

Ecological Design Thinking for a Circular Economy: the impact of the forest metaphor for circular business

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Abstract

This paper presents an evaluation of the educational tool *Ecological Design Thinking for a Circular Economy*, which uses the metaphor of a forest to support new ways of thinking about circular business models. The study responds to concerns that circular economy (CE) discourse continues to be shaped by mechanistic and linear metaphors, which may limit how change is understood and implemented in practice.

The forest metaphor emphasises interconnection, non-linearity, and ongoing transformation. The tool was designed as an origami-style pamphlet with structured prompts to guide participants in relating forest dynamics to circular economy principles. An exploratory comparative case study was conducted to assess the tool's impact. One workshop in 2023 engaged participants with the forest metaphor without the tool, while a second workshop in 2025 used the tool to support the same process. In both cases, pre- and post-programme surveys were used to explore conceptual change and perceived value.

The results show that the tool supported participants in generating more concrete insights and applying ecological ideas to circular economy contexts. It also brought attention to the contrast between some ecological principles and the realities of existing businesses and organisations.

This study contributes to circular economy education by showing how metaphor-based tools can support conceptual development. It indicates that working with ecological metaphors can help participants question dominant assumptions and consider alternative models for circular practice.

Keywords Circular Economy · Circular Business · Conceptual Metaphor Theory

1. Introduction

The idea of a circular economy (CE) was introduced to minimise waste and pollution, keep products and materials in use for longer and regenerate natural systems (Ellen MacArthur Foundation, 2013). It was intended as a proposal for a radically different economic system (Webster, 2021) and gained substantial traction in both business sustainability discourse as well as academia (Alnajem et al., 2020). Despite ambitions for radical systemic change from a linear to a CE, current CE discourse is mostly shaped by metaphors rooted

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in linear economic thinking (Fromberg et al., 2023a; Webster, 2021). These dominant metaphors include the machine metaphor, which emphasises efficiency and control; metaphors such as sports and war, emphasising competitive elements between businesses; and the journey metaphor, which frames a CE as a step-by-step transition (Fromberg et al., 2023a).

Metaphors are pervasive because they shape most abstract thought (Lakoff & Johnson, 1982), and therefore, they influence how problems and solutions are thought of. They determine what is prioritised, what remains overlooked and how solutions are conceptualised. The current dominant metaphors seem mechanistic and tend to reinforce direct causation patterns (Lakoff, 2010), suggesting that one event or action produces another without intermediary factors. If a CE continues to be informed by the same metaphors that influence a linear economy, it risks perpetuating the same cognitive patterns instead of prompting transformative change and radically different outcomes (Fromberg et al., 2023b). To address this, one can engage in different ways of thinking that could potentially lead to new lines of enquiry (Lockton et al., 2019).

An alternative metaphor with the potential to lead to different insights for a CE is the forest metaphor (Fromberg et al., 2025). This metaphor can be considered part of a broader category of ecological metaphors for a CE, which is considered an enabler for a more resilient CE (Zisopoulos et al., 2025). Given the complexity and the dynamic properties of ecological systems, this cluster of metaphors holds potential for effectively incorporating systemic causation (Lakoff, 2010), which conceptualises outcomes as emerging from the interactions of multiple factors within systems, thereby aligning with principles of systems thinking. Previous studies suggest that engaging with the forest metaphor for a CE can help highlight the holism of the economic system, the importance of relationships between different entities and conceptualise the diversity of change processes that can happen concurrently (Fromberg et al., 2025). Figure 1 shows a comparison of the current dominant CE discourse as per (Fromberg et al., 2023), with the insights that could lead from the forest metaphor for a CE (Fromberg et al., 2025).

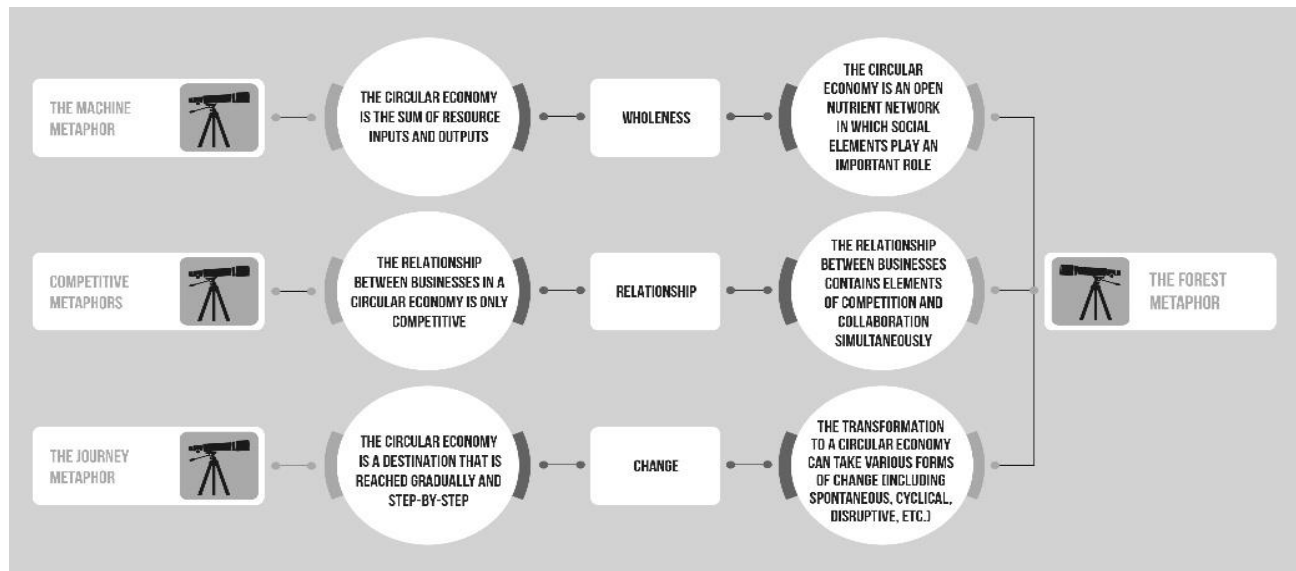


Figure 1 Current dominant CE discourse versus the insights of the forest metaphor for a CE.

To engage with this different, more systemic, conceptualisation of a CE, the authors developed a pedagogical intervention in the form of a learning tool (Appendix 1) that applies Ecological Design Thinking for a Circular Economy in a concrete and tangible way. The tool offers a structured engagement, resulting in ideas and solutions in line with this conceptualisation. It presents 18 subdomains of the forest metaphor, which emerged from prior empirical research (Fromberg et al., 2025) that explored which aspects of a forest ecosystem were perceived as intuitive by business professionals. These intuitively resonant elements were subsequently projected onto CE discourse. It serves as a pragmatic entry point, purposely limited to those subdomains that facilitate engagement with business professionals. The objective of this engagement is for

participants to reflect on their current conceptualisations as well as come up with novel ideas for a CE that are radically different from ideas resulting from current dominant metaphors.

