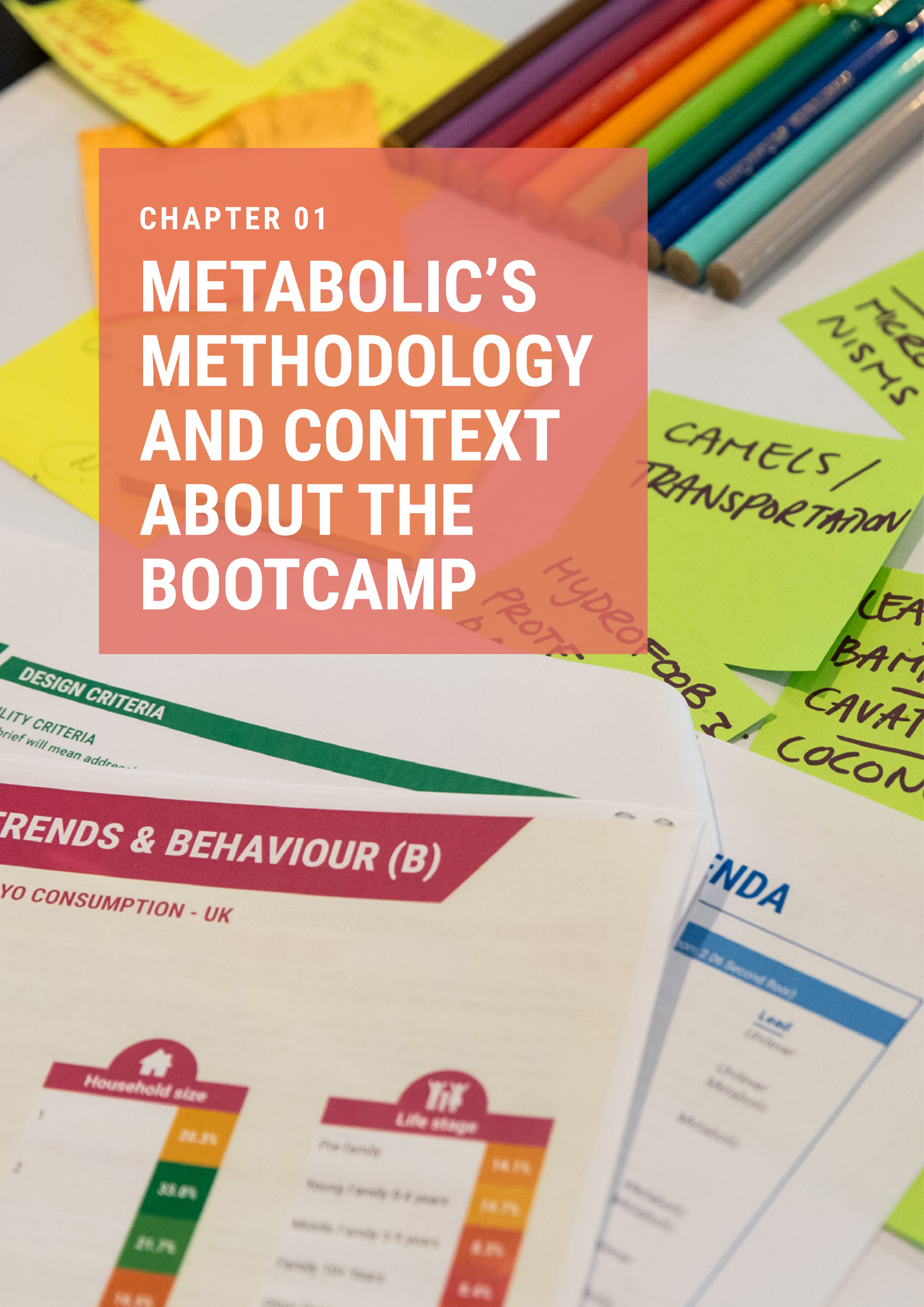


Fig.1 Project structure and approach

CHAPTER 01

METABOLIC'S METHODOLOGY AND CONTEXT ABOUT THE BOOTCAMP



INTRODUCTION

This chapter tries to answer research question Q1-3.

Q1: What is Metabolic's methodology? (Ch. 1.1)
Q2: What is Metabolic's motivation for running the Bootcamp? (Ch. 1.2)
Q3: What goals does Metabolic want to achieve through the Bootcamp? (Ch. 1.3)

The insights gained help ensure that the CSD process is cohesive with other parts of the projects and fits into the bigger context of Metabolic's intentions and goals.

1.1 WHAT'S METABOLIC'S METHODOLOGY?

1.1.1 The Seven Pillars of the Circular Economy

Metabolic defined the Seven Pillars of the Circular Economy (Eva Gladek, 2019) to specify what kind of 'sustainable state' they aim for, and this definition has become an essential belief in their methodology (Fig. 2). Metabolic has realized that most people took an activity-based definition of the circular economy and focused on closing the material and product cycle. However, sometimes making materials and products circular can have a burden-shifting effect on other environmental and social indicators. For example, recovering certain materials might be energy-intensive and cause more impact on the environment than business-as-usual.

Therefore, Metabolic identified seven critical aspects: materials, energy, water, biodiversity, human society and culture, health and well-being, and generating value beyond financial means, as criteria when assessing if a circular concept can lead to a sustainable state.

Fig. 2 The Seven Pillars of the Circular Economy (Source: Metabolic)

1.1.2 Systems thinking + Science-based decision making

Metabolic has realized that the change will not be made without considering the interconnectedness between environmental, social, and economic systems. Therefore, they employ systems thinking as the core thinking skill to tackle the received challenges.

Systems thinking perceives parts of a larger system as intertwined components rather than independent entities (da Costa Junior et al. 2019). Contrary to traditional scientific methods that take the Reductionism mindset to disassemble problems to their fundamental parts for analysis, Systems thinking advocates the Holism mindset that looks at parts and puts them together to see how a bigger system works. In other words, systems thinking focuses on the interdependence and relationship between different actors and believes that those were making the function or goal of the system what it is. With this mindset, Metabolic perceives negative impact as a systemic property that emerges from the interconnectedness of different actors (e.g., companies, products, supply chains, consumers, governments, environment) and seeks to understand their relationship.

Furthermore, systems thinking gives people the freedom to identify the root causes of problems and see new opportunities (Donella Meadows, 2009). Problems observed are often apparent behaviors or patterns, for example, product waste or job loss for local workers. However, that is, purpose, mindset, or structure drives those patterns behind the scenes. Therefore, Metabolic aims to uncover the root causes of problems and develops interventions accordingly. Finally, with a holistic view, Metabolic could ensure new solutions will avoid unintended consequences due to the burden-shifting effect.

On the other hand, Metabolic also believes that actions cannot be taken without data; in other words, critical knowledge is essential for meaningful change. Therefore, Metabolic uses data science to identify the impact hotspots within systems and develops interventions based on academic research. Data also helps prioritize interventions by calculating the impact reduction potential of interventions.

Metabolic's five-stage process for transforming systems is introduced below to explain how Metabolic applies systems thinking and science-based methods in their consulting projects.

1.1.3 FIVE STAGE PROCESS

The five stages are 1. Current state analysis, 2. Goal setting, 3. Interventions, 4. Implementation, and 5. Monitoring, which is generally applied to most Metabolic projects (Fig. 3). It can be argued that this process adopted the Backcasting method outlined by John B. Robinson from the University of Waterloo in 1990. It is a planning method that starts with defining a desirable future and then works backward to identify strategies and interventions to help achieve that specified future ("Backcasting," 2021). Each stage is further explained below:

Stage one: Current state analysis

The projects start with understanding 'Where we are' regarding sustainability conditions and the root cause of negative impacts. Metabolic conducts multiple types of analysis, including:

- Material Flow Analysis (MFA) and Impact assessment: help understand the sustainability condition and identify the impact hotspots.
- Root cause analysis: helps identify places where to intervene to make the system more circular by mapping the system structure and applying the iceberg model
- Trend analysis: helps illuminate leverage points, the concept borrowed from Donella Meadows's 12 leverage points (1999), within systems to drive meaningful change.

Stage two: Goal setting

After knowing the current state, the next step is to define 'Where we want to go.' Metabolic assists clients to set sustainable visions with a focus on impact hotspots.

Stage three: Intervention

After knowing the goal, the next step is to develop interventions that propel the changes towards the sustainable visions, in other words, 'How to get there.' Based on the team's expertise, the learning from best practices, and academic research, Metabolic helps clients develop interventions and build business cases.

Stage four: Implementation

With the interventions ready, the next step is to turn them into action plans and roadmaps. Metabolic first prioritizes interventions based on the calculation of impact reduction and then defines concrete plans that clients could implement.

Stage five: Monitoring

Last but not least, Metabolic builds a tool like a dashboard that helps clients monitor the effectiveness of the implementation by tracking critical indicators so they can iterate the plans.

Mini takeaway

To keep the CSD process aligned with Metabolic's methodology, it is needed to consider the features below:

- *Seven Pillars: The CSD process should ensure the outcomes are circular by the definition of the Seven Pillars.*
- *Systemic: The CSD process should facilitate participants to understand problems from systemic perspectives and design on system levels.*
- *Backcasting: The CSD process should follow the Backcasting logic by starting with defining future vision or goals.*
- *Data-driven: The CSD process should utilize the finding of current state analyses to support science-based decision-making.*

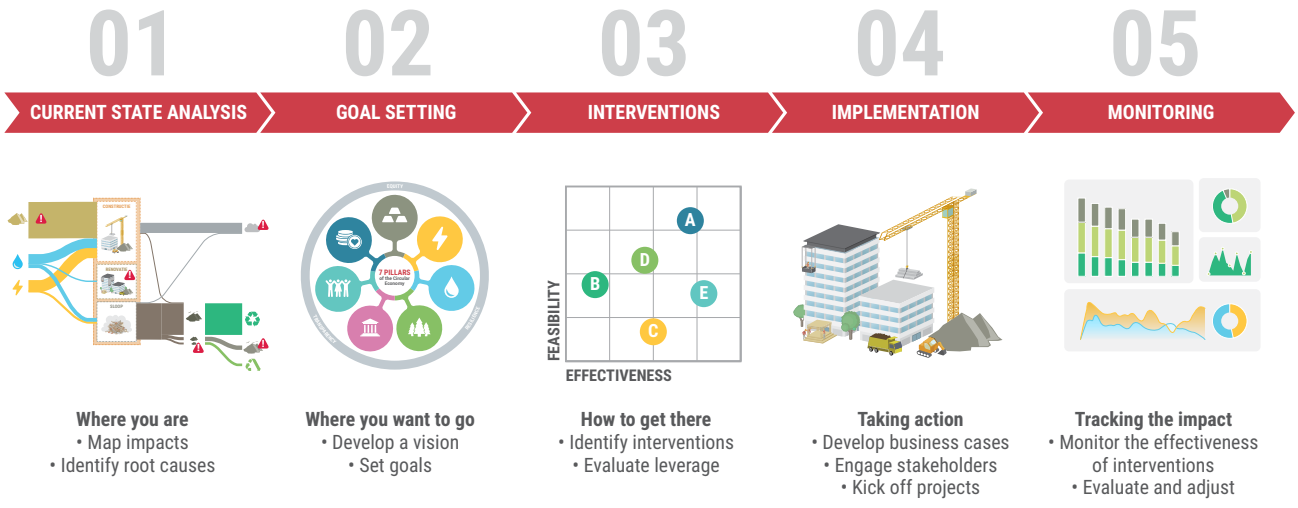


Fig. 3 Metabolic's five stage process (Source: Metabolic)

1.2 WHAT MOTIVATED METABOLIC TO DEVELOP THE BOOTCAMP?

As mentioned in Ch. 0, most of Metabolic's Circular Products and Services cluster clients looked for Metabolic to advise on operational levels, like data standardization, green manufacturing, or supply chain redesign. Metabolic's CEO (Eva Gladek) pointed out the core problem of this phenomenon:

"A lot of companies want to reduce their footprint overall, but often it seems like an end of pipe process, where you already have all the value chain, and all sets of products, then you try to figure out how to tweak those a little bit. Like change a supplier or change a logistic pathway. However, fundamentally, the main driver of the impact of our physical economy is mostly decided at the design stage. For example, in architecture, research shows that 75% of the carbon emission is determined at the design stage. So, design is so instrumental in determining everything downstream."

This phenomenon reflects companies' mindset that the team lead of the Circular Products and Services cluster, James Souder, has learned from years of working with them. "Many companies still perceive sustainability as a 'clicking the box or side thing to comply with' instead of a core strategy of running business." Driving by the pressure of regulation or consumers, companies ask Metabolic to identify negative impacts created by the current system and seek to reduce or remove them (for example, uses water as efficiently as possible, has solar panels on the roofs of its properties, or emits no toxic waste into the environment), instead of seeking new opportunities for redesigning product and business and turn them as a positive force that benefits to society, environment, and the company itself.

Therefore, besides physical outcomes, Metabolic also hopes to change the mindsets of clients through the Bootcamp:

"We aim to shift clients' mindset to perceive sustainability as a critical purpose for company success," says James.

On the other hand, Metabolic Institute's Research Director (Liz Corbin) pointed out an extra meaning that the Bootcamp brought to Metabolic:

"People start recognizing the power of circular and sustainable design in terms of how they engage the companies in supply chains. So, as part of the sustainability transition work for companies, product redesign starts coming up."

As a result, Metabolic came up with the idea of bringing critical stakeholders to a Bootcamp, not only to explore how a product could be redesigned into a more circular and sustainable state and discuss what skills, principles, and people are needed to implement new design, but also to change the mindset of stakeholders. Also, the Bootcamp became one of the first attempts that Metabolic adopted processes, methods, and tools from the design field to provide service for clients.

Mini takeaway

Due to the inertia of conventional business mindsets, discussion of sustainability was often missing in the product design stage. That's why mindset change becomes a critical mission for the Bootcamp. Therefore, the CSD process is expected to prompt companies to take sustainability as the core of their business strategy.

Besides, contrary to Metabolic's primary methodology, which is more systemic and analytic, the Bootcamp brought a more creative, object-oriented design process that most Metabolic employees might be unfamiliar with. Therefore, a communication tool should be developed to help explain the rationale of the CSD process to the internal members of Metabolic.

1.3 WHAT DOES METABOLIC WANT TO ACHIEVE THROUGH THE BOOTCAMP?

As mentioned, the Bootcamp focuses on redesigning products or services into a more circular and sustainable state. Besides this primary goal, some other important goals are summarized below from the interview with the Circular Products and Services cluster lead, James.

Help clients view themselves as part of a more extensive system and aim to reach systemic sustainability

Metabolic encourages participants to recognize that a circular product can only exist within a circular system. Therefore, they aim to help clients think through how their product interacts with the larger system and bring broader stakeholder perspectives to the Bootcamp. By re-thinking clients' relationships with stakeholders and exploring new collaboration with parties out of their current value chain, systemic change is then more likely to be made. According to James, Metabolic currently focuses primarily on the 'product-service system' level, referring to this graphic below (Fig. 4). And they want to be shifting more towards the 'Design for system innovations and transitions.'

Empower clients to become impact champions, so they can drive sustainability transition in the company

There are several tools developed for the Bootcamp to facilitate circular product redesign. Metabolic not only assists clients in using the tools through the Bootcamp but wants them to learn how to use those tools on their own for future tasks. As stated by the team leader of the Circular Products and Services cluster team:

"We don't want them to come out at the workshop with just one product design. We want them to feel empowered to make circular decisions in their everyday work. That's the shift we want to move forward."

Impact reduction

As mentioned in Ch. 1.1, Metabolic has realized that not every circular solution on the market is inherently sustainable (Fig. 4). For example, replacing a very energy-inefficient washing machine may be more sustainable than extending its life. That is why Metabolic defined the Seven Pillars of the circular economy and set indicators according to measure if the new concepts reduce the overall impact in each aspect.

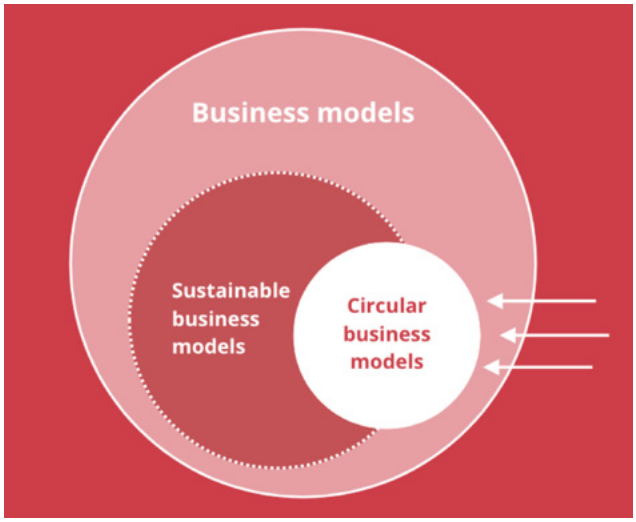


Fig. 4 Relationship between sustainable business models & circular business models (Source: Geissdoerfer et al., 2018).

Mini takeaway

Three essential features for the CSD process were identified:

- *It should facilitate clients to understand the challenges and design from a system perspective.*
- *It should be a co-creation process, so Metabolic can empower clients to become impact champions through the workshop.*
- *Outcomes should be both circular and sustainable.*

1.4 TAKEAWAY

Considering Metabolic's methodology, motivation towards the Bootcamp, and goals for the Bootcamp, the design of the CSD process should comply with the points below to stay cohesive with other parts of the projects and fit into the bigger context of Metabolic's intentions and goals.

- **Seven Pillars:** The Bootcamp should ensure the outcomes are circular under the standard of the Seven Pillars of the circular economy.
- **Systemic perspective:** The Bootcamp should facilitate clients to understand problems from a systemic perspective and collaborate with multi-stakeholders to design on the system level. It requires enhancement of communication and shared understanding among different stakeholders.
- **Backcasting:** The Bootcamp should follow the Backcasting logic by starting with defining future vision or goals.
- **Data-driven:** The Bootcamp should utilize Metabolic's science-based analyses to support decision-making.

- **Mindset change:** The Bootcamp should prompt companies to take sustainability as the core of the business strategy.
- **Empower:** The Bootcamp should empower clients to become impact champions.
- **Instruction:** The Bootcamp should come with tools that help communicate the rationale of methods and tools used to the internal members of Metabolic.