This study investigates the research question: To what extent does the tool for ecological design thinking for a circular economy support participants in obtaining new insights and discoveries? To address this research question, an exploratory comparative case study was conducted. One case study explored participant engagement with the forest metaphor for a CE without the tool, and the other case explored this engagement with the tool. This case study evaluates (1) participants' overall workshop experience, (2) the conceptual impact of engaging with the metaphor by using the tool, (3) whether engaging with the tool led to new insights and discoveries, and (4) the design and the content of the tool.

By exploring how engagement with ecological metaphors, such as a forest, can influence conceptual thinking, this study contributes to both theoretical discussions on CE discourse as well as practical approaches for CE education and pedagogy.

2. Background

2.1. Conceptual Metaphor Theory

Metaphors are often seen as the decoration of a language, but they are much more than that: they are fundamental to human cognition (Lakoff & Johnson, 1980). Kövecses (2016, p.13) explains that metaphors function as a “conceptual tool for structuring, restructuring, and even creating reality”. They not only affect communication but are also deeply integrated into cognitive processes that influence how we think, reason, and form our worldview (Lakoff & Johnson, 1980).

The cognitive basis of metaphor was established by Lakoff and Johnson (1980) in their book *Metaphors We Live By*. In their work on Conceptual Metaphor Theory (CMT), they argue that metaphor is a cognitive phenomenon which influences how humans make sense of abstract ideas by mapping familiar experiences or domains onto more complex or unfamiliar ones. Through a mapping process, CMT shows how people can understand the unfamiliar or more complex domain (the target domain) in terms of another, more familiar one (the source domain) (Lakoff & Johnson, 1980). Conceptual metaphors are typically written in the form TARGET DOMAIN IS/AS SOURCE DOMAIN and are capitalised. Examples of conceptual metaphors are LIFE IS A JOURNEY, ANGER IS FIRE, and THEORIES ARE BUILDINGS (Kövecses, 2016).

One of the main features of conceptual metaphors is their systematicity. For example, in the commonly cited metaphor ARGUMENT IS WAR, elements such as attack, defence and strategy are mapped from war onto the act of having an argument, which shapes how people conceptualise debates (Dancygier, 2016), as shown in Figure 2. Even though conceptual metaphors are systematic, they do remain figurative, and only some of the aspects from the source domain are mapped onto the target domain, not all (Gibbs Jr, 2011).

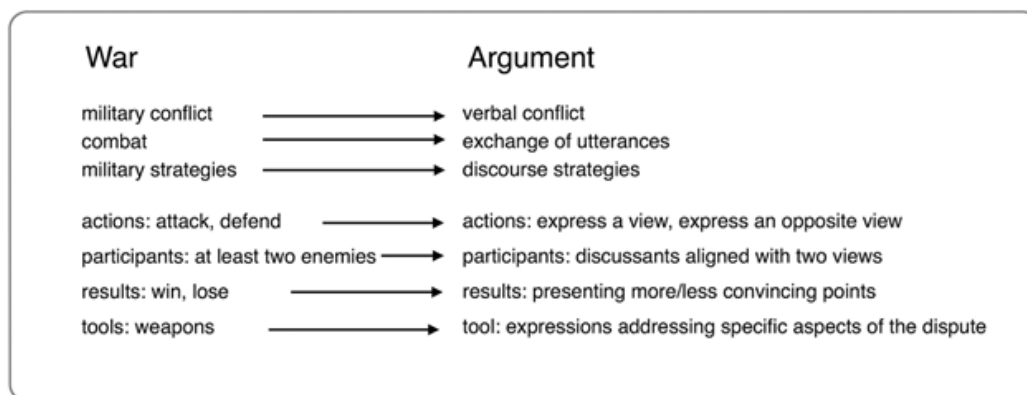


Figure 2 The conceptual metaphor ARGUMENT IS WAR (Dancygier, 2016).

Plato claimed metaphors to be dangerous rhetorical devices for deceiving (Gerhard & Russel, 1984), and Lakoff (2014) has also elaborated on this in the context of American politics and how metaphor is used to deceive and manipulate. However, when used thoughtfully and transparently, metaphors have the potential to be helpful in an educational setting because of their cognitive properties, allowing new concepts to be associated with familiar ones. Aristotle recognised metaphors' pedagogical potential, describing them as valuable tools for discovery and understanding (Kirby, 1997). More recently, metaphors have also been proven to help improve the understanding of abstract concepts in science education (Mayer et al., 1995).

However, in a study from Low et al. (2008), it was found that lectures which actively use metaphors to explore abstract phenomena often fail to explain the role of the metaphor itself. This can cause issues for participants who are not taking part in their first language (Littlemore et al., 2011). It is, therefore, important for teachers and educators to explain explicitly the role of metaphor and the meaning of the metaphors that are used in the learning setting. Even though it requires additional explanation and sufficient linguistic skills from participants who engage outside of their first language, teaching about conceptual metaphors has been proven to promote critical thinking among both native and non-native speakers (Littlemore & Sheldon, 2004).

Besides using metaphors in a reflexive way or to prompt critical thinking, metaphors can also be used to arrive at new ideas and solutions. When that is the case, they are used in a generative way (Schön, 1993). When used generatively, metaphors can support innovation, enabling individuals to see problems and solutions in new ways and explore new lines of enquiry (Lockton et al., 2019). This study evaluates a pedagogical tool for a CE that uses metaphor in both a reflexive and generative way.

2.2. Pedagogical Tools for a CE

In recent years, a growing number of educational tools have been developed to support learning about CE, particularly in business and design contexts. The Ellen MacArthur Foundation, a UK-based charity, provides a wide range of online learning resources, including the *Circular Design Guide*, which offers methods and tools aimed at helping professionals integrate CE principles into business practices (Ellen MacArthur Foundation, 2025).

There are also learning tools developed by academics. Santa-Maria et al. (2022) developed the *Circular Design Sprint*, a design thinking tool for CE education and innovation contexts. As part of the EU-funded Circular X project, Konietzko et al. (2020) introduced *The Circularity Deck*, a card-based tool that helps professionals analyse and develop the circularity potential of their business ecosystems.

More playful and interactive tools have also been introduced. *In the Loop*, one of the earliest CE-focused serious games, is a simulation centred around resource flows and supply chain disruption and resilience (Whalen et al., 2018). *Risk & RACE* is a similar tool, which also includes financial trade-offs in circular strategies from a business perspective (Manshove & Gillabel, 2021). The game *NEXTGEN* focuses on CE in the context of the urban water cycle (Khoury et al., 2023).

While many of these tools focus on business model innovation, resource flows and efficiency, or stakeholder dynamics, none explicitly explore how metaphors shape how a CE is conceptualised. This study builds on CMT and explores the implications of these metaphors as part of a pedagogical tool. Specifically, it examines how the forest metaphor can shape new understandings about a CE.

3. Methodology

Through an exploratory comparative case study, this research compared the results of a 2023 case study (Fromberg et al., 2023b) to the results of the workshop in 2025. The methodology used is an exploratory comparative case study and took a qualitative approach to understand the implications of the forest metaphor and tool in depth (Mill et al., 2009).

A textual analysis by Fromberg et al. (2023a) showed that there is a pattern of dominant metaphors in current CE discourse. However, within this broader pattern, Kirchherr et al. (2023) also found 221 distinct

definitions for a CE. Therefore, it is expected that within the patterns of dominant CE metaphors, the concept of a CE can be understood differently by various stakeholders. Therefore, this research adopts an interpretivist epistemology to acknowledge the subjective and culturally embedded nature of knowledge. It views a CE as conceptually plural, shaped by elements such as conceptual metaphors (McVittie, 2009). An interpretivist epistemology gives space for the researcher to view the world through the lens of the participant and to acknowledge how their perceptions and experiences influence their view (Thanh & Thanh, 2015).

To do so, this study used surveys, which showed the implications of the learning tool and how this changed the participants' perception and their view of a CE (Bartlett & Vavrus, 2017). These surveys were employed for two case studies, each a two-day workshop on systems thinking, organised by the University of Cambridge Institute for Sustainability Leadership. The first case study took place on 27-28 February 2023, and the second on 10-11 March 2025. The workshop design, facilitators and workshop facilities were the same across both case studies. The cohort size was 36 in 2023 and 21 in 2025.

The first morning of the course provided lectures on systems thinking, CE and how metaphors influence patterns of thought. The first afternoon was centred around a 2.5-hour workshop on Ecological Design Thinking for a Circular Economy – this session is the scope of this research. The purpose of the inclusion of this session in these workshops was to support the change from thinking through direct causality towards systemic causality. The second day of the workshop was centred around dimensions that are considered out of scope for this research.

3.1. Participant Recruitment

Before the workshop, all potential participants received the opportunity to sign up for the study voluntarily and complete their pre-programme survey. They were presented with a consent form before completing the pre-programme survey (Appendix 2). All participants who completed the consent form, the pre-programme survey and the workshop were sent the post-programme survey (Appendix 3).

This study also includes the perspective of the facilitator through a post-programme survey after the 2025 workshop. The facilitators delivered both the 2023 and the 2025 workshops, and the authors of this study were excluded from the facilitator survey. This resulted in the inclusion of three facilitators.

3.2. Overview of Participants

In the first workshop in 2023, there were 36 participants enrolled in the workshop. 19 of them signed up for the study, completed the pre-programme survey, the workshop and the post-programme survey. An overview of the participants is presented in Table 1.

Table 1. Overview of participants of the 2023 workshop.

Number	Age	Sector	Self-reported familiarity with CE and CE competencies
23.1	50s	Business	Competent
23.2	40s	Business	Beginner
23.3	30s	Business	Moderate
23.4	30s	Business	Moderate
23.5	40s	Business	Competent
23.6	40s	Policy making	Beginner
23.7	20s	Business	Moderate
23.8	40s	Business	Moderate

Table 1 (Cont.). Overview of participants of the 2023 workshop.

Number	Age	Sector	Self-reported familiarity with CE and CE competencies
23.9	30s	Policy making	Moderate
23.10	50s	Finance	Moderate
23.11	20s	Education	Moderate
23.12	40s	Business	Competent
23.13	40s	Business	Moderate
23.14	50s	Consultancy	Expert
23.15	20s	Academia and Research	Competent
23.16	40s	Consultancy	Moderate
23.17	30s	Academia and Research	Competent
23.18	50s	Business	Moderate
23.19	50s	Business	Competent

The second workshop, in 2025, had 21 participants enrolled, of whom 16 participants signed up for the study, completed the pre-programme survey, the workshop and the post-programme survey. An overview of these participants can be found in Table 2.

Table 2. Overview of participants of the 2025 workshop.

<i>Number</i>	<i>Age</i>	<i>Sector</i>	<i>Self-reported familiarity with CE and CE competencies</i>
25.1	20s	Business	Moderate
25.2	20s	Coaching	Competent
25.3	40s	Education	Expert
25.4	50s	Academia and Research	Moderate
25.5	40s	Business	Competent
25.6	60s	Education	Moderate
25.7	50s	Business	Moderate
25.8	50s	Academia and Research	Competent
25.9	50s	Business	Moderate
25.10	50s	Business	Moderate
25.11	50s	Business	Competent
25.12	40s	Business	Competent
25.13	40s	Business	Moderate
25.14	40s	Academia and Research	Competent
25.15	40s	Business	Competent
25.16	40s	NGO	Beginner

Even though two different cohorts of participants engaged in the workshop across the two years, most of the participants stated that they were in their 30s, 40s, and 50s and work in business. Also, the level of familiarity and competencies related to CE is similar across the two cohorts.

As part of the 2025 sample, facilitators (Table 3) were asked to complete a post-programme survey and share their insights. The facilitators were involved in both the 2023 workshop and the 2025 workshop.

Table 3. Overview of the facilitators

Number	Sector	Self-reported familiarity with CE and CE competencies
F1	Academia	Expert
F2	Education	Expert
F3	Business	Expert

3.3. Workshop Design

A pre-workshop activity or “homework” before a workshop or lecture has proven to have a positive effect on overall learning (Yumusak, 2020). Therefore, the workshop required the participants to complete a pre-workshop activity called “Wide Angle Vision”, where they were asked to visit a forest, woodland, or other local natural ecosystem and observe its wholeness. At the beginning of the workshop, the participants were invited outside, in a woodland area, again, to make additional observations prior to the engagement with the tool. This allowed the participants and faculty members to activate any latent knowledge that they had about a forest.

After the completion of the Wide Angle Vision exercise, they were invited back to the plenary room, where they were placed in breakout groups, each with a facilitator. Upon arrival, they were asked to complete a worksheet, as per Figure 3, and present back to their breakout group how they believe (part of) a forest works. This exercise would reveal to the facilitator what potential source domains this group finds particularly intuitive.