What's next

This chapter outlined the context of Metabolic's methodology and the motivation and expectation for building the Bootcamp in the first place. Through this understanding, how systemic design could benefit the Bootcamp become explicit, and we also identified other design methods and tools that might benefit the Bootcamp. The next chapter introduces the systemic design and the tools identified and explores how they could be applied to optimize the Bootcamp.

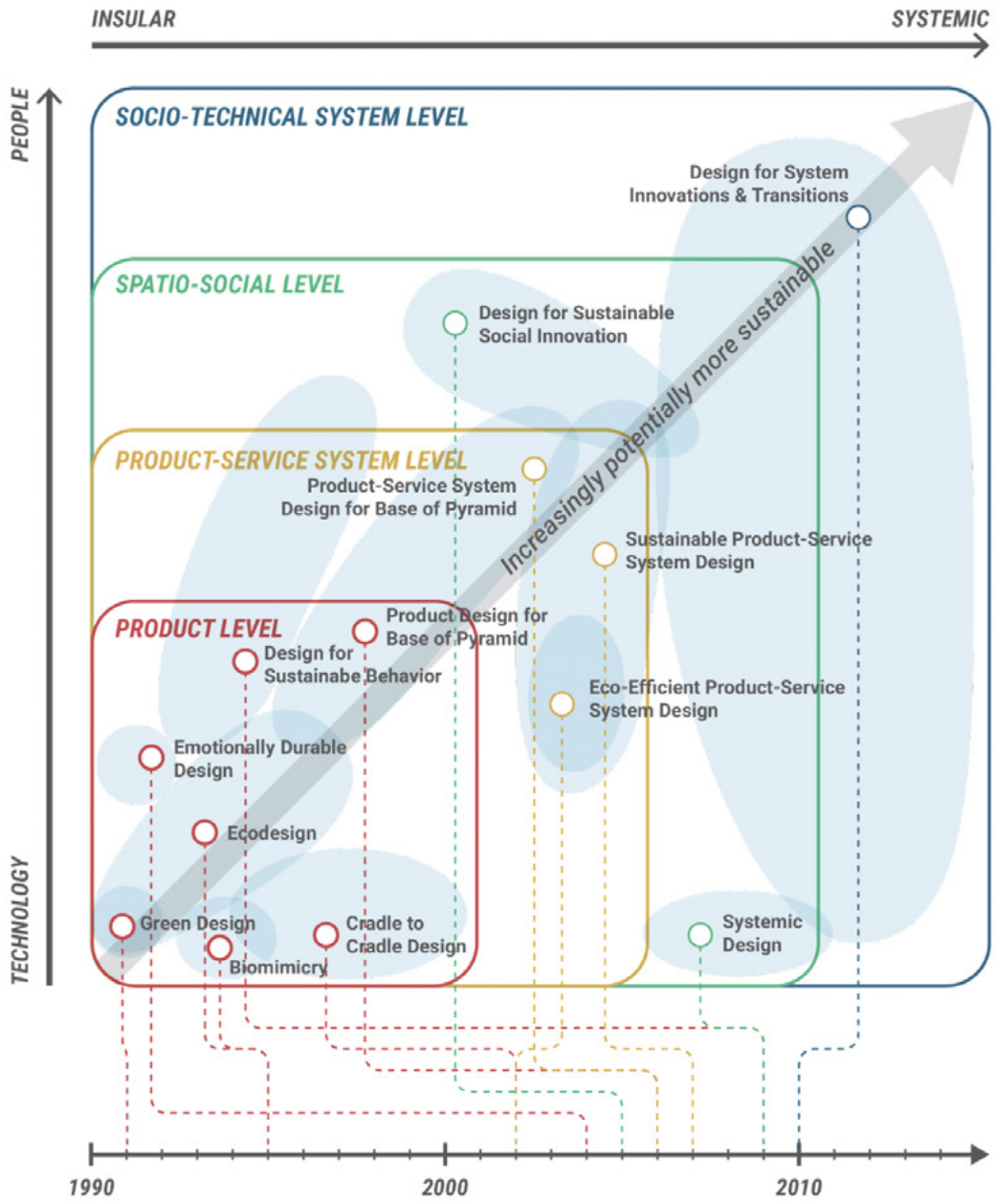


Fig. 5 Evolution of design for sustainability (Source: Ceschin & Gaziulusoy, 2016)

CHAPTER 02

LITERATURE REVIEW

DRS // CUMULUS 2013
2nd International Conference for Design Education Researchers
Oslo, 14–17 May 2013

...tems Oriented Design: The emerge... development of a designerly approach... address complexity

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OCEAN Design Research Association

Abstract: Designers are especially well suited to cope with th... the real world because of three reasons: they are trained to ... solutions from complex and fuzzy material and they are goo... which is an enormous advantage for thinking in complexity. ... creative people trained to come up with new solutions. There... design practices geared towards dealing with complexity. Bu... need to be systematized and developed further. One way of ... develop its relation to other practices of complexity found in ... and systems practices. This paper reports on the developme... Oriented Design, an approach to learn how to better cope w... issues as designers. The approach is influenced and inspired ... systems thinking and systems practice and inspired by gener... diagramming. Design practice, systems thinking, systems pr... thinking, information visualisation, diagramming, GIGA-map... design, research through design, design for complexity, sust...

Keywords: Design practice, systems thinking, systems practi... thinking, information visualisation, diagramming, GIGA-map... design, research through design, design for complexity, sust...

INTRODUCTION

This chapter tries to answer research question Q4-5.

Q4: What is Systemic design, and how could it benefit the Bootcamp? (Ch. 2.1)
Q5: What other design methods and tools could benefit the Bootcamp? (Ch. 2.2 & 2.3)

With the insights gained from Ch. 1, two other design fields were identified to be beneficial for the Bootcamp: Design (tools) for sustainable business model innovation (Ch. 2.2) and Circular design tools (Ch. 2.3). First, the Bootcamp tries to motivate clients to take sustainability as the core of the business strategy; therefore, design methods and tools for sustainable business model innovation are promising for this purpose. Second, as the primary strategy used for the Circular Design Bootcamp, the Circular design field has also developed many design methods and tools that are expected to benefit the Bootcamp potentially.

2.1 WHAT IS SYSTEMIC DESIGN, AND HOW COULD IT BENEFIT THE BOOTCAMP PROCESS?

What is systemic design?

The systemic design aims to create the synergy between systems thinking and design due to the rising need to tackle systemic problems. Systems thinking, introduced in Ch. 1.1, is proposed to complement the traditional design world with three significant strengths: a holistic perspective, diversity of views, and complexity-handling capacity (da Costa Junior et al., 2019).

On the other hand, the design also brings value to the limitation of systems thinking. It is asserted that although systems thinking helps analyze a system, it does not provide methods to develop interventions (Ackoff, 2004). By bringing in designers' competence in synthesis, creation, and visualization, systems can be described, reconfigured, and proposed new solutions. Especially when designing new solutions for complex problems, it requires a thorough understanding of many issues and relations, and visualization helps people understand complex systems without being constrained by our limited mental capacity (Jones, 2014).

How could systemic design benefit the Bootcamp?

There have been different systems thinking approaches throughout the history of system science development, and one of them is the 'Hard systems thinking' approach. This approach assesses systems from an objective perspective and quantifies relationships to identify leverage points for optimization. It is speculated that Metabolic's science-based methodology is similar to the Hard systems thinking approach. For example, Metabolic often used the Causal loop diagram to visualize and analyze system structure quantitatively.

However, the Hard systems thinking approach has been criticized for 'Not everything can be squeezed into a cause-effect model,' especially for more complex problems that entail diverse views from involved stakeholders (da Costa Junior et al., 2019). Besides, when it comes to design and generating new ideas, a fixed traditional systems models' will then become molds that constrain innovation (Sevaldson, 2013).

On the other hand, System-oriented design, a branch of systemic design, seeks to increase the complexity of systems understanding by considering stakeholders' culture, different perspectives, capacity, etc. (Sevaldson, 2013). Furthermore, it utilizes mapping techniques to inquire data, allow dialogue between stakeholders, and make the richness of information accessible. One of the System-oriented design's mapping tools is the Giga map (Fig. 6) which process is broken down into the following three stages by Sevaldson (2013) and introduced here to give a more concrete idea of mapping techniques from systemic design:

- **Open mapping**: Start mapping the system without additional data inquiries into literature or other sources. Open mapping aims to make existing knowledge and preconceptions that we tend to take for granted explicit.
- **Data inquiry**: After open mapping, gaps, where additional knowledge is needed, are identified. Therefore, extra data from the literature, experts, etc., are studied and fed into the map.
- **Reinterpretation**: The maps are fleshed out with new data that stimulates reinterpretation and discussion.

To be noted, there is no fixed rule for making the Giga map. The whole point is to organize the data at hand by relating different elements in terms of flow, logic, relationship, timeline, etc. Sevaldson (2013) also summarized the benefits of this mapping technique as follows:

Create shared understanding among stakeholders

Mapping can act as a dialogic tool in workshop scenarios. Mapping in a group allows misalignment and different perspectives to be explicit and trigger conversations that lead to a shared understanding. Besides, 'co-mapping' with stakeholders makes the overview of the system become their work and more willing to accept it.

As a tool for data inquiry

Synthesizing data through mapping helps emerge new questions for data inquiry. Besides, the open-ended map encourages stakeholders to incorporate diverse knowledge rather than just cause-effect data for the rigid system pattern.

Generative process

With designers' nature and capacity, mapping can shift from a descriptive process to a generative process that generates ideas about new structures and solutions (Sevaldson, 2013). For example, Faludi (2015) developed an innovative tool for sustainable design by adopting Whole system mapping (Fig. 7) to facilitate brainstorming on radical system innovation.

Mini takeaway

Metabolic applied cause loop diagram as the primary tool to explain systems. However, as mentioned, this mapping tool under the mindset of the Hard systems thinking approach is constrained by its capability to present a more 'soft' side of the system, such as relationship, perspective, and value. As a result, Metabolic often felt tricky about projects with more complex problems, like a city food system, which involves multiple purposes and issues, including economics and fairness, health, obesity, poverty, etc.

Metabolic once organized a mapping workshop with stakeholders from different fields. The workshop started by facilitating stakeholders to brainstorm on 'From your perspective how the system looks like' and map down the system. After a while, it showed how different system maps could be merged, which helped stakeholders see the common interest and potential conflict. Finally, stakeholders were asked to think about intervention by ideating solutions as deep as in the iceberg model, 'how could we change the mental model?'

From the interview with one of the workshop hosts, Metabolic's Green Building Consultant (Nico Schouten) shared his uncomfortable feeling about this type of mapping:

"It is not a system map in its purest sense of its words. Because usually a typical system that you can put into software, you could calculate it."

"Because we are very technical and data-driven, so we want to quantify everything to help us make decisions, it will be quite nice if based on the system map we could say, 'you see this is the problem."

"It's tough to say, 'ok, we found these interventions, but how impactful is it?' We couldn't calculate it."

These remarks show that some Metabolic employees are not comfortable with this way of mapping mainly because of their science-based culture and mindset.

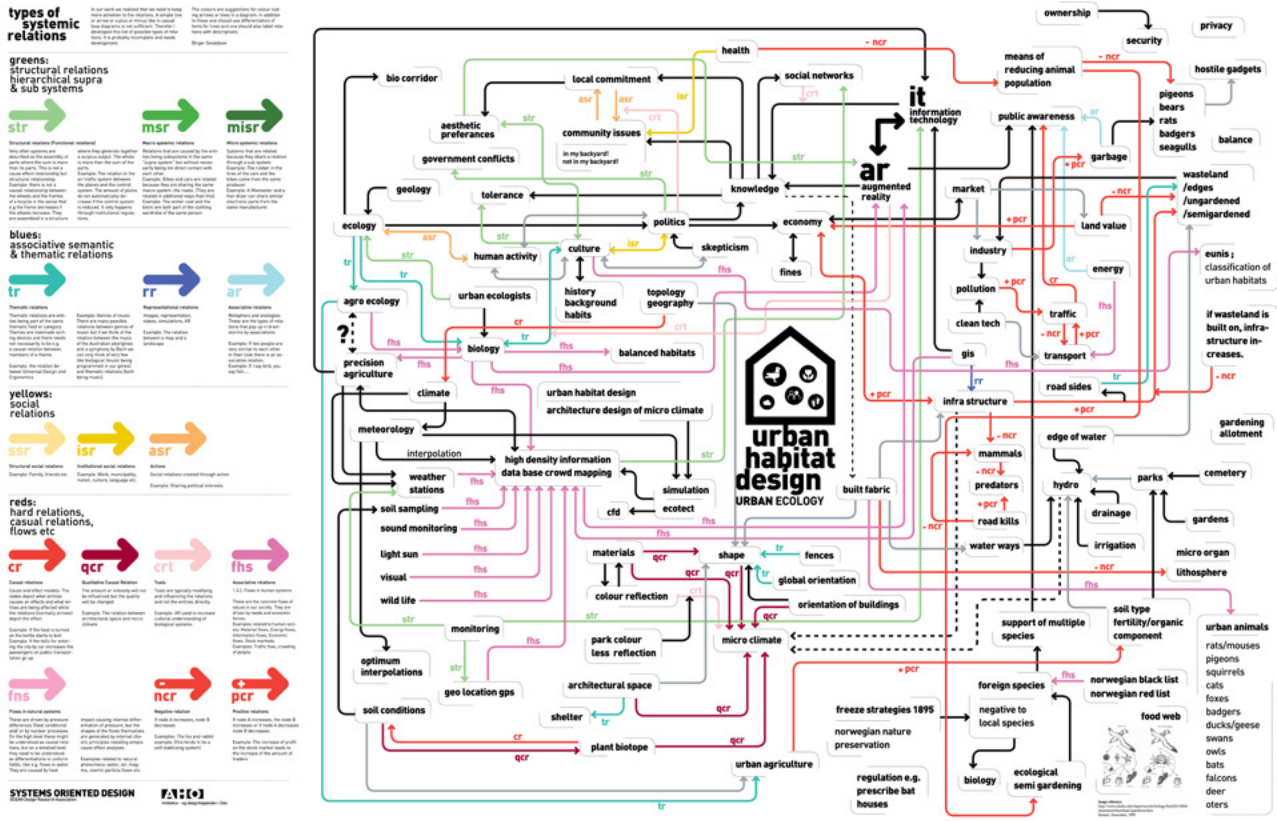


Fig. 6 Giga map sample (Source: Young Eun Choi, Birger Sevaldson, AHO, 2013)

Therefore, the systemic design complements Metabolic's systems thinking approach that is analytic and descriptive, with generative and dialogic functions when dealing with complex systems. It also points out that Metabolic requires designers' capability to deal with fuzzy and vague data when executing this kind of mapping work.

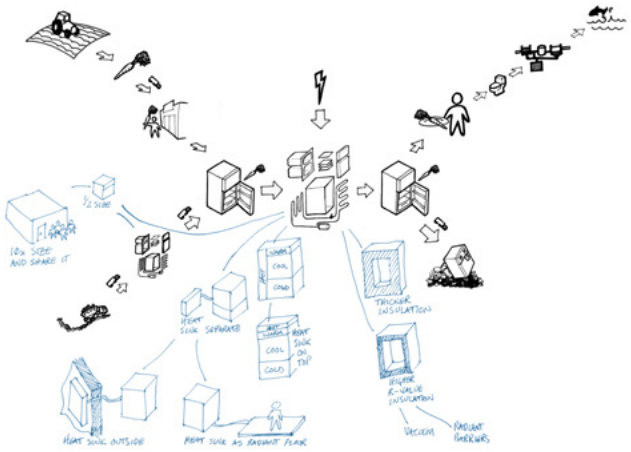


Fig. 7 Whole system map sample (Source: Faludi Design)

2.2 DESIGN (TOOLS) FOR SUSTAINABLE BUSINESS MODEL INNOVATION

What is sustainable business model innovation?

The concept of Sustainable Business Models (SBM) was built upon business models to integrate sustainability considerations into companies and help them achieve sustainable goals. Since SBM defines what value companies create and how business activities are done, it acts as a core driver of sustainability innovation (Stubbs & Cocklin, 2008).

There are different definitions of SBM. According to Stubbs and Cocklin (2008), *'an ideal SBM adopts the triple bottom line (economy, environment, and society) to define a company's purpose and success and consider the needs of all stakeholders rather than giving priority to shareholders' expectations.'* For Geissdoerfer et al. (2018), *'SBM is business models that incorporate pro-active multi-stakeholder management, the creation of monetary and non-monetary value for a broad range of stakeholders and hold a long-term perspective.'*

From the above definitions, it shows three essential elements that distinguish SBM from the traditional business model:

- SBM does not restrict to provide use value for customers in return for economic or monetary value but explores other forms of value. For example, the cellphone manufacturer, Fairphone, designs cellphones in a modular way, so customers are empowered with the value to repair their cellphones.
- SBM considers broader stakeholder groups as audiences of value proposition and pursues mutual benefit for all.
- SBM aims for firm-level as well as system-level change, which requires multi-stakeholder collaboration.

These three elements show that transition from traditional business models to SBM not only involves new business activities but a brand new mindset that might be against conventional business thinking. Stubbs and Cocklin (2008) provide an excellent summary of this transition:

"Organizations adopting a SBM must develop internal structural and cultural capabilities to achieve firm-level sustainability and collaborate with key stakeholders to achieve sustainability for the system that an organization is a part of."

How could design tools for sustainable business model innovation benefit the Bootcamp?

The SBM mindset is about creating overall value for multi-stakeholders, and that matches one of the goals for the Bootcamp, reaching systemic sustainability. Therefore, this section studies two SBM-related pieces of literature. The first one is a design tool that assists companies and their stakeholders explore value proposition with the SBM mindset. The second one is a design concept that helps companies reduce the uncertainty caused by multi-stakeholder collaborations for new SBM innovations.

2.2.1 Value mapping tool

Conventionally, companies focus on the value created for customers. Some companies may also be aware of the negative impact they have made through business activities. However, few of them took those negative impacts as the 'value' they have missed or destroyed for stakeholders like the environment and society. Instead, those impacts are perceived as a consequence of non-sustainable manufacturing or operation processes that need to be adjusted.

Bocken et al. (2013) developed the value mapping tool under the context of SBM (Fig. 8). The tool helps

companies assess their current value proposition for broader stakeholder groups and explore value opportunities for a new sustainability value proposition.