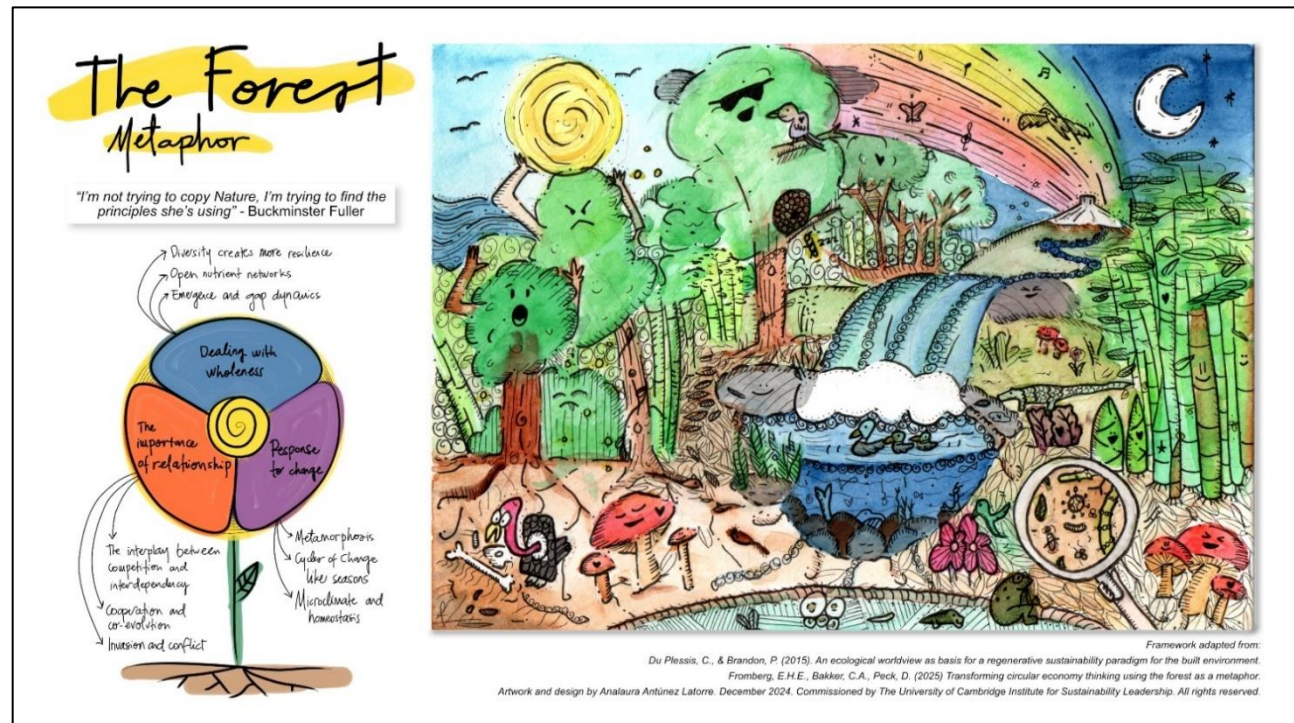


Figure 3. The worksheet used after Wide Angle Vision by Antúnez Latorre (2025). The participants were instructed to make notes on “how they believe (part of) a forest works.”

After the engagement with the worksheet, the participants were directed to the 18 cards that each of them had in front of them. All groups engaged in the same first card: Open Nutrient Networks. This card was used to explain the design of the tool. The complete tool can be found in Appendix 4.

The first part of each card is dedicated to a reflection completed individually and in silence, as shown in Figure 4. The purpose of this part is to activate the source domain of the metaphor. This part shows a written prompt with information about a forest that was considered intuitive by sustainable business professionals in Fromberg et al. (2025).

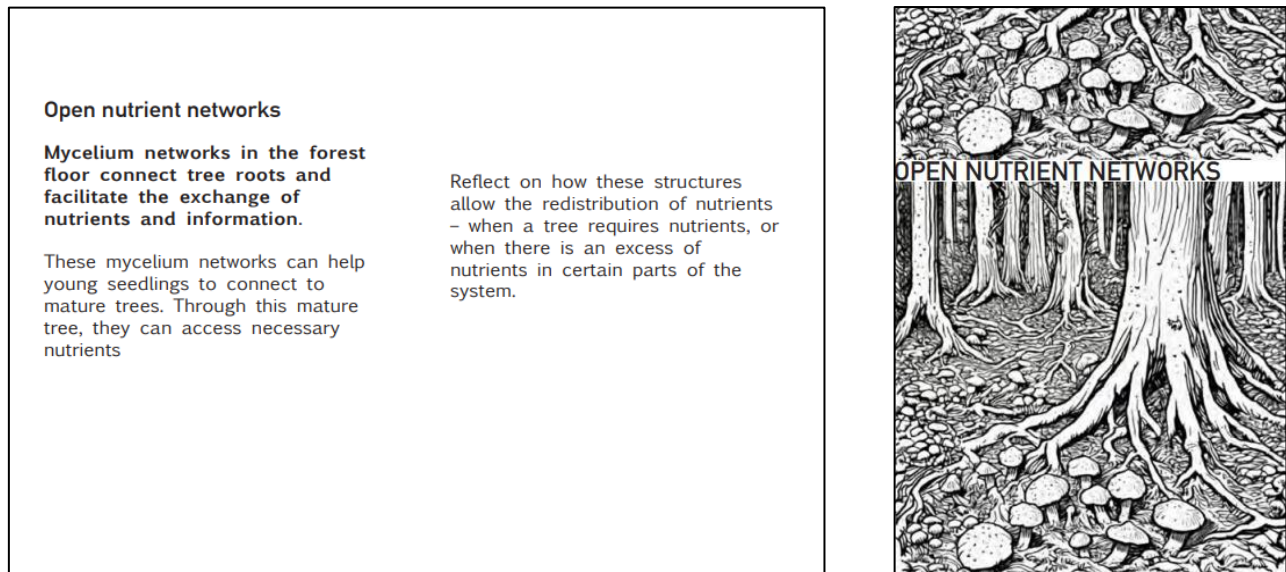


Figure 4. Open Nutrient Networks Card, the front of the card and stage one: metaphor activation.

The second stage presents a prompting question that asks the participants how they can relate the insights from the source domain to circular business discourse, the target domain, as shown in Figure 5. To allow for more inspiration, suggestions are given, including a real-world example.

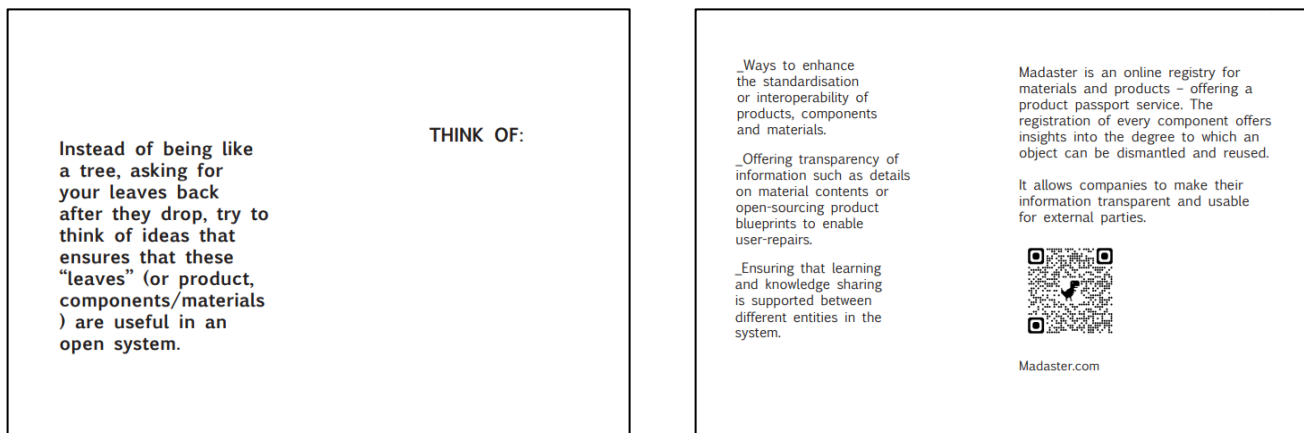
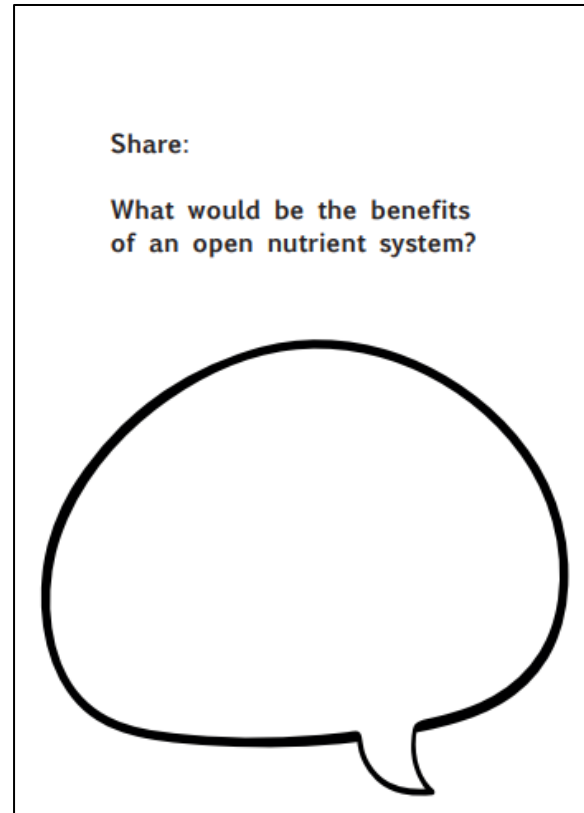


Figure 5. Open Nutrient Networks Card, the second stage, where the source domain is related to the target domain.

Finally, at the back of the card, as per Figure 6, a broader question is presented that allows for dialogue between the different participants.

Figure 6. Open Nutrient Networks Card, the final stage, including a prompt for a group dialogue.



After the completion of the first card, the facilitator directed the group to the next card. This same process was repeated with the other cards. This process continued for approximately 1 hour and 45 minutes. Finally, the workshop was brought back into the plenary and wrapped up by the main facilitator. This part consisted of a facilitated dialogue about the three components of the forest metaphor: dealing with wholeness, the importance of relationship, and the response to change (Du Plessis & Brandon, 2015; Fromberg et al., 2025).

The total workshop lasted 2.5 hours (including the activation exercise and the wrap-up). After the workshop, participants and facilitators were asked to complete the post-programme survey.

3.4. Data Collection and Analysis

In total, two surveys were conducted as part of the 2023 workshop: a participant pre-workshop and post-workshop survey. As part of the 2025 workshop, three surveys were conducted: a participant pre-workshop and post-workshop survey, as well as a facilitator survey (Appendix I) conducted after the workshop. All surveys included both closed- and open-ended questions.

The surveys were presented through Qualtrics and Google Forms, and participants were given a participant number to collect pseudonymised data from the start. The insights were analysed manually using Microsoft Excel.

Frequencies and percentages were used to analyse the closed responses. For the open-ended questions, a qualitative analysis was conducted to identify recurring patterns. All answers to open questions were coded and clustered around themes. The patterns and quotes provided illustrative insights, offering a descriptive understanding of how participants experienced the tool.

Four dimensions were measured across the surveys: (1) participants' overall workshop experience, (2) the conceptual impact of engaging with the metaphor by using the tool, (3) whether engaging with the tool led to new insights and discoveries, and (4) the design and the content of the tool. A summary of constructs and measures can be found in Table 4.

Table 4. Summary of constructs and measures.

Dimension	Item Type	Example Question	Theoretical Foundation												
Workshop experience	Likert scale and open questions	How would you rate the overall learning experience of the workshop: <ul style="list-style-type: none"> ○ Very negative ○ Somewhat negative ○ Neutral ○ Somewhat positive ○ Very positive 	Developed by the author.												
Conceptual impact	Multiple choice questions with experimental sentences and open questions	How did the workshop affect your understanding of a circular economy? <ul style="list-style-type: none"> ○ It deepened my understanding of a circular economy. ○ It changed my understanding of a circular economy. ○ It did not affect my understanding of a circular economy. ○ Other: <input style="width: 50px; height: 15px;" type="text"/> 	Posner et al. (1982) Piloted experimental sentences by the authors.												
Fruitfulness of the new conceptualisation	Likert scale questions, multiple choice questions and open questions	Please rate the statement below: "I will be able to implement some of the insights from the forest metaphor in my profession, business or organisation."	Posner et al. (1982)												
Tool design and content	Likert scale questions and open questions	Please evaluate the following statements: <table style="margin-left: auto; margin-right: auto; border: none;"> <tr> <td style="padding: 0 10px;">Disagree</td> <td style="padding: 0 10px;">Neutral</td> <td style="padding: 0 10px;">Agree</td> </tr> </table> <ul style="list-style-type: none"> The visual design of the cards was clear and supportive in the activity. <table style="margin-left: auto; margin-right: auto; border: none;"> <tr> <td style="padding: 0 10px;">○</td> <td style="padding: 0 10px;">○</td> <td style="padding: 0 10px;">○</td> </tr> </table> The time given for each activity was sufficient. <table style="margin-left: auto; margin-right: auto; border: none;"> <tr> <td style="padding: 0 10px;">○</td> <td style="padding: 0 10px;">○</td> <td style="padding: 0 10px;">○</td> </tr> </table> The cards sparked inspiration and new ideas. <table style="margin-left: auto; margin-right: auto; border: none;"> <tr> <td style="padding: 0 10px;">○</td> <td style="padding: 0 10px;">○</td> <td style="padding: 0 10px;">○</td> </tr> </table> 	Disagree	Neutral	Agree	○	○	○	○	○	○	○	○	○	Tahir & Wang (2020)
Disagree	Neutral	Agree													
○	○	○													
○	○	○													
○	○	○													

4. Results

The surveys revealed a variety of insights related to the workshop experience, the effects on the understanding of a CE, the conceptual accommodation and the tool design.

4.1. Workshop Experience

The comparative elements of this case study are visualised in percentages, in which the number of participants included in the 2023 study is 19 and in the 2025 study is 16. As shown in Figure 7, the overall workshop experience in 2025 was more positive compared to the one in 2023.