The current value proposition is broken down into three different types of value: value created (e.g., customer value), value missed (e.g., under-utilized assets), and value destroyed (e.g., pollution). And stakeholder groups are four main categories, customers, network actors, environment, and society.

This tool helps companies build the mindset of SBM and prompt them to perceive negative impact as value missed or destroyed which could potentially be turned positively as new opportunities. Besides, having proxy representatives of each stakeholder category 'co-value mapping,' different perspectives can be explicit, and a shared understanding of current and future value proposition will be created. Finally, the tool is meant to be the start point of SBM innovation since value proposition is the primary driver of business model innovation (Ries, 2011).

The value mapping process is briefly introduced as follows:

- Identify stakeholders for the companies in four main categories: customers, network actors (actors on the value chain, e.g., suppliers), environment, and society.
- Discuss companys' purpose, in other words, why does the company exist in the first place.
- Brainstorm collectively on what value is currently captured, missed, or destroyed
- Discuss how to turn negative value into positives and what new value might be created or captured by changing how companies do business.

Bocken et al. (2013) identified the benefit the tool brings:

Embedding sustainability into the core of the business model

The tool assists companies in re-thinking their value proposition under the context of SBM. That helps them build an intrinsically sustainable business.

Systemic value assessment

The tool allows multi-stakeholders to share their perspective on the value proposition created by the

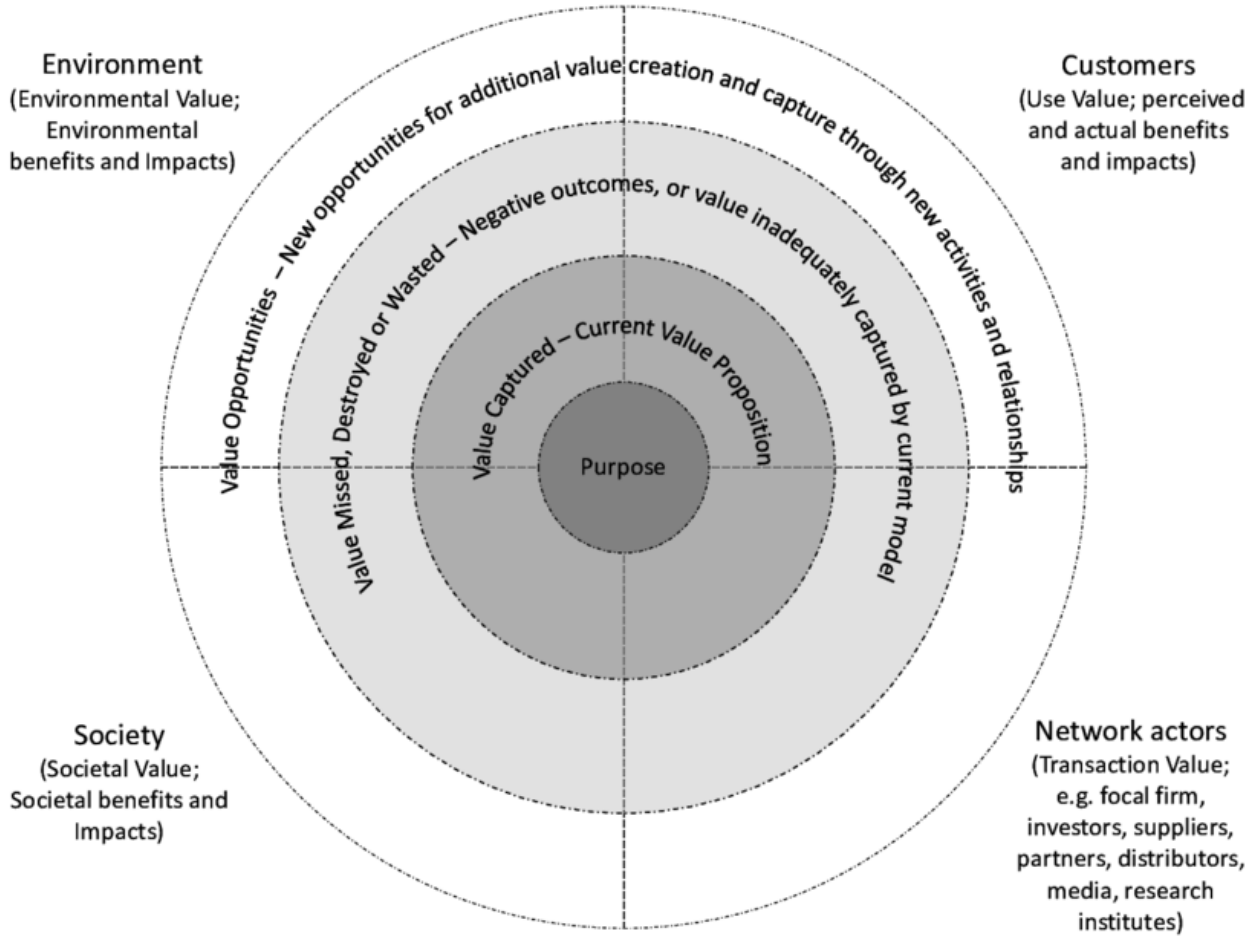


Fig. 8 The value mapping tool (Source: Bocken et al. 2013)

current value network. So conflicting values between stakeholders can be explicit, and a new mutually beneficial value proposition for all stakeholders in the system can be defined.

Complement quantitative tools to stimulate idea generation and discussion

Quantitative tools like impact assessment can support identifying the hotspots of value destroyed, or MFA can help point out value missed. On the other hand, the value mapping tool provides a qualitative way to enhance discussion and idea generation on where and how to transform those negative values into positive value propositions.

2.2.2 Experimenting with a circular business model

Experimentation has been perceived as an essential step to reduce uncertainty in new business model innovation by entrepreneur theories like the lean startup. It helps test the assumptions of business models so uncertainty can be reduced. As mentioned, SBM innovation encompasses high uncertainty. Circular business model, as an archetype of SBM are also believed to entail high uncertainty due to the nature of inter-organizational collaboration (Antikainen and Valkokari, 2016) and customers perception (e.g., doubt about the quality of returned and resold productsproducts) for new circular product-service systems (Shaharudin et al., 2015). Therefore, with eight case studies on companies that transition towards circular business models, Bocken, Schuit, and Kraaijenhagenc (2018) assert that experimentation is critical in bridging the gap between design and pilot of new circular business models.

Bocken et al. (2018) specify that experiments should come before running a pilot due to their fast-learning features and low resources requirement. Experiments test assumptions of different parts of the business model; in contrast, pilots put all assumptions together and test them at once. Bocken et al. (2018) also suggest companies test circular business models in a sequence of value proposition, value delivery, value creation, and value capture. However, according to the case studies, this process can be back and forth due to new learning and correction on assumptions (Fig. 9).

Mini takeaway

As mentioned in Ch. 1.2, Metabolic's primary motivation of the Bootcamp is to push clients to consider sustainability in the design stage and design on a more extensive system level. However, they also pointed out the need to change clients' perceptions of sustainability as a 'clicking the box' thing.

Therefore, the value mapping tool could help fulfill this need by guiding different stakeholders to discuss and create a shared understanding of the value proposition under the definition of SBM. Furthermore, the concept of experiments before pilots could benefit the Bootcamp by increasing the possibility to implement new concepts generated.

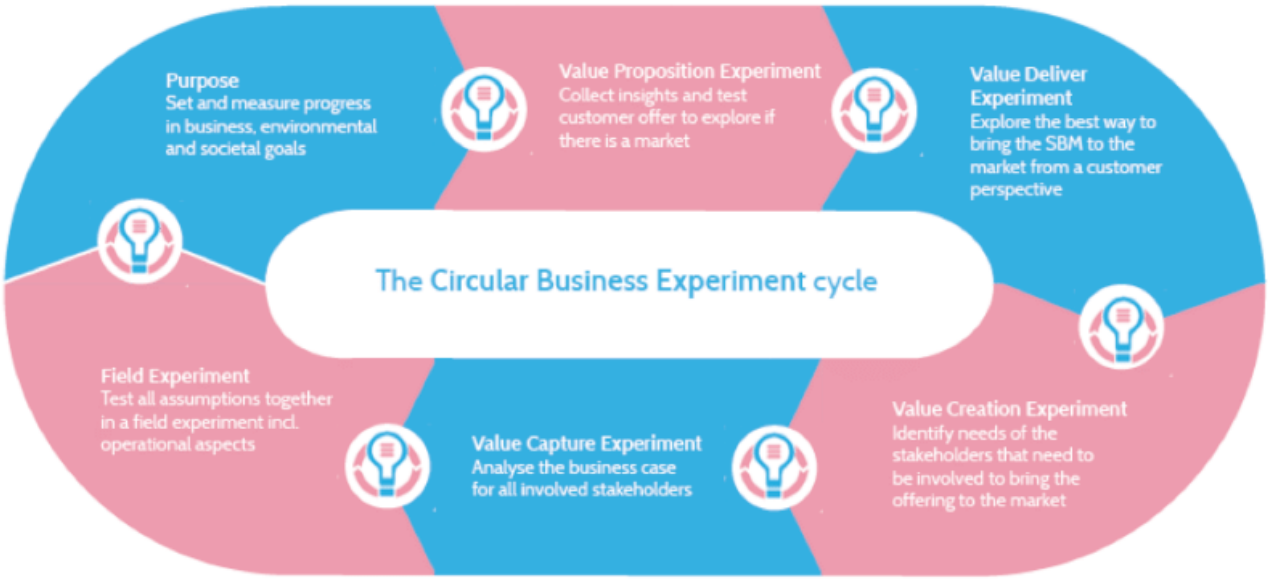


Fig. 9 The circular business experiment cycle (source: Bocken et al., 2018)

2.3 CIRCULAR DESIGN TOOLS

What are circular design tools?

Many circular design tools have been developed to facilitate the circular design process, for example, the value hill by Achterberg et al. (2016), 9Rs framework by Kirchherr et al. (2017), the circular collaboration canvas by Brown et al. (2019), and the circular design guide by Ellen MacArthur Foundation and IDEO. Below some tools are picked in consideration of how likely it could fit into the Bootcamp-like environment and if it could support the goals of the Bootcamp identified in Ch. 1.4.

2.3.1 Value Hill

The Value Hill is a tool that helps companies position their business in a circular context and develops future strategies for a circular economy (Achterber et al., 2016) (Fig. 10). The 'hill' graphic conveys a straightforward message: A product aggregates its value through the manufacturing process, reaches the highest value state after handing it over to users, and drastically drops after users discard products without capturing their embodied value.

Companies can use the value hill to map out their current circular business condition and identify where a new activity or partnership is needed to succeed in a circular value network. For example, the following process can be followed: Step 1: Position companies' current business model on the Value Hill; Step 2: Place value chain partners on the Value Hill; Step 3: Identify gaps and opportunities in the circular value network; Step 4: Formulate future circular business strategies.

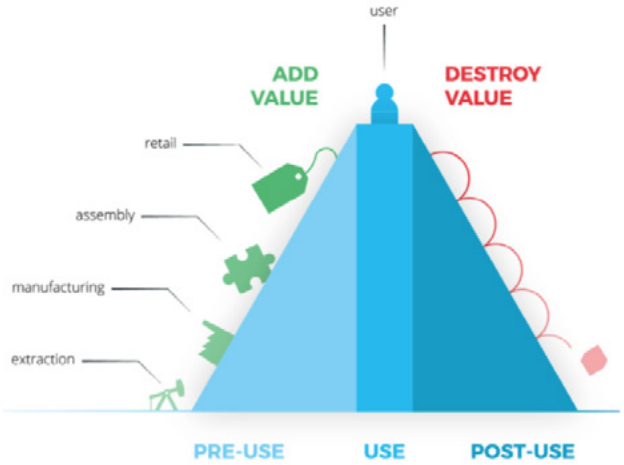


Fig. 10 Value hill (Source: Achterberg et al., 2016)

2.3.2 9R strategies

The 9R framework provides nine important circular design strategy concepts (Kirchherr et al., 2017) (Fig. 11). These nine strategy concepts are further prioritized into three levels of circularity to help companies pick the one that leads to fewer natural resource use and less environmental pressure. The 9R framework can complement the value hill tool, for example, in Fig. 12, Metabolic aligns the 9R framework with three phases of the value hill to show what strategy concepts companies could adopt after gaps and opportunities for circular business are identified on the value hill.

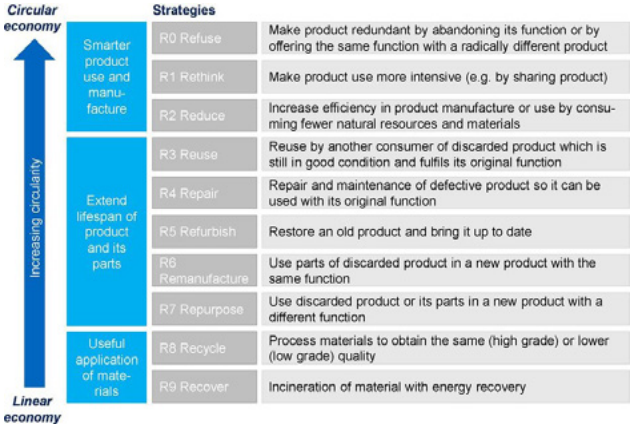


Fig. 11 9R strategies (Source: Kirchherr et al., 2017)

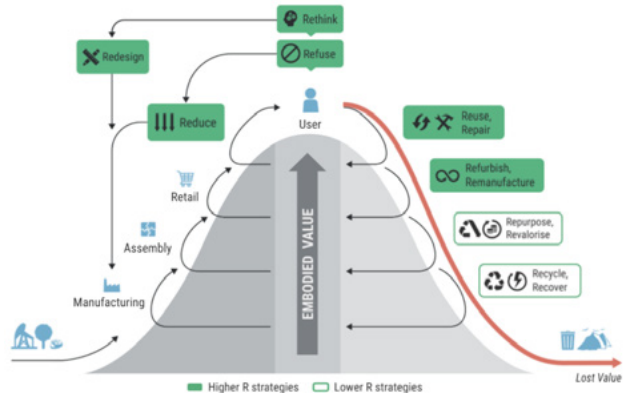


Fig. 12 Adapted value hill to include 9R strategies (Source: Metabolic)

2.3.3 Circularity deck

The circularity deck, developed by Konietzko et al. (2020), is a tool to assist circular idea generation (Fig. 13). As the name implies, it is a card deck. Each card provides one circular design strategy with an example of application to inspire analogy thinking: how this strategy might be implemented in my context.

The circular design strategies provided are ranging across product, business model, and ecosystem level. Besides, all strategies could be categorized into four circular principles defined by Bocken et al. (2016): slow, narrow, close, regenerate with an additional one, inform.

The deck is suitable for workshop-like environments, and it is suggested to be used with the following three steps. First, start by briefing the circular design goal of workshops to make sure everyone is on the same page.

Then perform open ideation without the deck. Finally, access the cards for inspiration.

Fig. 13 the Circularity deck example (Source: Konietzko et al., 2020)

2.3.5 Circular collaboration canvas

Research has shown that circular innovation that seeks radical, systemic, and collaboration-required changes is increasing to gain more considerable sustainability impact (Brown et al., 2019). Therefore, a tool (Fig. 14) is developed to assist companies in identifying partners and adapt circular propositions to incentivize collaboration (Brown et al., 2021).

The tool helps reduce the uncertainty and interest misalignment that might be raised from collaboration with potential partners (Brown et al., 2021). With four main sections on the canvas, the tool aids companies to find a balance between sustainability challenges, viability, desirability, and feasibility to engage partners. In addition, as Brown et al. (2021) state, the tool can reveal the assumptions of circular concepts so companies can adapt their engagement strategy and perceived value for potential partners.

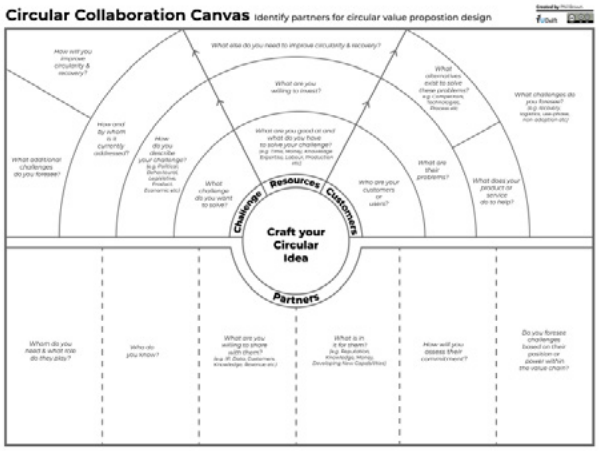


Fig. 14 Circular collaboration canvas (Source: Brown et al., 2021)

Mini takeaway

The four circular design tools studied in this section can benefit the Bootcamp in the sense of design thinking's double diamond framework:

- *Discover: The Value Hill helps explore clients' current circular business conditions and identify potential gaps and opportunities.*
- *Define: The 9R framework helps transform gaps and opportunities into potential circular design directions.*
- *Develop: The circularity deck helps ideate circular design ideas on the product, business, and system level*
- *Deliver: The circular collaboration canvas helps reduce the uncertainty and interest misalignment raised from future collaboration*

2.4 TAKEAWAY

So far, the project has explored systemic design, design tools for sustainable business model innovation, and some circular design tools. Gathering the mini takeaway from each section, the following things can be said:

- A generative and dialogic type of mapping session can help Metabolic deal with more complex system features, such as relationship, conflict value, etc.
- Involving stakeholders in mapping sessions helps them activate existing knowledge and preconceptions that they tend to take for granted about the issue at hand.
- Involving stakeholders in mapping sessions makes the overview of the system become their work and thereby more willing to accept it.
- SBM mindset can help clients take sustainability as the core of their business strategy
- Value mapping with multi-stakeholders help build a systemic value proposition that aims to provide benefit for all (including the environment and society)
- Experiments before pilots could benefit the Bootcamp by increasing the possibility to implement new concepts generated.
- Circular design tools can optimize the Bootcamp in the sense of design thinking's double diamond framework.

What's next

This chapter explored how systemic design, design tools for SBM innovation, and circular design tools could benefit Bootcamp. However, to transform these insights into the concrete design concepts of the CSD process requires further understanding of the current Bootcamp to scope out opportunity areas for optimization.

CHAPTER 03

OPPORTUNITY AREAS FOR BOOTCAMP OPTIMIZATION

INTRODUCTION

With the understanding of 'why' the Bootcamp is needed in the bigger context of Metabolic's consultancy work (Ch. 1) and 'how' systemic design and other design methods and tools could benefit the Bootcamp (Ch. 2), the next step is to scope out 'what' part of the Bootcamp should be optimized. Therefore, this chapter tries to answer the research question Q6: How was the Bootcamp constructed? (Ch. 3.1), which helps identify the opportunity areas for optimization.

3.1 METABOLIC'S DESIGN BOOTCAMP

As mentioned in Ch. 1.2 & 1.3, the Bootcamp aims to facilitate clients to redesign products into a more circular and sustainable state. For better understanding, the Bootcamp is broken down into five steps: Build awareness, Understand the current state, Design brief, Circular design, and Roadmapping. Below, each session is explained further.

Build awareness

Not only sustainability teams but stakeholders across departments from clients' companies are invited to the Bootcamp. Therefore, it is needed for Metabolic to build up a consensus of reasons to change among stakeholders. To do so, Metabolic usually gives presentations about the circular economy, systems thinking, and sustainability innovation trends. Also, the product targeted to redesign during the Bootcamp is introduced to stakeholders.

Understand current state

After raising the awareness, the next step is to help stakeholders create a shared understanding about 'where we are' regarding the targeted product's current sustainability conditions by presenting the research findings of MFA or impact assessment. Besides, Metabolic creates a system map, which combines the material flow diagram and insights of root-cause analysis, to assist stakeholders in discussing and identifying intervention points in the current product value chain.

Design brief

After knowing 'where we are,' the next step is to define a circular design goal for the targeted product, in other words, 'where we want to go.' Here, Metabolic introduces a predefined design brief that indicates an optimal circular state as the goal for the redesign.

Circular design

With the design goal declared, the next step is to facilitate stakeholders redesigning the targeted product into a circular state. First, Metabolic separates stakeholders into small groups and then kick-off the design process with warm-up exercises. For example, 'Learn from nature,' which inspires people to think of nature-inspired solutions, or 'product-service flip,' which stimulates people to apply a product-service system as a circular business model.

After the exercises, a long list of circular design ideas is expected to be generated. Metabolic then gives stakeholders 'circular scorecards,' built upon the Seven Pillars of the circular economy, to evaluate and screen those ideas. Then, stakeholders are asked to further develop the winning ideas into circular product concepts with Metabolic's circular concept canvas (Fig. 15). Finally, stakeholders iterate the concepts by presenting them to other groups to get feedback.

Roadmapping

With the concepts finalized, Metabolic facilitates stakeholders to fill Metabolic's implementation plan (Fig. 16) to plan pilots for new circular product concepts. After the Bootcamp, all deliverables are documented and written into a report for clients to execute pilots independently.

Fig. 15 Circular concept canvas (Source: Metabolic)

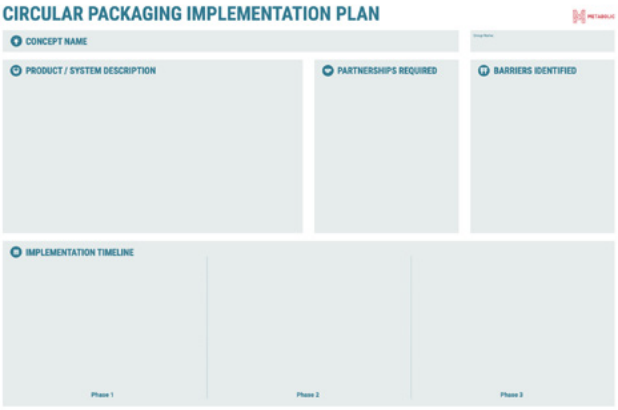


Fig. 16 Circular implementation canvas (Source: Metabolic)

3.2 OPPORTUNITY AREAS

With the overview of the current Bootcamp introduced, combining with the knowledge from Ch. 1 & 2, opportunity areas for optimization can be identified.

3.2.1 Opportunity area 1: Assist clients (and stakeholders) in exploring the value proposition of targeted products with a systemic mindset

What is the opportunity?

As mentioned in Ch. 1.2, most companies still took sustainability as an end of pipeline thing due to the conventional business mindset. Therefore, Metabolic tries to change clients' perspectives during the 'Build awareness' step by presenting solid reasons why businesses can benefit from sustainability as a core strategy. Though, this purpose can be strengthened by facilitating clients and their stakeholders to explore the value proposition of the targeted products with a systemic mindset.

How could the value mapping tool address this need?

The value mapping tool prompts companies to take a sustainable business model mindset, aligning with Metabolic's mentioned goal (from section 2.2.2 & 3). Besides, the co-defined value proposition could act as concrete design goals in the 'Design brief' step.

3.2.2 Opportunity area 2: Co-mapping current system with different stakeholders

What is the opportunity?

As mentioned in Ch. 1.3, Metabolic aims to help clients view themselves as part of an extensive system and bring broader stakeholder perspectives to the table. Therefore, Metabolic creates and presents system maps in the 'Understand current state' step to help clients and stakeholders get a holistic view of current value chain systems and stimulate opinion exchange. However, clients could benefit from co-mapping the current system with stakeholders.

How could systemic design address this need?

The system-oriented design makes existing knowledge and preconceptions among different stakeholders explicit, which helps create a shared understanding of current systems (from section 2.1.2). Besides, the understanding won't be restricted to rigid cause-effect structures but also consider stakeholders' relationship, capacity, etc. (from section 2.1.2).

3.2.3 Opportunity area 3: Apply existing circular design tools

What is the opportunity?

The Bootcamp's primary goal is to facilitate clients to redesign circular products, and methods and tools from the design field were adopted. Therefore, it is argued that the current 'Circular design' step could benefit from some of the latest developed circular design tools.

How could circular design tools optimize the circular design step?

For example, the Circularity deck could help stimulate idea generation by introducing circular design strategies (from section 2.3.4). The Circular collaboration canvas could help reduce the risk deriving from collaboration in new circular concepts (from section 2.3.5).

3.2.4 Opportunity area 4: Plan experiments before pilots

What is the opportunity?

At the 'Roadmapping' step, Metabolic helps clients develop pilot plans to test new circular concepts as a whole. However, clients could benefit from experimenting with different parts of new concepts' circular business model before pilots.

How could 'Experimenting with a circular business model' address this need?

The concept of experimenting with circular business models helps reduce resource investment and get traction from stakeholders (from section 2.2.4). This concept could be applied to redesign Metabolic's implementation plan canvas.

3.3 TAKEAWAY

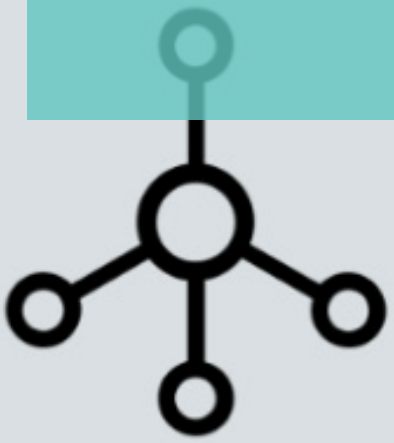
Based on the research findings, four opportunity areas were formulated to present ways the Bootcamp could be optimized. We summarized these opportunity areas in the table on the right page.

OPPORTUNITY AREA	WHAT IS THE OPPORTUNITY	WHICH DESIGN METHODS OR TOOLS COULD ADDRESS IT	HOW COULD THE DESIGN METHODS OR TOOLS ADDRESS IT
Help clients (and stakeholders) explore the value proposition of the targeted products with a systemic mindset	• Metabolic aims to prompt clients to take sustainability as the core of their business strategy • Currently gives presentations to accomplish the goal • This goal can benefit from exploring the value proposition of the targeted product with a systemic mindset	the Value mapping tool (Section 2.2.3)	Facilitate companies to take a sustainable business model mindset through an improved understanding of value proposition
Co-mapping the current system with different stakeholders	• Metabolic aims to help clients view themselves as part of an extensive system and bring broader stakeholder perspectives to the table • The current system map, which is used to accomplish the goal, is pre-defined and restricted in the information provided • This goal can be benefit from co-mapping the current system with stakeholders	System-oriented design's mapping methods (Section 2.1.2)	Make existing knowledge and preconceptions among different stakeholders explicit through co-mapping processes
Apply existing circular design tools	• Metabolic aims to redesign clients' products into a more circular state • It is argued that the circular design process of the Bootcamp can benefit from the existing circular design tools	Circularity deck (Section 2.3.4), Circular collaboration canvas (Section 2.3.5)	Stimulate circular idea generation, and assess the risk of collaboration within new concepts
Plan experiments before pilots	• Metabolic currently helps clients develop pilot plans to test new circular concepts as a whole • However, clients could benefit from experimenting with different parts of new concepts' circular business model before pilots	Experimenting with a circular business model (Section 2.2.4)	Reduce resource investment and get traction from stakeholders through experiments planning

Table 1 Opportunity areas for Bootcamp Optimization

CHAPTER 04

CONCEPT DEVELOPMENT AND TESTING



esign with a systemic perspective

Un

Create a holistic shared-understanding on where the intervention points are

Current state presentation

Intervention points presented in slides

INTRODUCTION

With the opportunity areas identified from the Bootcamp in Ch. 3, this chapter proposes a new concept for Metabolic's Circular System Design (CSD) process. This concept then went under concept testing and usability testing for further iteration. The insights of the tests are shared in this chapter too.

4.1 CONCEPT PROPOSAL FOR METABOLIC'S CSD PROCESS

The new CSD process is composed of four parts: three main sessions and one follow-up meeting. These four parts are respective to the four opportunity areas. They are introduced in the following sections:

4.1.1 Session 1: Value mapping

Session one functions similarly to the Bootcamp's 'Build awareness,' 'Understand current state,' and 'Design brief' steps. An adapted value mapping tool is applied to this session (Fig. 17). As mentioned in section 3.2.1, it also helps address opportunity area one: Help clients (and stakeholders) explore the value proposition of the targeted products with a systemic mindset.

How was the value mapping adapted?

The insights of the MFA and impact assessment done by Metabolic are provided to participants during the session.

MFA helps identify materials wasted, for example, incinerating at the end of life, and can be perceived as value missed. Impact assessment helps identify the impact hotspots within the value chain and can be perceived as value destroyed. This information could assist participants in converging the discussion.

An additional ring is added to the original value mapping tool: ' future trend and emerging niche initiatives.'

The idea was inspired by the 'Rich context' tool developed by two design agencies, Namahn and shiftN (2016). The tool helps people frame the context of an issue by mapping the system's current practices, trends, and innovative initiatives. Therefore, we adopted this concept to added an extra ring layer within the value mapping tool. For example, information like the trend that particular material is becoming scarce in the next five years could be filled in this layer to prompt clients to make well-informed decisions when defining the value proposition. These information could be retrieved from Metabolic's trend analysis (Section 1.1.3)

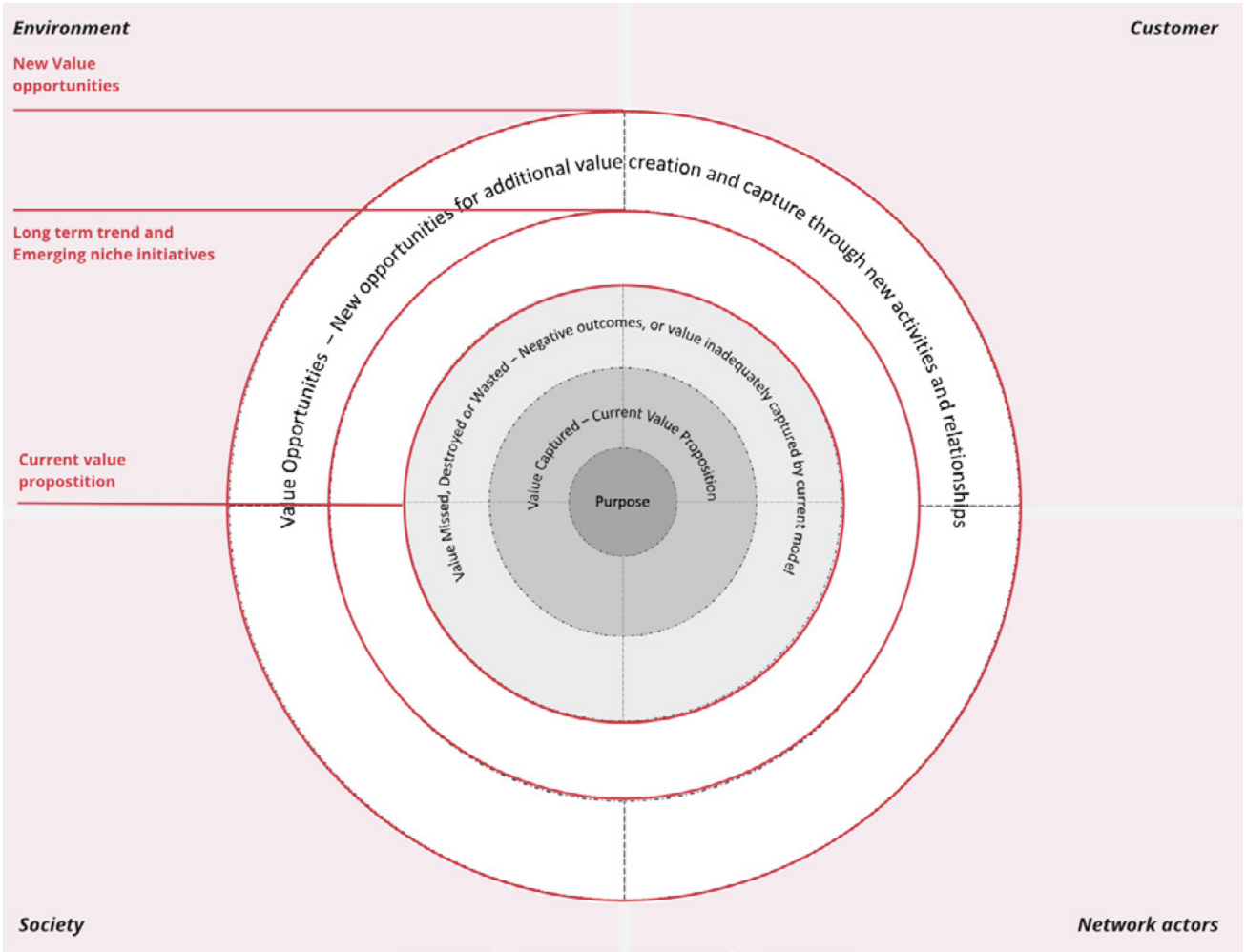


Fig. 17 Adaped value mapping tool (First version)

What are the benefits for clients?
With an improved understanding of the value proposition, clients can develop a value proposition that benefits all stakeholders and drives the sustainability business model innovation.

Furthermore, by involving proxy of different stakeholder groups in the session, the tool helps integrate multi-stakeholder perspective into the early stage of the eco-innovation, which is essential for clients' strategic processes towards sustainability (Bocken et al., 2013)

In summary, these values are identified by the tool inventor, Bocken et al. (2013)

- Understand both positive and negative aspects of the value proposition
- Identify conflicting values (e.g., one stakeholder's benefit cause a negative value for another stakeholder)
- Embed sustainability into the core of business models
- Help align stakeholders' perspectives on sustainability opportunities and value proposition.

How could the tool create synergy value with Metabolic's work?
The value mapping tool can optimize how Metabolic shares findings of current state analysis with stakeholders. First, in the context of value mapping, the impact hotspots identified by the MFA or impact assessment could be perceived as the value missed or destroyed (Fig. 18). Therefore, stakeholders could utilize those data-driven insights to facilitate their value mapping process. Second, the outcome of the value map, a sustainability value proposition, could serve as the clients' future sustainability goals for the targeted product.

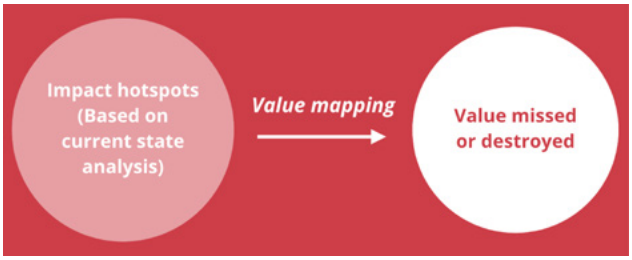


Fig. 18 Perceive environmental impact as negative value

4.1.2 Session 2: Current system mapping

Session two functions similarly to the Bootcamp's 'Understand current state' step. A 'current system mapping' exercise was developed for this session, and as mentioned in section 3.2.2, it helps address opportunity area two: Co-mapping the current system with different stakeholders. In addition, the exercise not only adopts system-oriented design methods but also incorporates two circular design tools: the value hill and 9R strategies.

The exercise is explained in detail as follow:

Step one: Open mapping (System mapping on the value-hill as a canvas):
stakeholders are provided with the materials and guidance to map out the current system behind the targeted products on the value hill (Fig. 19). The value hill visual helps identify where stakeholders should intervene in the system to make the product more circular. This step provides the first impression about the current system and how different stakeholders think differently about it.

Step two: Data inquiry (Intervention points):
Metabolic provides the research findings of the root cause analysis to inform participants with more insights about where and why particular places in the current system are critical to intervene, as the concept learned from Meadows (1999).

Step three: Reinterpretation (9R strategy in the form of the How Might We (HMW) questions):
Metabolic suggests proper R strategy for each intervention point and presents in the form of the HMW questions. These questions will help bridge the analysis stage with the design stage by pointing out potential circular design strategies.

What are the benefits for clients?
Mapping on the value hill canvas in groups helps stakeholders understand the business from a systemic perspective and brings everyone on the same page of the current circular issues. Besides, mapping together fosters dialogues and collaboration and makes misalignments or misunderstood views explicit. In summary, these values are identified

- Help see the bigger picture of the product life cycle
- Bring stakeholders on the same page of what the current circular issues are
- Identify intervention points decide critical ones to focus

How could the tool create synergy value with Metabolic's work?
The current system mapping can improve how Metabolic share insights of the root cause analysis with stakeholders. First, inviting stakeholders to co-create system maps without prior inquiry data activates existing knowledge and imagination about the current system (Sevaldson, 2013). Therefore, the current system mapping empowers stakeholders to make inherited perspectives that they tend to take for given explicit, so they can compare their view with the intervention cards provided by Metabolic. Second, by mapping the system on their own, stakeholders can easily take this overview as their product instead of what Metabolic has told them.