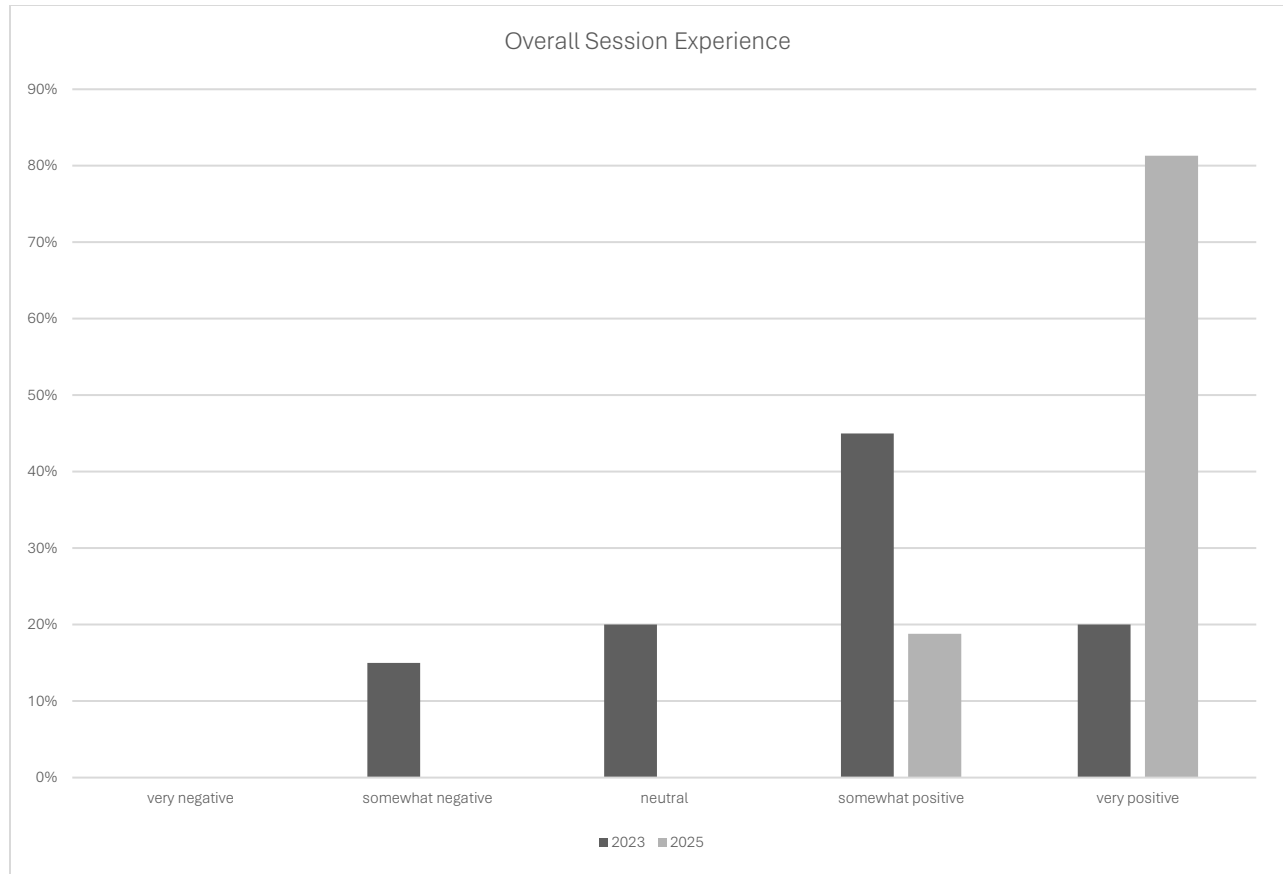


Figure 7. The overall session experience.

Most participants rated their experience as either “somewhat positive” or “very positive”, indicating a generally positive reception of the workshop. In an optional open question, participants were asked to elaborate on this. A participant of the 2025 workshop reflected: “I think this was a very powerful learning experience, and the cards are a highly innovative artefact.”

The facilitators rated the overall experience of delivering the workshop as very positive (by 2) and somewhat positive (by 1). They were asked to provide their reflections on the content and the design of the cards through an open question. One facilitator elaborated: “The setup creates a clear connection through metaphor from the forest to the CE, which allowed for relational thinking to become the foreground and enabler of circular thinking.”

4.2. Effects on the understanding of a CE

In both pre-programme surveys, the participants were asked to select a so-called experimental sentence to express what kind of conceptualisation resonated most with them. There were multiple sentences proposed, containing competitive metaphors and ecological metaphors. The outcomes are visualised in Figure 8 and show a similar composition across both cohorts, each with 3 participants selecting a competitive metaphor and 16 (2023) and 13 (2025) selecting an ecological metaphor.

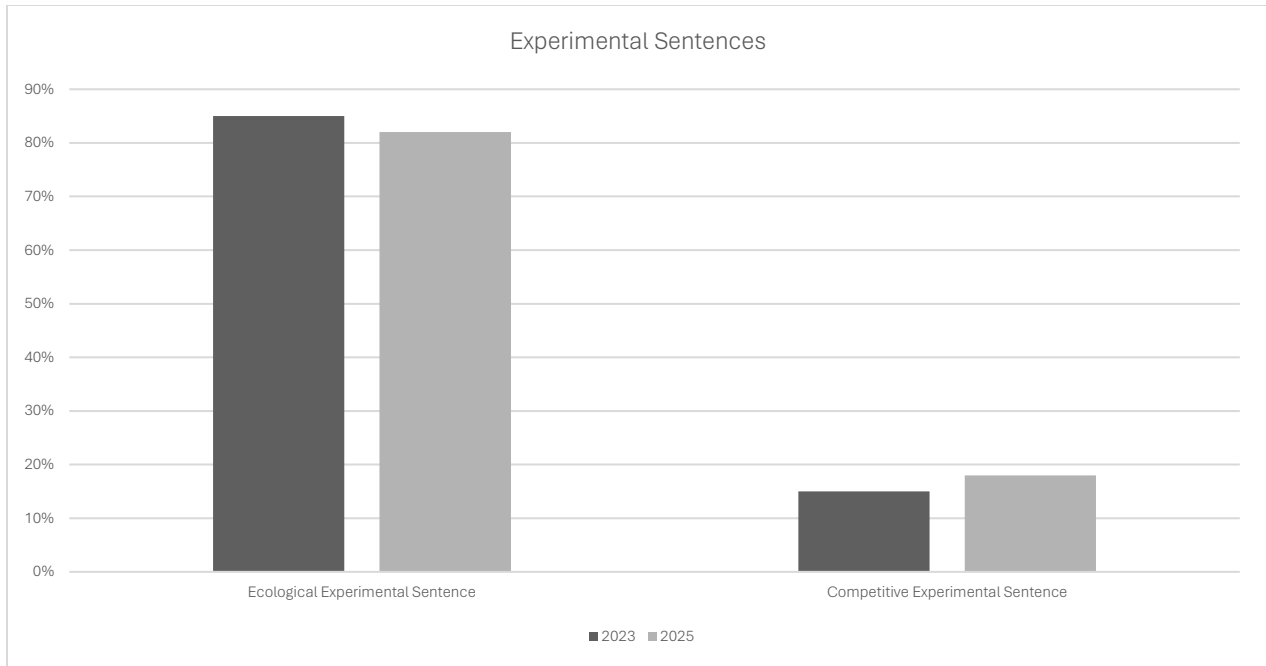


Figure 8. A comparison of the selection of experimental sentences across the two workshops.