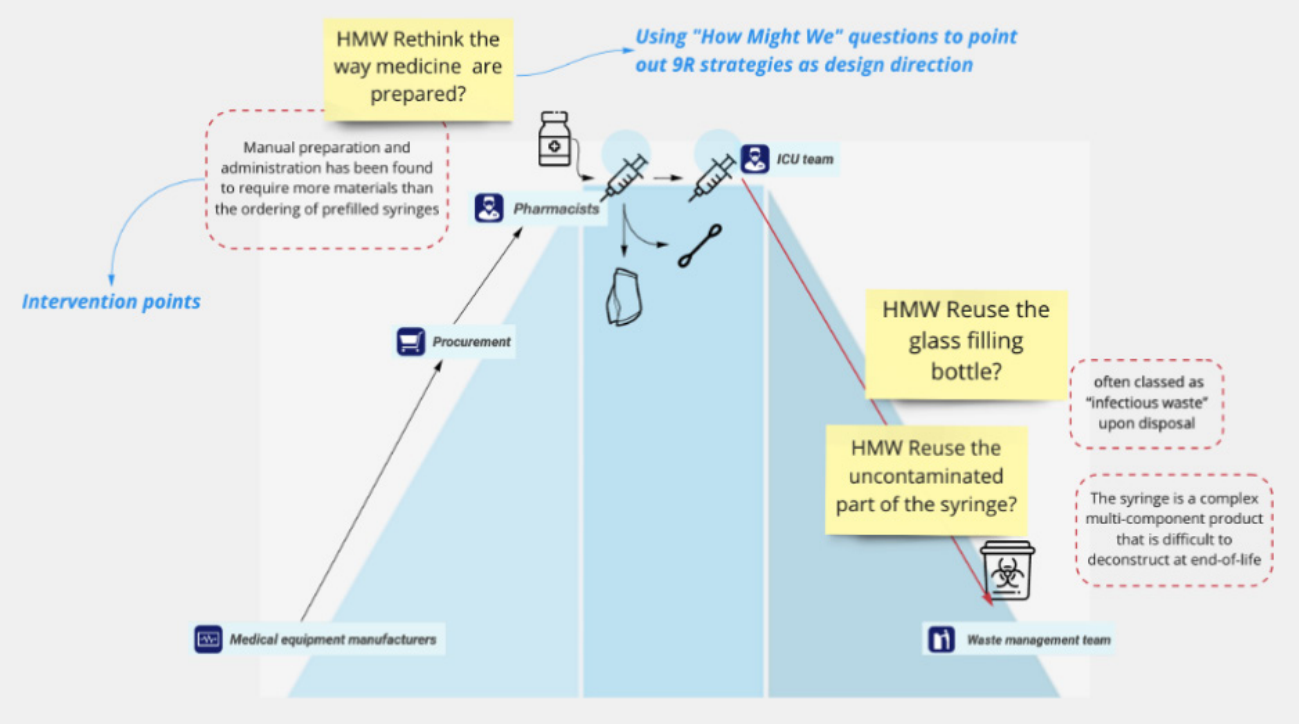


Fig. 19 Current system mapping (first version)

4.1.3 Session 3: Circular design + Concept building

Session three functions similarly to the Bootcamp's 'Circular design' step. A series of circular design exercises were developed for this session, and as mentioned in section 3.2.3, it helps address opportunity area three: Apply existing circular design tools.

Circular design: A 'future system mapping' exercise supplemented with the Circularity deck was developed to assist stakeholders in creating new circular product-service systems for the targeted products (Fig 20). This exercise was designed to be executed individually.

Concept building: Then, stakeholders select the winning ideas through dot voting and build them into Sustainable Business Models (SBM) with the SBM canvas adapted from (Bocken, 2021) (Fig. 21). Finally, questions about collaboration risk assessment, captured from the circular collaboration canvas (Brown et al., 2021), are asked to reduce collaboration risk within the new system. These questions are attached right next to the stakeholder section of the SBM model canvas (Fig. 21).

What are the benefits for clients?

In the circular design sub-session, a balanced mix of individual work and group work ensures the quality of the ideas won't be jeopardized by the group thinking effect (Donald et al., 1958). Besides, In the concept building sub-session, stakeholders are empowered to discuss the business model and future collaboration in detail.

How could the tool create synergy value with Metabolic's work?

Session three facilitates Metabolic to co-create with stakeholders so their creativity and industry knowledge (such as customercustomers insights and market intelligence) can contribute to the final solutions. On the other hand, Metabolic's knowledge in circular strategies, literature, and case studies can feed into the design process.

4.1.4 Follow-up meeting: Implementation canvas

This follow-up meeting functions similarly to the Bootcamp's 'Roadmapping' step. An implementation canvas was developed for this session and tries to address opportunity area four: Plan experiments before pilots (Fig. 22).

In this follow-up meeting with clients, Metabolic facilitates clients to plan the experiments for the new circular concepts with the canvas. The canvas is an expanded SBM canvas with prompt questions that ask clients to think of experiments for the four main SBM elements: value delivers, value proposition, value capture, and value creation

What are the benefits for clients?

Planning experiments for new concepts in detail lower the threshold for clients to start taking action. With clear indicators for critical aspects of the new concept, clients can validate the assumptions and iterate the concepts

until they are promising to persuade stakeholders to join. This implementation canvas can serve as a guide for clients to get the new concept off the ground.

How could the tool create synergy value with Metabolic's work?

Metabolic has the spirit of getting hands dirty instead of just planning. However, due to the nature of consulting work, Metabolic often couldn't ensure that clients would implement the interventions they suggested. Therefore, filling out this implementation canvas with clients gives Metabolic a chance to provide necessary support like impact assessment, communicating media creation, etc.

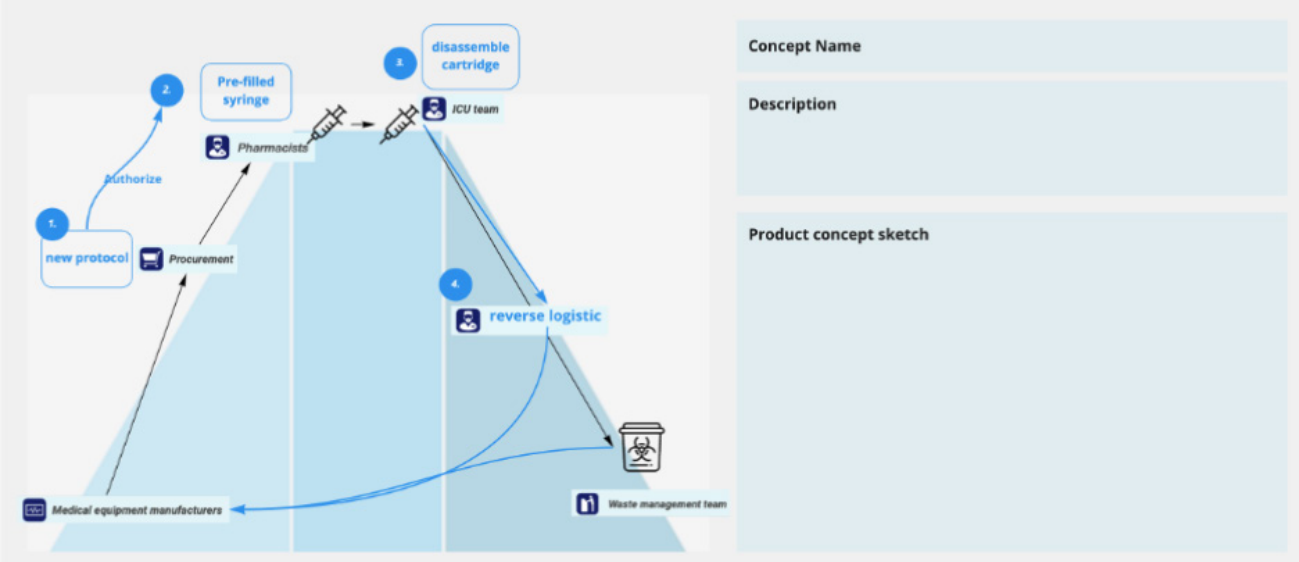


Fig. 20 Future system mapping canvas (first version)

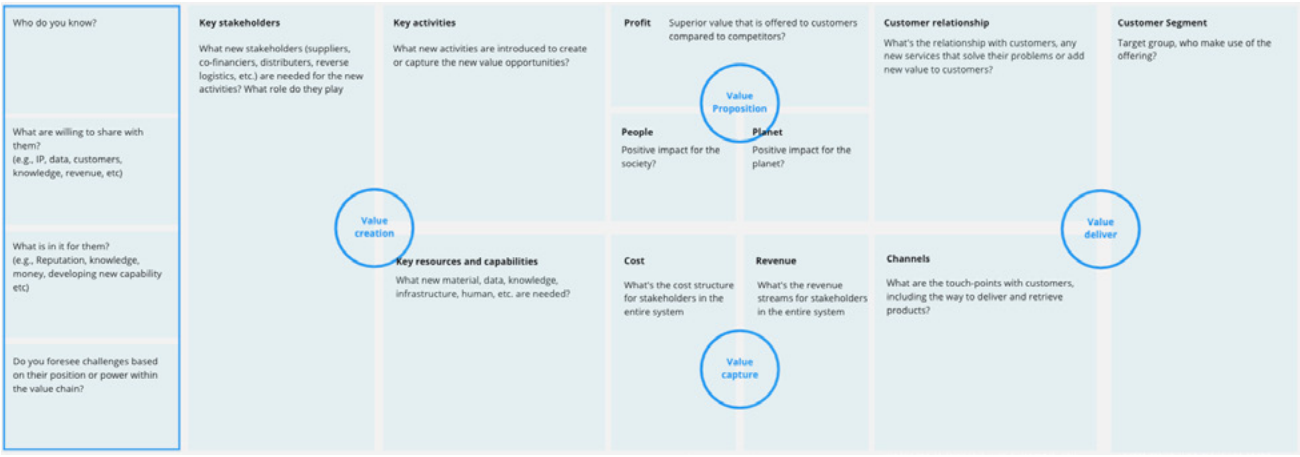


Fig. 21 The SBM canvas with collaboration risk assessment

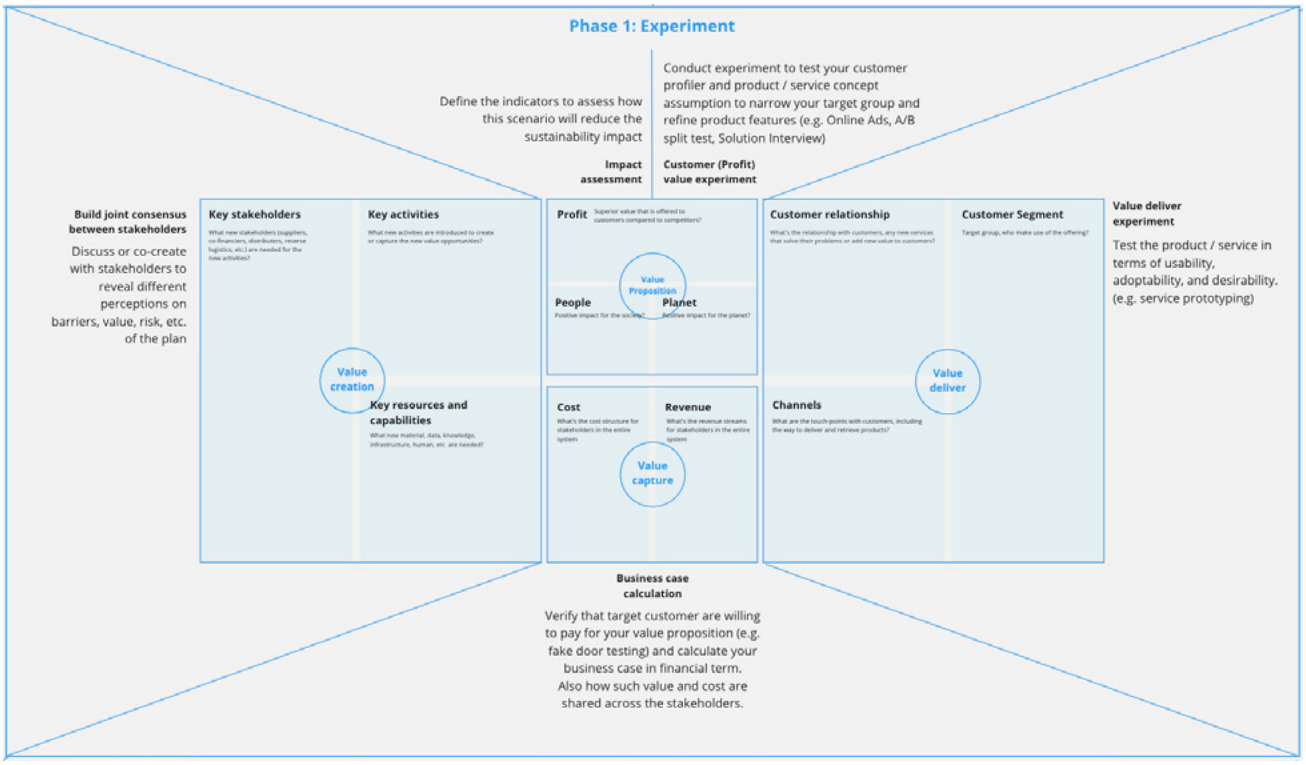


Fig. 21 Implementation canvas (first version)

4.2 CONCEPT TESTING + USABILITY TESTING

With the new concept proposed for Metabolic's CSD process, it was then tested by means of concept testing and usability testing. The concept was first tested twice through concept testing with Metabolic members to understand, from their perspective, what value the concept brings. Then, the concept was revised and further developed into a CSD process prototype. The prototype was then tested twice through usability testing with design students from TU Delft and other industry professionals to assess the ease of use of the tools in the workshop scenarios.

4.2.1 Method

Concept testing

The concept testing was conducted in a focus-group-like discussion environment through an online workshop hosting tool, Miro. The first test was with two Metabolic's Circular Product and Service cluster consultants, the Institute's Research Director, and an intern. The second test was with four consultants of Metabolic's Circular Product and Service cluster. Both tests lasted around 1.5 hours.

The tests start with introducing the project context, agenda, and the goal of the tests. Then, the concept was introduced to the participants session by session, with explanations of the following aspects:

- The rationale of the concept and the goals it aims to achieve.
- The benefit or value that the new concept brings.
- How does the new concept work.

Then, guided group conversation took place among participants with some prompts questions asked, such as:

- How might (not) this tool/session provide value to Metabolic/clients?
- Does it fit Metabolic's working context?
- How would you suggest adapting it further?

Usability testing

The usability testing was conducted through an online workshop hosting tool, Miro. The first test was with three TU Delft students specializing in SPD. The second test was with an environmental NGO worker, a Design Thinking coach, and a sustainability activist. Both tests lasted around 1.5 hours.

The tests start with introducing the project context, agenda, and the goal of the tests. Then, participants were given a hypothetical project scenario to role-play as clients going through the CSD process. With that being set, testers facilitated participants to operate the prototype session by session (Fig. 22). During the test, testers observed the participants' behaviors and discussion and asked follow-up questions, such as:

- How difficult did you feel when working with the tools?
- What challenges did you face?
- Did you need extra support or information? What were they?

Fig. 22 example of participant's work of the value mapping session during usability testing

Below, the result of concept testing and usability testing of each session is presented.

4.2.2 Testing result session 1: Value mapping

What value does Metabolic perceive?

The most significant value provided by this session is a chance to bring stakeholders' different or even conflicting perspectives on sustainability opportunities and value proposition explicit so that they could be aligned. As the quote from the Institute's Research Director:

"Having everybody piling into a common brief (value map) is an added value for the company because you are helping them build up a collective intelligence of what they see the value opportunities being. So cross-departments and even cross-partners will be on the same page."

What pitfall needs to be avoided?

Although the value map is believed to enhance perspective exchange, not every stakeholder will attend the workshop, especially those standing for the environment and society, from Metabolic's experience. Therefore, one solution will be inviting proxy from the academic fields, e.g., Professors of the circular design lab at TU Delft, on the table.

One potential issue was brought up, "how to deal with conflicting opportunities? how to keep discussions on these issues structured?" The workshop's timeframe needs to be followed for practical reasons, and unending debate on conflicting values should be prevented. Therefore, a suggestion will be to give a "parking lot" area, where unsolved thoughts could be held on and dealt with later.

Key insights of usability issues

- A proper theory introduction to the session is needed for those who are not familiar with the mindset of SBM.
- When discussing new value opportunities, new stakeholders that could either be value recipients or contributors will pop out. Therefore it should allow participants to name and add new stakeholders.

4.2.3 Testing result session 2: Current system mapping

What value does Metabolic perceive?

Metabolic recognizes the primary value of the new mapping process as "It's nice to have a visual map that shows the relationships among different stakeholders," said a Metabolic consultant, since "most of the time they work in a very siloed way." Besides, showing relationships on the system map "might show this stakeholder is super relevant since many connections go to them," said a Metabolic consultant.

What pitfall needs to be avoided?

One concern was brought up:

"We may fall into a lock-in situation where we over-enhance the current situation too much. And fall into micro-managing and micro-improvement. Sometimes people reach a system innovation because they didn't think about how to tune the current system."

One suggestion fed by the team's experience with the Bootcamp, "it's helpful to feed participants new design principles before jumping into design activities, as a refresher to get them thinking out of the box."

Key insights of usability issues

- Participants might be uncomfortable with mapping. Therefore a more step-by-step guide will be helpful.
- The boundaries and the level of detail of the system should be pre-communicated with participants.
- A selection process is needed to choose the intervention points that participants want to work on in the design stage.

4.2.4 Testing result session 3: Circular design + Concept building

What value does Metabolic perceive?

One value mentioned was that system maps work as a tool to communicate individuals' circular ideas from a systemic perspective, "A great tool for each participant to gain new perspectives on how fellow stakeholders view the system," said a Metabolic consultant. However, someone doubts how feasible it is for stakeholders to map a future system from scratch on their own.

What pitfall needs to be avoided?

Some experienced workshop hosts from the Circular Products and Services cluster team were suspicious about "solo sketch out the whole system because they all come from quite a niche background. You need someone from a different perspective to help you do that." Also, "People might get a bit overwhelmed by all the potential space that they can think about."