The most often selected experimental sentence was: “By implementing a circular economy, businesses can create a flourishing ecosystem to thrive in.” This indicates that most of the participants across both workshops found an ecological conceptualisation of a CE somewhat natural before engaging with the tool.

When asked how the workshop affected their understanding of a CE, the participants replied similarly across both workshops, as shown in Figure 9.

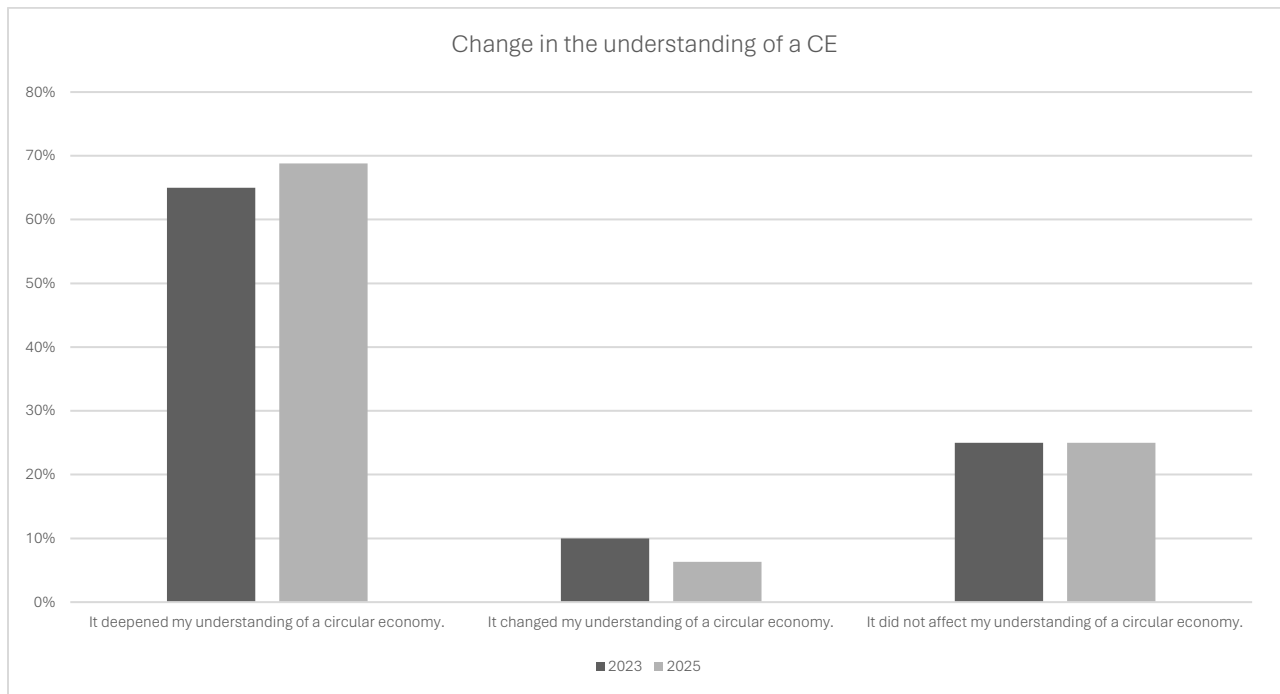


Figure 9. Change in the understanding of a CE.

Most of the participants experienced a deepening of their understanding of a CE: 65% (13) of the participants in 2023 selected this, compared to 68.8% (11) of the participants in 2025.

4.3. Conceptual Accommodation

This study evaluates the success of engagement with the metaphor and the tool specifically through four conditions for conceptual accommodation by Posner et al. (1982), which include:

1. Intelligibility – whether the new concept is understandable.
2. Initial plausibility – whether the new concept seems reasonable.
3. Dissatisfaction with the old concept – whether the participants recognise the limitations in their existing concepts.
4. Fruitfulness – whether the new concept leads to meaningful new insights and discoveries.

It was concluded that the first three conditions were met after the 2023 workshop; however, the fruitfulness condition at that time was insufficiently met (Fromberg et al., 2023b). At that stage, without the tool, participants were only able to generate more abstract solutions that were perceived as incompatible with the competitive nature of businesses (Fromberg et al., 2023b).

This part of the study assesses whether participants were more able to come up with new insights and discoveries through their use of the tool. This would mean that they would consider the conceptualisation more fruitful.

First, the participants were asked to express whether they felt a tension between the insights from the forest metaphor and the reality of businesses and organisations. The result is shown in Figure 10, which compares the results from the 2023 workshop to the 2025 workshop.