Another concern is the feedback session after the circular design and before the concept building, "people in the workshop can't provide critical enough feedback, always members from Metabolic to provide a system or environmental perspective."

Key insights of usability issues

(Noted: This session has been revised majorly after the concept testing. A series of ideation exercises were added as a more easy starting point for participants. The future system mapping was moved to a later phase as a method to assess circular ideas from a systemic perspective)

- During the SBM canvas exercise, participants might split out, and each took sections of it. So how to keep the whole group conversation going rather than focusing on one piece of the canvas is critical.
- Use business model canvas to facilitate participants to list elements for the system mapping.
- Suppose the purpose of the system mapping here is more like a tool for communication instead of a creativity tool. In that case, facilitators could intervene more to help stakeholders map the system out.

4.2.5 Testing result follow-up meeting: Implementation canvas

What value does Metabolic perceive?

The value of planning for experiments is highly recognized, "experiment is more like concept testing before we start going down to see if there is something we need to change." However, an issue that Metabolic has been facing in many projects was brought up:

> **"How to get clients' commitment is a big but critical question. We often hope that the fundamental part of the last day (at the Bootcamp) is to have a higher up there and get the momentum to move forwards, but often clients just cancel the project at the last minute. So what we haven't really cracked the nut yet is how to get buy-in."**

Some Metabolic members suggested that they should support clients to get stakeholders' buy-in, such as materials for communicating the value proposition of the new concepts:

> **"We need not end this project until that is clarified and no matter what form of the media is produced and that team feels really confident and delivering in, then we can stop."**

Therefore, it is suggested that the canvas also helps identify: whose buy-in is fundamentally required; what is needed to get that buy-in (e.g., slides, video).
(To be noted: the canvas didn't go through the usability testing due to the limited time available)

Mini takeaway

The testing results of the new CSD process were summarized and present in Table 2.

4.3 TAKEAWAY

After testing, the CSD process prototype was revised and developed into the final state according to the revising ideas listed in the table above. The final work is presented in the next chapter in the form of a guidebook for Metabolic. Here, a summary of the difference between the new CSD process and the Bootcamp is presented as this chapter's takeaway in Table 3.

What's next

The next chapter presents the final outcome that was delivered to Metabolic.

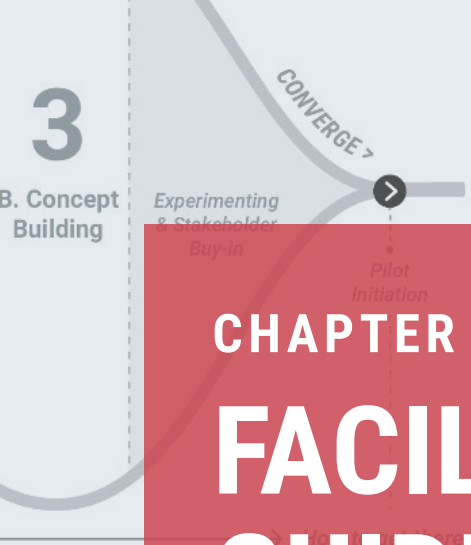
SESSION NAME	VALUE OF THE SESSION FROM METABOLIC'S PERSPECTIVE	POTENTIAL PITFALL & USABILITY ISSUES	REVISING IDEAS
1. Value mapping	Help align stakeholders' perspectives on a sustainability value proposition	Ensure the discussions are structured; A proper introduction about SBM is needed due to its complexity by nature.	Giving example contents for the value mapping
2. Current system mapping	Bring everyone on the same page of what the current system looks like	Avoid micro-improvement on the current system; A more step-by-step guide will be helpful; Screen the intervention points that participants want to work on in the design stage.	Provide participants out-of-box circular strategies; A selection process for intervention points
3. Circular design + Concept Building	View circular idea from systemic perspective	Less feasible for individuals to work on in the early design stage; People within the group work in scattering on different pieces of the sustainable business model	Move the future system mapping exercise to a later stage, and mapping collaboratively instead of individually; More comprehensive circular ideation process; Clear guide to lead the discussion
Follow-up meeting	Help plan experiments to test circular concepts before pilots	_	It will be valuable if it also helps identify the required stakeholders' buy-in and the media that helps to get those buy-in

Table 2 Testing results of the new CSD process

CIRCULAR DESIGN BOOTCAMP			CIRCULAR SYSTEM DESIGN PROCESS		
Session	**Exercise**	**Tools**	**Session**	**Exercise**	**Tools**
Build awareness	Presentation	Pitch deck	Build awareness	Presentation	Pitch deck
Understand current state	Presentation	Pitch deck, System map	Value mapping	Value mapping	adapted Value mapping tool
			Current system mapping	Current system mapping	adapted Value hill canvas
				Intervention point selection	Intervention cards
Design brief	-	Design brief	-	-	-
Circular design	Ideation	Learn from nature canvas/ Service flip canvas	Circular design + Concept building	Ideation	Learn from nature canvas Service flip canvas Circularity deck
	Idea selection	Circular scorecard		Idea selection	Sustainability business feedback and score table Concept sketching canvas
	Concept building	Circular concept canvas		Concept building	SBM canvas Future system mapping Collaboration assessment table
Roadmapping	Roadmapping	Circular implementation canvas	Follow-up meeting	Roadmapping	Circular experiment planning canvas

Newly added tools
Revised tools from the Bootcamp
Orginal tools

Table 3 Comparison between the new CSD process and the Bootcamp



CHAPTER 05

FACILITATOR GUIDEBOOK: METABOLIC'S CIRCULAR SYSTEM DESIGN PROCESS

A sustainable busi
beyond delivering
include a considera
value (proposition)
stakeholders

value
rstand
want to go
mindset

Value mapping

Where we are

Assess the current value that we have **captured**, **missed**, or **wasted** for **broader stakeholder groups**

Where we want to go

Identify **where and how to transform the current value proposition** to reduce negative outcomes and improve the overall outcome for the broader stakeholders - especially for society and the environment

INTRODUCTION

After concept testing and usability testing, the CSD process was revised and iterated into the final state. The final deliverables include two parts. First, the sessions and tools design of the CSD process on Miro. Second, a guidebook for facilitators to learn and be empowered to facilitate the process. In this chapter, the guidebook will be presented and supplemented with screenshots of the Miro boards to introduce the final CSD process design.

5.1 GUIDEBOOK INTRO

A CSD process for Metabolic to empower clients to implement circular and sustainable solutions from a holistic, systems-based perspective.

The Metabolic Circular System Design (CSD) process complements what Metabolic has excelled in helping industry clients for many years, tackling sustainability challenges with a systems thinking mindset.

Since a circular product can only exist within a properly functioning circular system, Metabolic helps clients analyze sustainable challenges and design intervention from a systemic perspective. However, to innovate on the system level strongly requires collaboration between different stakeholders. Therefore, empowering relevant stakeholders to build a shared understanding of 'Where we are' and 'Where we want to go' will benefit the designing of a new circular system.

By integrating a mix of design methods and tools, including systemic design, sustainable business model design, and the circular design, the 'Metabolic Circular System Design process' helps Metabolic engage clients and relevant stakeholders on a journey towards designing a new circular system. Besides, through the process, stakeholders are expected to:

- Understand and define the sustainability value proposition of clients' business.
- Embed sustainability into the core of business strategies.
- Become impact champions of the circular transformation.

Due to the uncertain time of the Covid era, the session tools are designed with and meant to be run with Miro, an online workshop space. This guidebook will introduce all the details that Metabolic required to run and facilitate the sessions.

Facilitators and group size

All sessions are required to run in small groups. A group size of 5-7 participants is suggested for running this style of session. Though this number still needs to be tested and adjusted based on future experience. It is recommended to have one facilitator for every two groups because a relatively high assistant is required.

Participants

As mentioned before, the process helps engage different stakeholders. Therefore, two types of participants combination are suggested. (To be noted, the term 'participants' and 'stakeholders' are interchangeably used in this guidebook)

- Cross department stakeholders within a client company
- Cross organization stakeholders representing different organizations related to a client company, e.g., suppliers, recyclers, NGOs, governments

Schedule and timings

The process is customized for Metabolic's consulting work to provide modularized sessions that could be picked to fit different project needs. If all sessions are conducted consecutively, it is estimated to require two days, or sessions could be pulled out to be hosted solely at different times. The suitable timing for each session will be explained later.

Miroboard URL link: https://miro.com/app/board/o9J_l3y8nEQ=/?invite_link_id=70717641920

5.2 CSD PROCESS FRAMEWORK

A framework was created to help communicate the structure and rationale of the CSD process to Metabolic and participants. It's composed of a triple diamonded structure to manifest the three main diverging and converging sessions (Fig.). As stated, the process aims to complement Metabolic's methodology; therefore, Metabolic's five stage process is put below to show how the framework aligns with it.

The process kicks off by creating awareness of the urgency for sustainability transformation among stakeholders. To do so, Metabolic can give opening speeches about the circular economy, systems thinking, trends of sustainability transformation in industries, etc. Then, with the awareness being built, the following three sessions compose the central part of the process.

The first session

Defining a 'new sustainability value proposition' for the business is the goal of this session, and Value mapping is the means to achieve that goal. The session starts with a diverging process that leads stakeholders to explore 'Where we are' (stage one: current state analysis) by understanding the value created, missed, or destroyed by the business. Then, a converging process follows to define 'where we want to go' (stage two: goal settings) in the form of a new sustainability value proposition.

The second session

Identifying' intervention points' is the goal of this session, and the Current system mapping is the means to achieve that goal. The session starts with a diverging process that facilitates stakeholders to explore products' life cycles in a more extensive system. Then a converging process follows to spot 'Where to intervene' in the system to achieve the sustainability value proposition set in the previous session.

The third session

Designing a new circular system and developing a plan for experimenting is the goal of this session, namely, 'how to get there' (stage three: interventions). There are two sub-sessions and a follow-up meeting within this session. Two sub-sessions collectively are co-creation processes that start with a diverging process, Circular design, to ideate circular ideas, and followed by a converging process, Concept building, to turn ideas into a new circular system. Then a follow-up meeting with clients is suggested to develop a plan for pilot initiation.

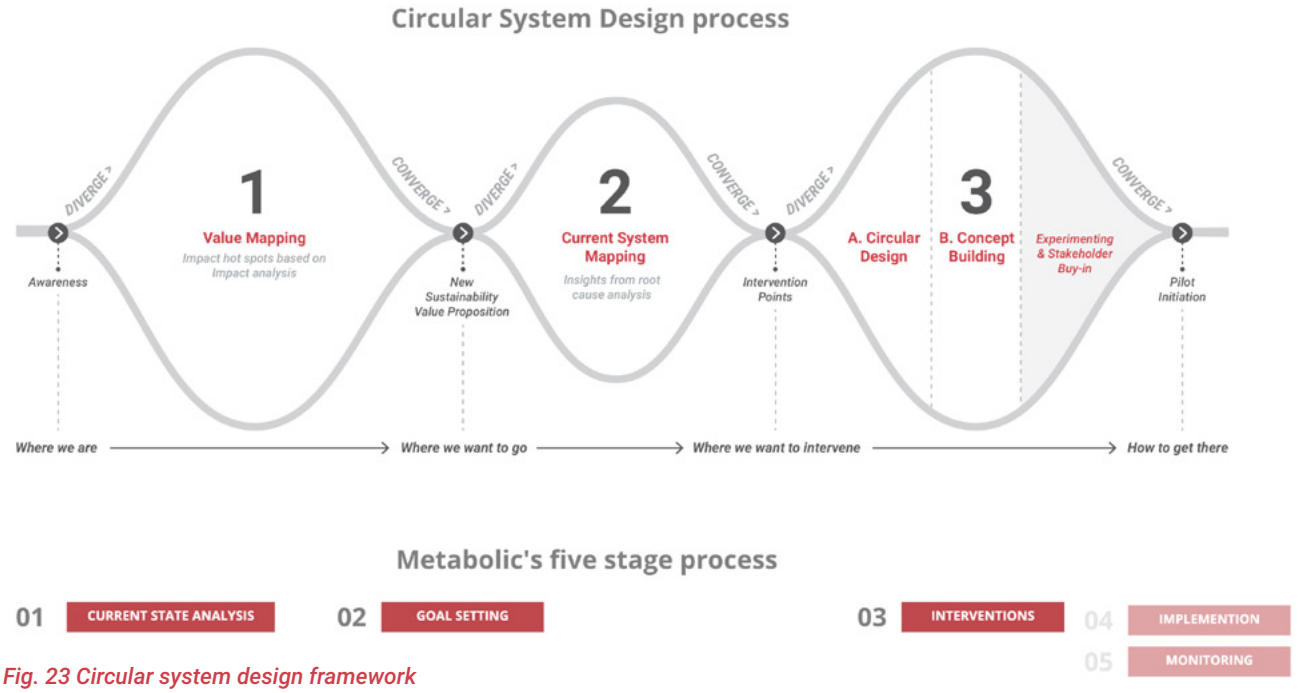


Fig. 23 Circular system design framework

5.3 SESSION 1: VALUE MAPPING

Learning objectives

After finishing session one, stakeholders will build a shared understanding of what value has been created, missed, or destroyed by clients' business and collectively define a new sustainability value proposition.

Timing for applying the session

This session is suitable for projects that aim to help clients develop new sustainable business models or enhance mutual understanding among different stakeholders. It's suggested to host this session after Metabolic's working stage one: Current state analysis.

Tool explanation

The value mapping tool assists companies in understanding both positive and negative aspects of their business's value proposition for broader stakeholder groups, including the environment and society.

The value mapping tool can be broken down into two parts, the inner rings (red) and the outer rings (blue) (Fig. 24). The inner rings assist stakeholders in creating a shared understanding of the value that the company has created, missed, and destroyed for stakeholders. The outer rings help stakeholders co-define a new sustainability value proposition by considering future trends (e.g., scarcity in particular raw material or new regulations by governments) and generating ideas on what new value opportunities can be created or captured.

Estimated total required time: 1h 40mins

There are three activities within session one. The required material and facilitator notes for each activity are introduced below. Besides, the authors of the value mapping tool wrote a guide for facilitators, which could be accessed here: http://nancybocken.com/wp-content/uploads/2016/10/Guide-for-facilitators_VM-tool_English.pdf

Before the session (preparation and material needed)

- Separate all stakeholders into groups of 5-7 people. Each group should contain stakeholders from different organizations or departments and preferably covers

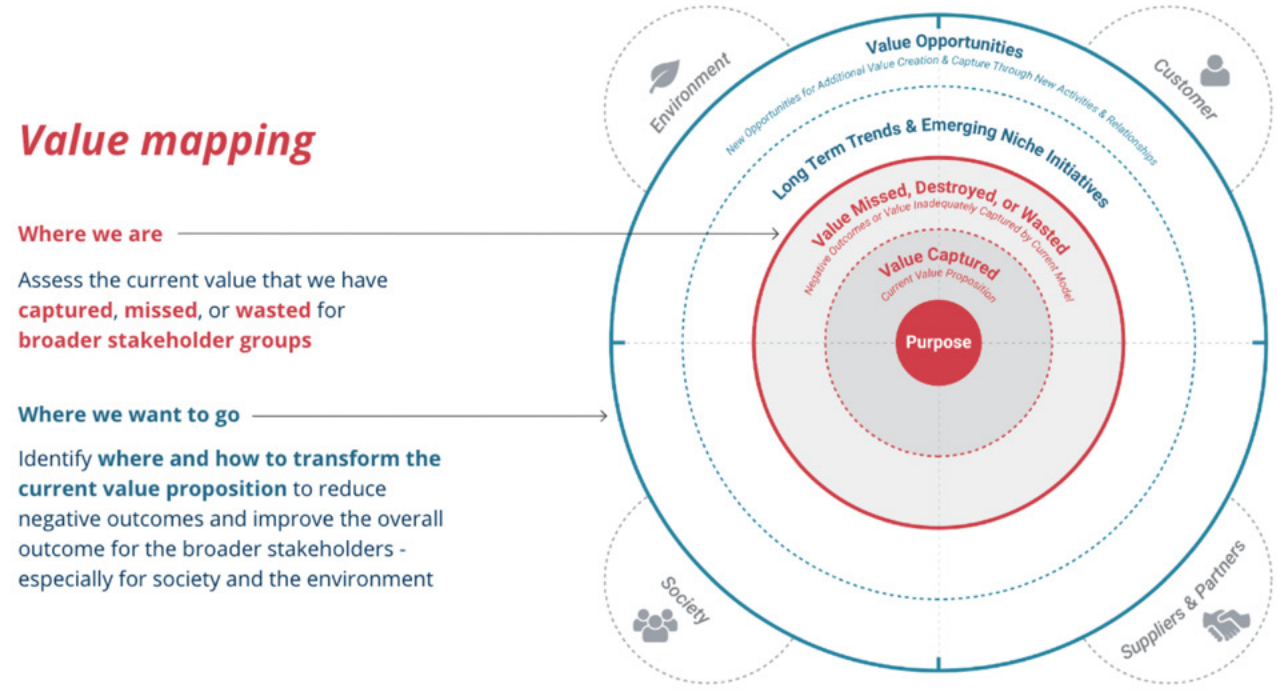


Fig. 24 Introduction of the value mapping tool

four main categories (customer, supplier & partner, society, environment).

- Prepare a short description of the targeted product of this project and update the product information on the session introduction frames (Fig. 25).

Activity 1: Open discussion

Activity one is the first round of the 'where we are' mapping (red circular area in Fig. 24) based on stakeholders' knowledge and perspectives without additional data feed. The goal is to make different perspectives on the current value proposition explicit.

Facilitating Guide:

1. Start by introducing the session, the value mapping tool, and targeted products with the session introduction frames to whole participants (Fig. 25).
2. Then explain how does the activity work with the 'How to ?' frame.
3. Let stakeholders work on their own until all groups are finished. (The required time for each step is on the Miro board)

Facilitators note:

- Assist stakeholders if they feel hard to understand what to do in each step
- Remind stakeholders that the same value captured, missed, or destroyed could be applied to different stakeholders.
- Remind stakeholders there might be some non-current stakeholders that are influenced by the value missed or destroyed. They can write them down on pink post-its and place them in suitable stakeholder categories.

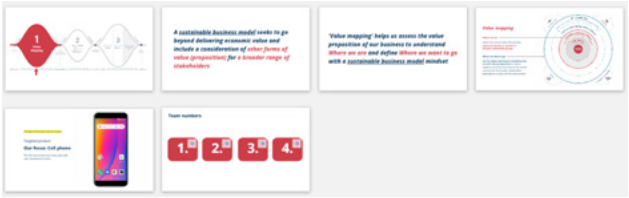


Fig. 25 Session introduction frames (Value mapping)

Fig. 26 Step instruction frames (Value mapping, activity one)

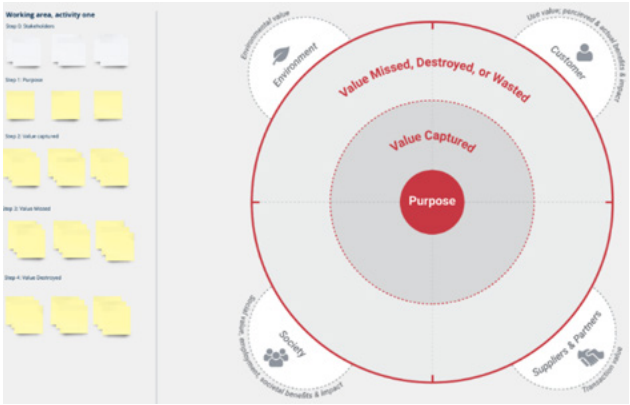


Fig. 27 Step instruction frames (Value mapping, activity one)

Activity 2: Learn from Metabolic's current state analysis

Activity two is the second round of the 'Where we are' mapping, fed with Metabolic's current state analysis insights. The goal is to let stakeholders reflect on their initial perspective with data-based insights and make science-based decisions on defining sustainability value proposition in the next activity.

Facilitating guide:

Before the activity

1. Currently, there are three default steps in this activity, which reflect three different kinds of analysis methods (MFA, impact assessment, and value hill). Though, these steps could be adjusted, removed, or added according to the analysis methods you chose in your project.
2. Distill insights from each analysis result and write them down on green post-it in Miro as 'insight post-it.' Also, if applicable, prepare summary diagrams for each analysis (e.g., material flow diagram for MFA). Then combine diagrams with insight post-it and place them on the steps instruction frames (Fig. 28).
3. (If needed) Prepare a slide deck for explaining the analysis result.
4. Copy the post-it from activity one and paste them to the working frame of activity two.

During the activity

1. Start by explaining the analysis result of step one with summary diagrams or an extra slide deck.
2. Then explain what stakeholders should do next:
3. Discuss what they have learned from the analysis within the group. (With the help of summary diagrams on the steps introduction frames (Fig. 28)
4. Move insight post-it from summary diagrams to suitable places of the working frame.
5. Let stakeholders work on their own until all groups are finished. (The required time for each step is on the Miro board)
6. Move on to the next step and repeat points 1,2,3 until all analyses are presented and discussed.

Fig. 28 Step instruction frames (Value mapping, activity two)

Activity 3: Future value mapping

Activity three is about generating ideas for 'Where we want to go' (blue circular area on Fig. 24) regarding the new sustainability value proposition for the targeted product. The goal is that multi-stakeholders agree with and want to be involved with the purpose (sustainability value proposition) generated.

Facilitating guide:

Before the activity

1. Copy the post-it from the value map of activity two and paste them to the working frame of activity three.
2. (If Metabolic has done future trend analysis) Distill insights from the analysis and write them down on green post-it in Miro as 'insight post-it.' and place them on the working frames (Fig. 29).
3. (If needed) Prepare slide deck for future trend analysis results.

During the activity

1. Start by presenting the findings of the analysis of the future trends (optional) or guide stakeholders to discuss future trends based on their knowledge in step one.
2. Then let stakeholders work independently with the step instruction frames (Fig. 30) until all groups are finished. (The required time for each step is on the Miro board) (Facilitators note: remind stakeholders to review post-its in the inner rings layers to stimulate idea generation and discussion)

Fig. 29 Step instruction frames (Value mapping, activity three)

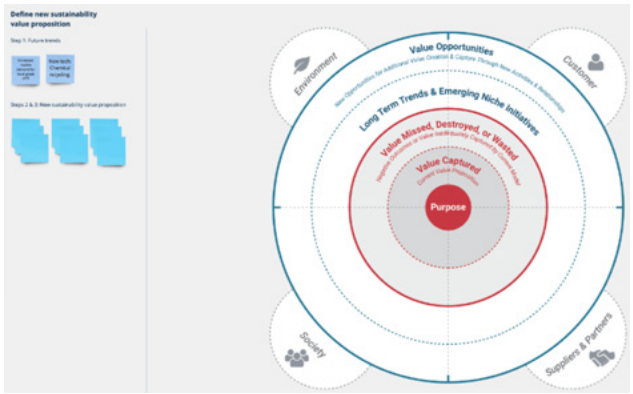


Fig.30 Working frame (Value mapping, activity three)

5.4 SESSION 2: CURRENT SYSTEM MAPPING

Learning objectives

After finishing session two, stakeholders will build a shared understanding of how the more extensive system behind the product life cycle works and identify the intervention points to make it more circular.

Timing for applying the session

This session is suitable for projects that aim to help clients understand current circular business conditions from a systemic perspective and decide which intervention points to focus on. It's suggested to host this session after Metabolic's working stage two: Goal setting.

Tool explanation

The current system mapping incorporates two existing tools, system mapping and the value hill (Fig. 31). The main idea is to facilitate stakeholders to co-create a system map that presents the product life cycle. The map entails how the product went through the pre-use, use, to post-use phases and the relationships between related stakeholders. Furthermore, mapping on the 'Value hill' visual helps stakeholders understand how products gain and lose value. They can spot the place to intervene to make the system more circular.

Besides, Intervention point cards are provided to share the insights of the root cause analysis with stakeholders and supplement the system map (Fig. 32). The cards describe why certain places in the system are critical for intervention and transform intervention points into How Might We (HMW) questions by applying 9Rs strategies to point out the potential directions of circular design. The cards are designed to be placed around related places of the system map as additional data that feeds back into the map so stakeholders can develop it further.

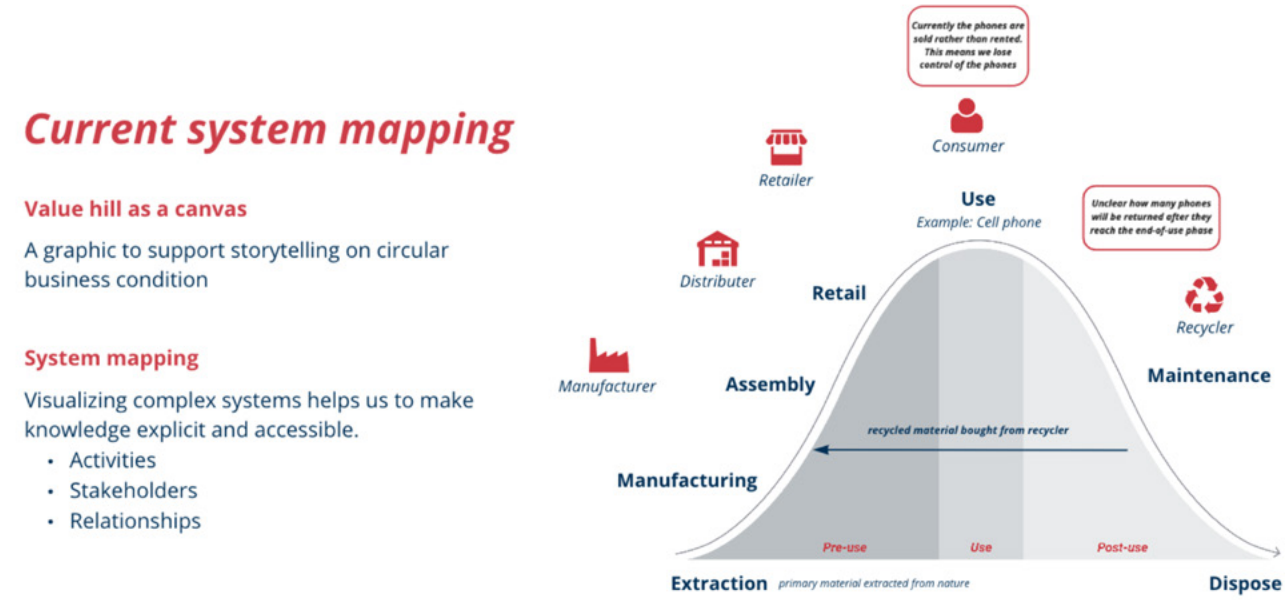


Fig. 31 Introduction of the current system mapping

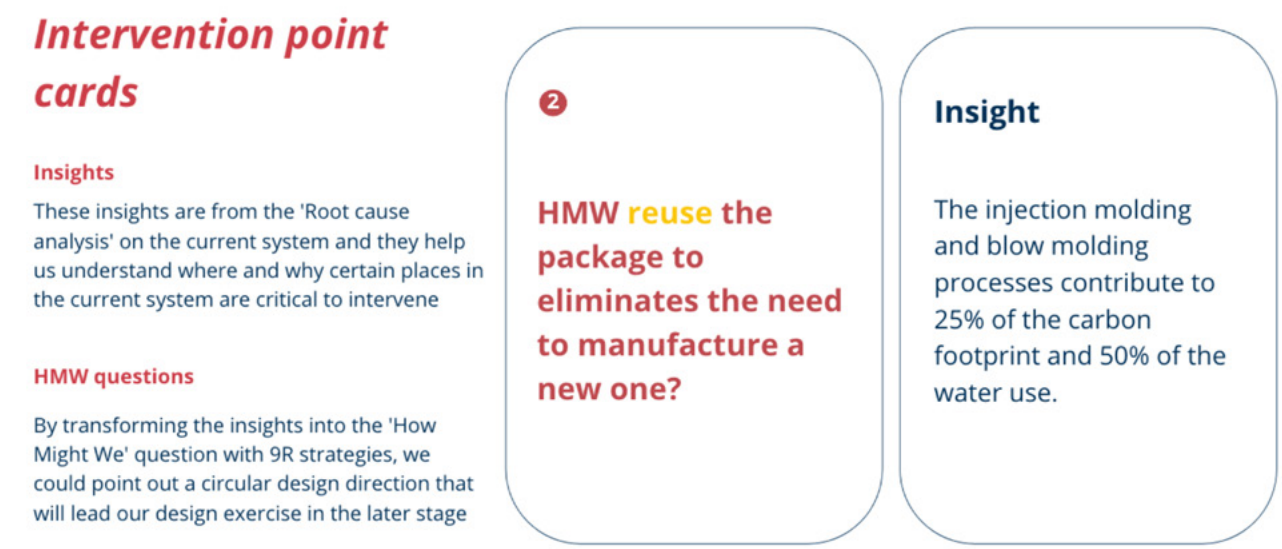


Fig. 32 Introduction of the intervention point cards

At the end of the session, there is a screening process to select the intervention points that stakeholders want to focus on in the design phase. Intervention cards will be scored based on the preference of higher R strategies and how relevant they are to the sustainability goals, the new sustainability value proposition defined in session one.

Estimated total required time: 1h

There are two activities within session two. The required material and facilitator notes for each activity are introduced below.

Before the session (preparation and material needed)

- Separate all stakeholders into groups of 5-7 people. Each group should contain stakeholders from different organizations or departments.
- Prepare relevant icons elements, including the primary activity names within the value chain and icons for potential stakeholders, for the mapping exercise.
- Prepare intervention cards, including the HMW questions incorporating the 9Rs strategies.

Activity 1: Current system mapping

Activity one aims to assist stakeholders in exchanging different perspectives on how the current system works and where it could be intervened to make it more circular.

Facilitating guide

1. Start by introducing the session and tools with the session introduction frames (Fig. 33).
2. Then, guide stakeholders with the step instruction frames (Fig. 34) to map out the current system on the working frame (Fig. 35). (The required time for each step is on the Miro board)

(Facilitating notes: System mapping is a relatively difficult exercise for stakeholders; therefore, better to explain all the steps briefly before letting them work on their own

1. Step one: Pre-communicate the expected granularity of the map with stakeholders, i.e., to what extent of the detail we want for the activities. Metabolic should base on their expertise to suggest the critical activities missed by stakeholders. (e.g., logistic)
2. Step two: The relationship and value transacted between stakeholders must be discussed and reflected on the map. Therefore, facilitators should prompt stakeholders to discuss these topics if they don't.
3. Step three: Remind stakeholders with the principles of the circular economy they have learned before they jump into thinking potential intervention points.)

Fig. 33 Session introduction frames (Current system mapping)

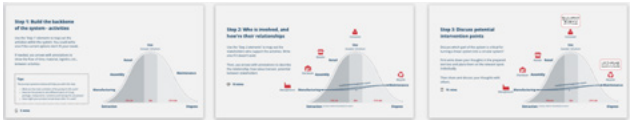


Fig. 34 Step instruction frames (Current system mapping, activity one)

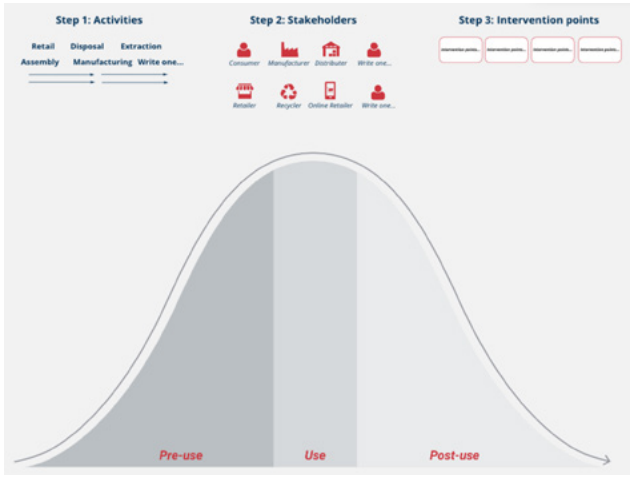


Fig. 35 Step instruction frames (Current system mapping, activity one)

Activity 2: Intervention points

Activity two follows the discussion in activity one and supplements Metabolic's root cause analysis insights to help stakeholders narrow the focus and make well-informed decisions of where to intervene in the current system.

Facilitating guides:

Before the activity

Copy the new sustainability value proposition from session one (if session one wasn't performed, create a design goal for being used here) to the activity instruction frames, step 2. This information will act as a reference for stakeholders to decide which intervention points are most related to creating the new value proposition.

During the activity

1. Start by introducing the intervention cards with the session introduction frames (Fig 33).
2. Then guide stakeholders to follow the step instruction frames (Fig. 36) to discuss each intervention card. (The required time of this step depends on how many intervention point cards to be discussed) (Facilitator note: briefly explain the 9Rs strategies and the difference between higher and lower Rs to stakeholders)

3. Facilitate the intervention points selection process at step 2 with the instruction frame (Fig. #). (The required time for this step is on the Miro board) (Facilitator note : briefly explain the rationale of the selection criteria to stakeholders.)

Fig. 36 Activity instruction frames (Intervention point cards,

5.5 SESSION 3: CIRCULAR DESIGN + CONCEPT BUILDING

Learning objectives

After finishing session three, stakeholders will generate concepts for new circular systems of their target product and evaluate how future collaborations within the new system will work. Besides, a plan will be developed to get ready for initiating the pilot.

Timing for applying the session

This session is suitable for projects that aim to design on the system level. It's suggested to host this session after Metabolic's working stage two: goal setting, or after session two: current system mapping.

Tool explaination

There are two sub-sessions in this session, Circular design and Concept building.

What's the Circular design sub-session?

The circular design sub-session is a sequence of creative exercises arranged to facilitate a circular design process. Two critical pieces of information guide the design process. First, the sustainability goal, defined by session one or other methods, serves as a design goal. Second, the intervention points, identified by session two or other methods, serve as problem insights to guide design directions.

The creative exercises are open brainstorming, analogy thinking (using the Circularity deck, developed by Konietzko, Bocken, and Hultink (2020) as analogy cases), building on others' ideas, and the Crazy 8. After enough ideas are generated, an idea selection tool developed by IDEO and Ellen Macarthur Foundation is adapted and applied to screen out ideas that contain the higher impact. Finally, a concept sketching activity is conducted to detail the ideas into concepts.

What's the Concept building sub-session?

The concept building sub-session combines three activities that further develop the selected circular concepts into circular systems. These three activities are sustainable business modeling, future system mapping, and collaboration assessment.

First, the sustainability business model canvas (P. , Fig. #), developed by Bocken et al. (2018), helps stakeholders turn concepts into business models so needed stakeholders, activities, resources, etc., can be discussed and considered.

Second, the future system mapping (P. , Fig. #), similar to the current system mapping in session two, helps visualize the extensive system behind the new product life cycle. Therefore, issues like how a new relationship between stakeholders works, where the interest lies, or how resource flow will become explicit so the business model can be assessed and iterated. Furthermore, the new system map can be compared with the current one to communicate the new design.

Finally, a collaboration assessment table (P. , Fig. #), adapted from Brown et al. (2019), helps clients consider how to involve new partners and reduce collaboration risk for the new system.

Sub session 1: Circular design

There are two activities within this sub-session. (Estimated total required time: 1h 40 mins)

Activity one

Activity one is a journey of individual idea generation, which ends with screening out two promising ideas per person.

Facilitating guide:

Before the activity

1. Separate all stakeholders into groups of 5-7 people. Each group is better to contain stakeholders from different organizations or departments.
2. Copy and paste the sustainability value proposition from session one and the selected intervention point card to the frame here before the activity start
3. Pre-select relevant cards from the Circularity deck as cases for analogy thinking in step 2.2.
4. Facilitators can decide whether to conduct 'Learn from nature' or 'Service flip' (from section 3.1) as optional warm-up exercises to stimulate sustainable ideas. The choice of which exercise to be conducted depends on the fitness of the project context.

During the activity

(The required time for each step is on the Miro board)

1. Step 1: Start by reviewing the sustainability value proposition and selected intervention points to recap design goals and design directions with the step instruction frame (Fig. 37).
2. Step 2.1-2.4: Guide participants to follow the step instruction frames (Fig. 38) to ideate circular ideas individually.

3. Step 2.5: Select two preferable ones and put them into the format of the idea sketch (Fig. 39). (Facilitator note: Let people search for pictures to present their ideas if they feel uncomfortable drawing. Remind participants to chose two preferable ideas based on the circular principles (the Seven Pillars of the circular economy))
4. Step 3: Facilitate peer review and give a score on each of the two preferable ideas based on the Sustainability business feedback and score table (Fig. 40).
5. Step 4: Facilitate a sharing session to walk stakeholders through each idea and relevant comments.
6. Step 5: Help calculate the scores of each idea from step 3 and plot them on the matrix to select two winning ideas per group (Fig. 41).

Fig. 37 Step instruction frame (Circular design, activity one)

Fig. 38 Step instruction frames (Circular design, activity one)

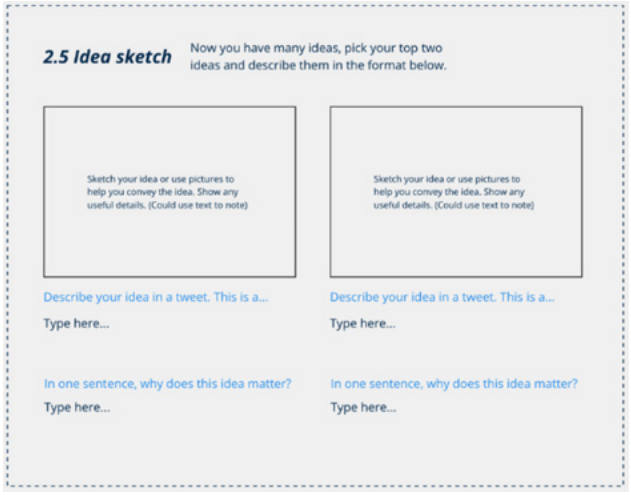


Fig. 39 Idea sketch frame

Fig. 40 Sustainability business feedback and score table

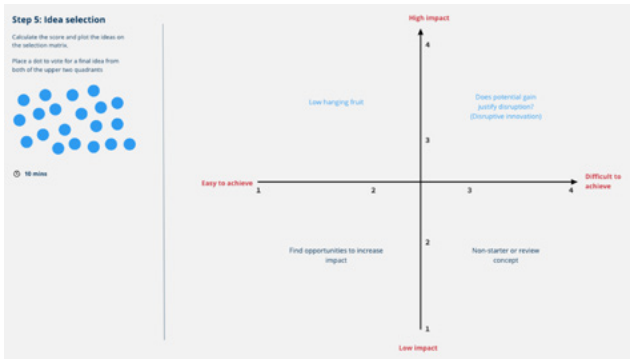


Fig. 41 Idea selection matrix

Activity two

Activity two is a concept sketching exercise adapted from Metabolic's circular concept canvas (Fig. 15). The updated canvas (Fig. 42) reflects the sustainable business models' main elements and separates them into three sections using the golden circle structure (Sinek, 2015).

Facilitating guide:

Guide stakeholders to fill up the canvas in the order of WHY, HOW, WHAT. (The required time for this step is on the Miro board)

- *WHY*: the why section describes concepts' core argument, what new value is created or captured, namely the value proposition. (Facilitator note: If a value mapping session is also performed in the project, then ask stakeholders to align this section with the sustainability value proposition defined in the value mapping session.)
- *HOW*: the how section describes three fundamental elements of a concept, who are the users, how do value chain and product-service systems work, and how to make revenue, namely the value delivery, creation, and capture parts of a business model.

- *WHAT*: the what section helps make concepts more concrete, what are the key features and potential barriers. By visualizing the concepts in a lo-fi sketch, it helps narrate probably complex or vague ideas. (Facilitator note: Let people search pictures to present their ideas if they feel uncomfortable drawing.)

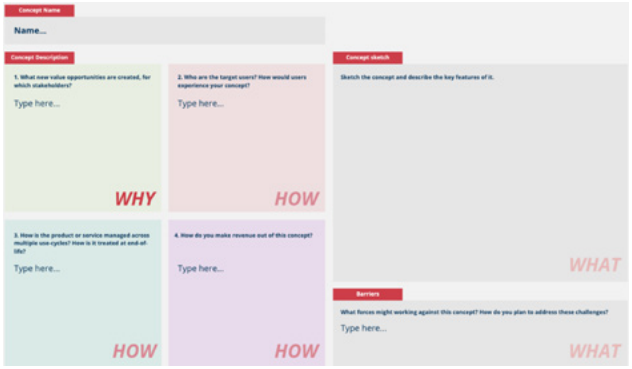


Fig. 42 Concept sketching canvas

Sub session 2: Concept building

As mentioned, there are three activities in this sub-session. (Estimated total required time: 1h 25 mins)

Activity one: Sustainability business modeling.

Facilitating guide:

Before the activity

Help copy the content of the one WHY and three HOW from concept sketching canvas (sub-session one, activity two) to the respective boxes surrounding the sustainable business model canvas. (Fig. 43)

During the activity

Guide participants to follow the step instruction frames to fill out the sustainable business model canvas step by step. (The required time for each step is on the Miro board)

Step 1: break down the WHY section, namely value proposition, into the triple bottom line structure to specify profit, people, and plant value.

Step 2: expand the description of targeted users (HOW section) into customer segment, customer relationship, and channels.

Step 3: expand the description of value chain (HOW section) into: key stakeholders, activities, and resources & capabilities.

Step 4: break down the description of making revenue (HOW section) into cost and revenue.

More content about the business model canvas can be access through: https://www.strategyzer.com/canvas/business-model-canvas

Activity two: Future system mapping

Unlike the current system map, the content of the future system map is mostly defined by the sustainable business model created from the previous activity.

Fig. 43 Sustainability business model canvas with four content boxes from the concept sketching exercise (sub-session one, activity two). Adapted from Bocken et al. (2018).

Facilitating guide:

- Help participants copy the content from the 'value creation' section of the business model canvas and paste them to the element area of the map.
- Then guide participants to follow the step instruction frames step by step to map out the future system. (Fig. 44 & 45) (The required time for each step is on the Miro board) (Facilitators note: It's an iterative process between the future system mapping and the sustainable business modeling. For example, if participants found a stakeholder that is crucial but missing on the business model canvas during the mapping exercise, they can go back to edit the canvas)

Fig. 44 Step instruction frames (Concept building, activity two)

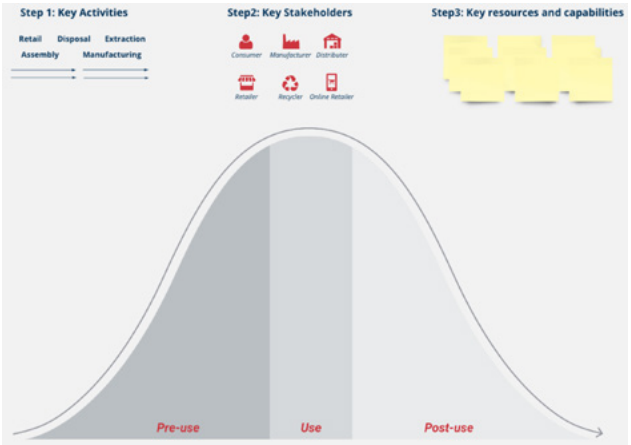


Fig. 45 Working frame (Concept building, activity two)

Activity three: Collaboration assessment

This activity aims to assess different aspects of future collaboration within the new system.

Facilitating guide:

Guide stakeholders to follow the step instruction frames (Fig. 46) to discuss and fill in the assessing table. (The required time for each step is on the Miro board) (Facilitator notes: remind stakeholders to utilize the sustainability model canvas and the future system map beside as a reference for assessing the collaborations)

Fig. 46 Collaboration assessment table and the step

5.6 FOLLOW UP MEETING

The last part of session three is a follow-up meeting with clients after circular concepts were developed. The key outcome is to create a plan for two tasks, first, experimenting with the circular concepts, second, getting stakeholders' buy-in. These two tasks are critical for getting the pilot off the ground.

It is valuable to experiment with separate parts of the business model assumption (desirability, sustainability, viability, and feasibility) before running pilots that test the whole concept at once. Because innovating towards circular business models can lead to many uncertainties, running experiments, which is a fast-learning process and requires low resources, can get higher managers' approval much easier. Besides, the result of the experiments can serve as a means to gain traction from internal and external stakeholders (Bocken et al., 2018).

An implementation canvas, adapted from the Sustainable Business Model Pilot Canvas (Baldassarre et al., 2020), will guide the planning process. The canvas contains three sections, namely, phase one, two, and three, which serve as a roadmap for companies to implement their new circular concept (Fig. 47). Phase one, experiment and stakeholder buy-in, is the primary part discussed during the follow-up meeting.

Phase one comprises four parts, business assumptions, methods for the experiment, media for communication, and a list for stakeholders' buy-in. The planning process starts from writing down the business assumption for desirability, sustainability, viability, and feasibility and defining relevant indicators to measure the assumption during experiments. Then the suitable methods for the experiment will be discussed. Finally, clients should think of essential stakeholders for approval for pilot initiation and what kind of media is needed to communicate with them.

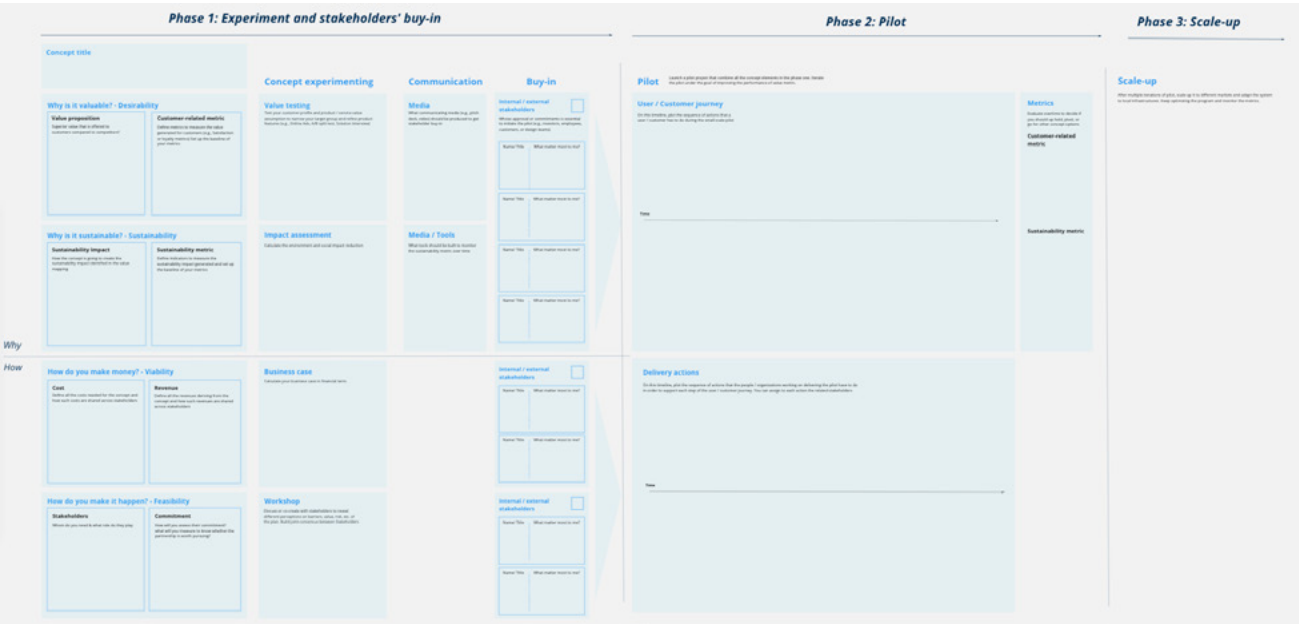


Fig. 47 The implementation canvas

CHAPTER 06

CONCLUSION

6.1 LIMITATIONS AND RECOMMENDATIONS

Limitation with validation

Due to the limited time available, the CSD process prototypes were tested in a much shorter timeframe (1h 30 mins for testing v.s. 6h for the whole process). Besides, the usability testing did not manage to test with real clients and related stakeholders. Therefore some potential usability issues might be revealed in the future when Metabolic uses them in a real project context and full time scale.

Limitation with project approach

Although most of the tools developed in this project are directly adopted or adapted from literature, some of the tools are relatively new and might not have been applied in the industry's environment. Therefore, this version of the CSD process is still in its early stage and requires Metabolic to iterate and refine further.

Recommendation for the focus of future iteration

Value mapping

During a feedback session of this project, Metabolic's CEO (Eva Gladek) pointed out her concern about "how to ensure that people are thinking about value holistically, how to ensure that they are not missing any key categories of impact." And that is why Metabolic has defined the Seven Pillars of the circular economy, "it's not meant to be a dogmatic definition of the circularity, it's kind of a dashboard to check whether or not there is a burden shift from new circular design."

As a result, we suggest Metabolic explore how the Seven Pillars of the circular economy can supplement the value mapping session. One initial thought is to match the four stakeholder groups of the value map with the Seven Pillars (Fig. 48). In that way, stakeholders could be aware that multiple aspects of the environment need to be considered to create a holistically sustainable value proposition.

Current system mapping

The current system mapping process adopts the mapping skills from the systemic design, which is still primary academia with limited application in the practical world. Therefore, it is required to tune the process based on practical experience in the future, so the theoretical result from the mapping process can be generated.

Besides, avoiding linear thinking caused by working with the value hill as a mapping canvas, as a concern stated by Eva Gladek, is another issue Metabolic should pay attention to in the future. For example, different frameworks could be tested as a mapping canvas, such as the butterfly diagram by Ellen MacArthur Foundation, to see which one can make the most synergy with systemic design mapping skills. Or try to map systems from scratch without any predefined canvas since the goal here is to visualize messier systems.

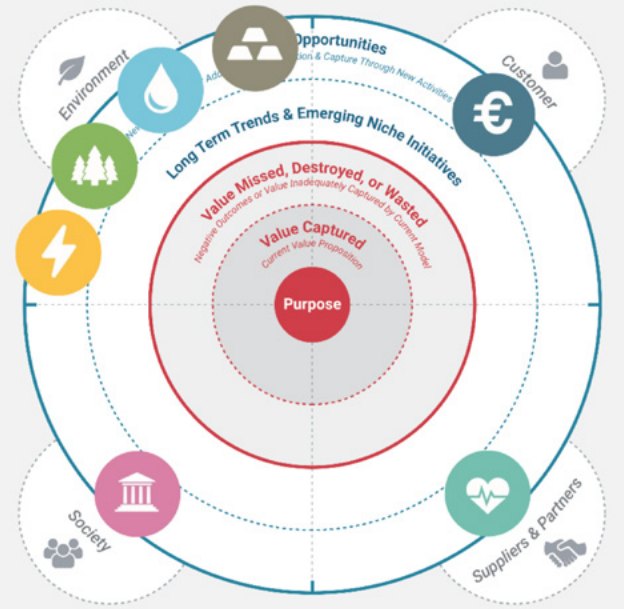


Fig. 48 Matching the value map with the Seven Pillars of the circular economy

6.2 CONTRIBUTION AND PERSONAL REFLECTION

Contribution in a small scope

As mentioned in section 1.2, the motivation of the Bootcamp was to assist companies in redesigning products and services into a more circular and sustainable state. According to Eva, to prompt more companies to make the circular transition at the design stage further, Metabolic plans to build the Bootcamp into a service area. As a result, the deliverable of this project, the Circular System Design process, becomes the start point of this journey.

Contribution in a big scope

At the moment of this project, there are some other circular design methods and tools developed by design consultancy, NGOs, and think tanks. Here, a brief comparison between them and the CSD process is presented in the table 4.

Among these circular design methods, two features distinguish Metabolic's CSD process from others. First, the CSD process integrates Metabolic's data analysis capacity (i.e., MFA, impact assessment) to support impact hot-spot spotting and solution validation. Second, the CSD process applies systemic design, a flourishing design field that tries to create the synergy of systems thinking and design. Therefore, it creates an opportunity to see how

NAME	DEVELOPER	BRIEF INTRODUCTION	FEATURES	FORMAT
Circular System Design process	Metabolic	Empower clients to implement circular and sustainable solutions from a holistic, systems-based perspective.	Engaging different stakeholders to co-create a new circular system for the targeted products, with an aim to launch pilots	A design process with tools complemented with Metabolic's science-based analysis work and supported with facilitation
Circular design guide	IDEO and Ellen MacArthur Foundation	Help innovators create more elegant, effective, creative solutions for the circular economy.	Integrating Design thinking and circular economy for a broad scope of design purpose	A design method with self-guided tools for applying in different purposes (e.g., industry, education)
Circular toolbox	Circle Economy	The step-by-step guide for apparel brands to design and launch a rental or resale pilot	Customizing for the apparel industry with an aim to launch pilots	A design method with self-guided tools for applying in the apparel industry
Ecodesign sprint	Design Forum Finland	Develop the business of SMEs and create more sustainable products and services for them.	An intensive and fast business development program that focuses on the company's strategic goals and operations and explores novel opportunities through the circular economy	A three-day training and acceleration program that is a joint project between a client company, a design agency, and a circular economy expert
Circulab toolbox	Circulab	Helps implement circular economy principles during the design stage of the product or service and embrace systems thinking to rethink all product/ service related impacts	Focusing on user needs, systems needs, as well as the role of all the stakeholders involved	Multiple self-guided design tools supported with Circilab's facilitation

Table 3 comparison between current circular design methods and the CSD process

systemic design could value the systems-based circular economy transition.

Personal reflection

At the start of this project, I was excited about exploring potential applications of systemic design in the circular economy transition. Especially, I was interested in how systemic design could help deal with complex relationships and perspectives between stakeholders when it comes to a circular economy change on systems level. Although it was a broad project scope initially, the collaboration with Metabolic helped me narrow down to 'how could systemic design benefit redesigning products and services into a circular state.'

However, after diving into this topic, I realized that most of the circular design projects in industries are still not inter-organizations involved by nature. Instead, companies prefer to work internally until most of the plans are settled, and then they reach out to other stakeholders. Fortunately, Metabolic recognizes that a circular product can only exist within a properly functioning circular system and thereby perceives system mapping and value mapping as essential methods for future projects. Therefore, I am glad that this project could play a role in transitioning circular design projects from firm-level to system-level.

Working with Metabolic helped me understand why systems thinking is critical to sustainability changes and how to apply it in practice. Besides, with the project focus on optimizing a circular design process, it requires me to study not only the systemic design but also the sustainable business model design and the circular design, which make me gain considerable knowledge. This journey makes me realize how 'design' is given more significant challenges and how it needs to work with other disciplines in order to make systemic changes. This project experience will nourish me with the mindset and skills I need to make the right decisions (creating holistic value for all) in whichever position I am in the future.

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