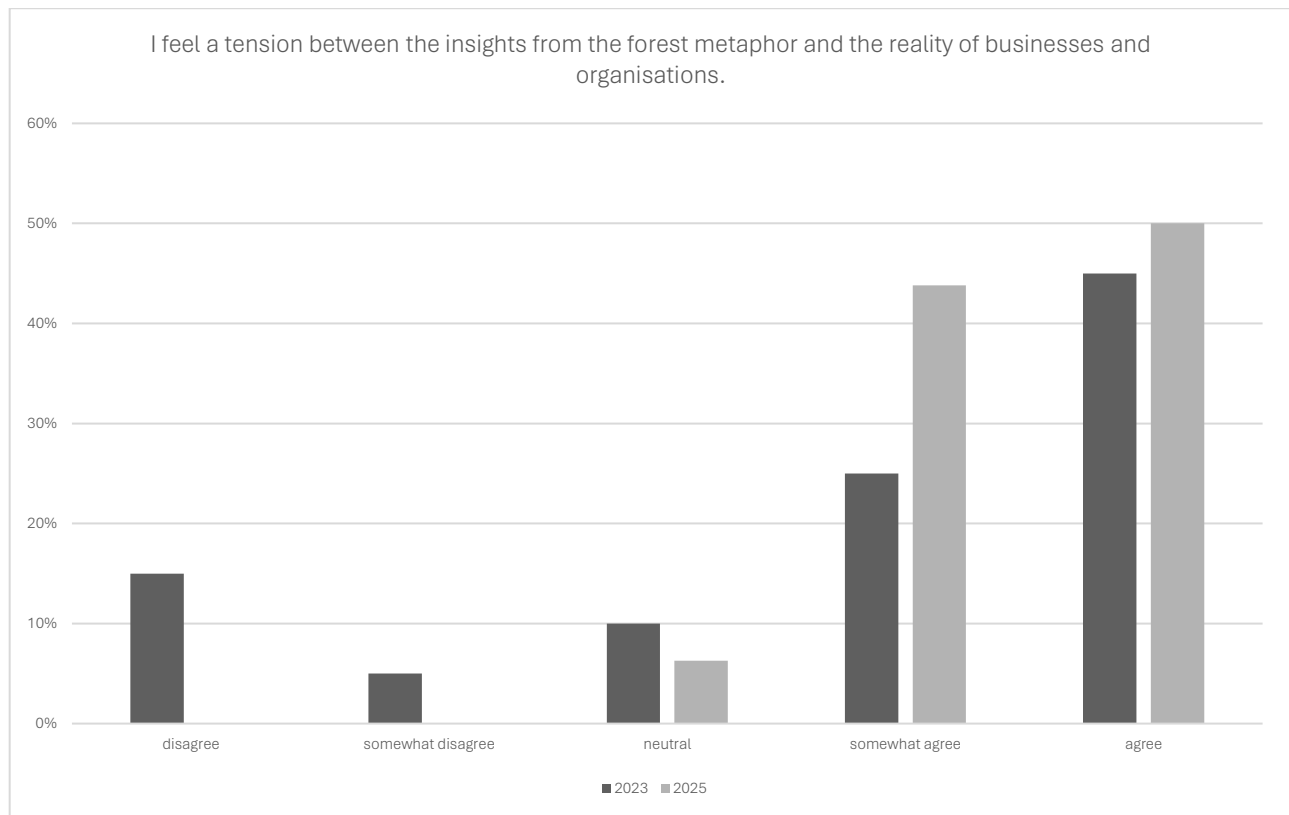


Figure 10. The use of the tool caused increased tension between the insights from the forest metaphor and the reality of businesses and organisations.

This shows an increase in tension between the insights from the forest metaphor and the reality of businesses and organisations. Together with this increased tension, the participants also found the metaphor more enriching compared to the 2023 workshop, as shown in Figure 11.

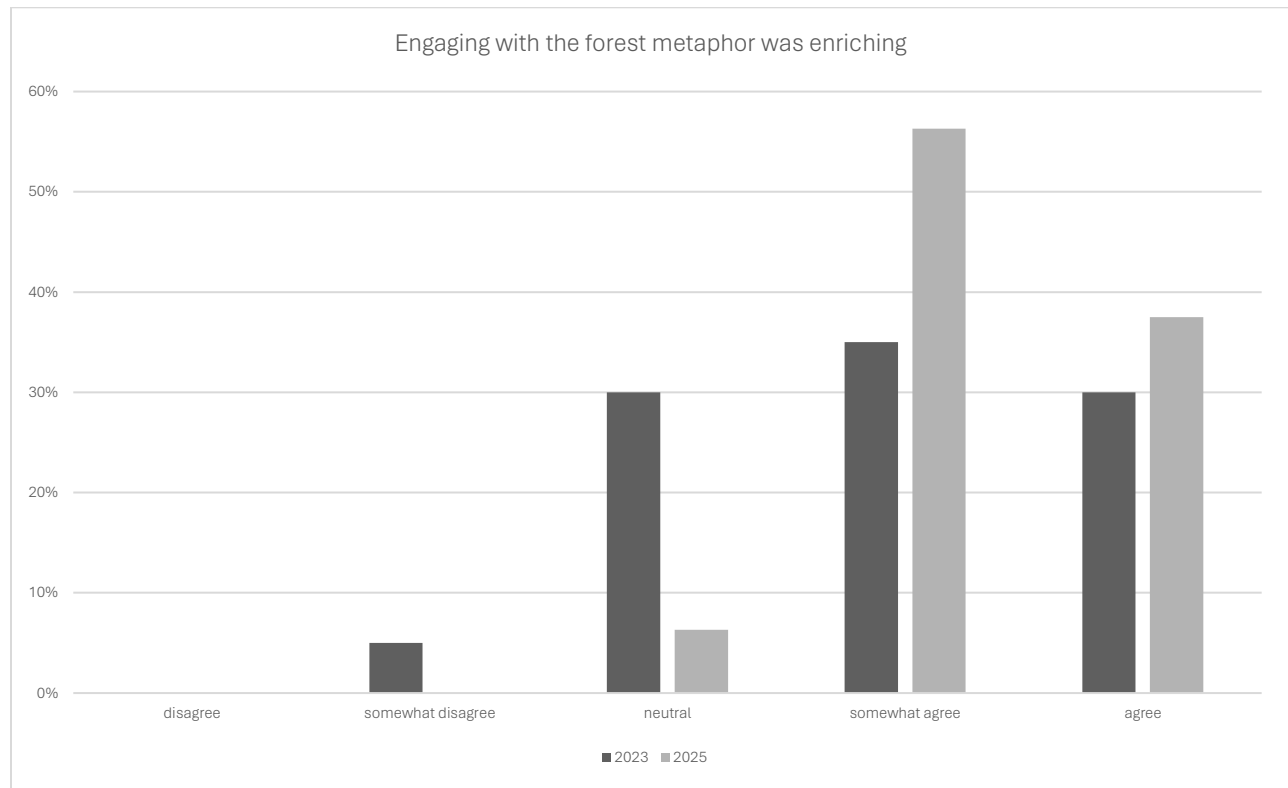


Figure 11. The use of the tool made the engagement with the forest metaphor more enriching.

During the open questions, participants were asked about the types of ideas that were discussed during the workshop. They were also asked to elaborate on what they consider realistic ideas to implement in a business and what they consider unrealistic to implement. Therefore, the open questions offer anecdotal evidence on the engagement with the metaphor.

The first card that was used by all groups related to open nutrient networks, which prompted reflections related to increasing utilisation of materials, components and products, as well as more flexible ways of evolving or reutilising these. Through this card, intellectual property rights were considered one of the key barriers to more open nutrient networks in a CE.

There was also dialogue about the role of the financial industry, and a need was expressed by one of the groups to create a card that explicitly refers to the extractive nature of financial services industries. Participants suggested that the source domain of a parasite would be appropriate for this. This resonates with the work from Michael Hudson (2015). In his book, *Killing the Host*, he argues that the finance, insurance and real estate sectors have gained control of the “economy’s brain” and are now favoured over the real economy of labour and production.

Other reflections were made on the current lack of “decomposers” in the system, referring to smaller-scale, more opportunistic entities that use what is available. These entities are also described as “gap exploiters” by Bakker et al. (2014). There was also an emphasis on infrastructure and assets that could be considered the commons, such as community-owned material banks.

The facilitators were also asked about what, in their opinion, the most interesting idea was that surfaced during the engagement with the tool:

- Facilitator 1: “[...] revealing additional possibilities through repair networks and skill shares that interwove pro-circular behaviours across communities”
- Facilitator 2: “The idea [...] that we were going to be a components company which allows local people to assemble and repair.”
- Facilitator 3: “The shift to an open-source company.”

Overall, the insights suggest that the participants were able to arrive at more concrete insights and discoveries with the use of the tool.

4.4. Tool Design

In the 2025 workshop post-programme survey, both the participants and facilitators were asked to rate the design and the content of the cards specifically. For the assessment of the tool design, the data of the participants and the facilitators were merged, resulting in 19 respondents for these questions. The result is presented in Figure 12 and shows that overall, the design and the content of the cards were experienced very positively.

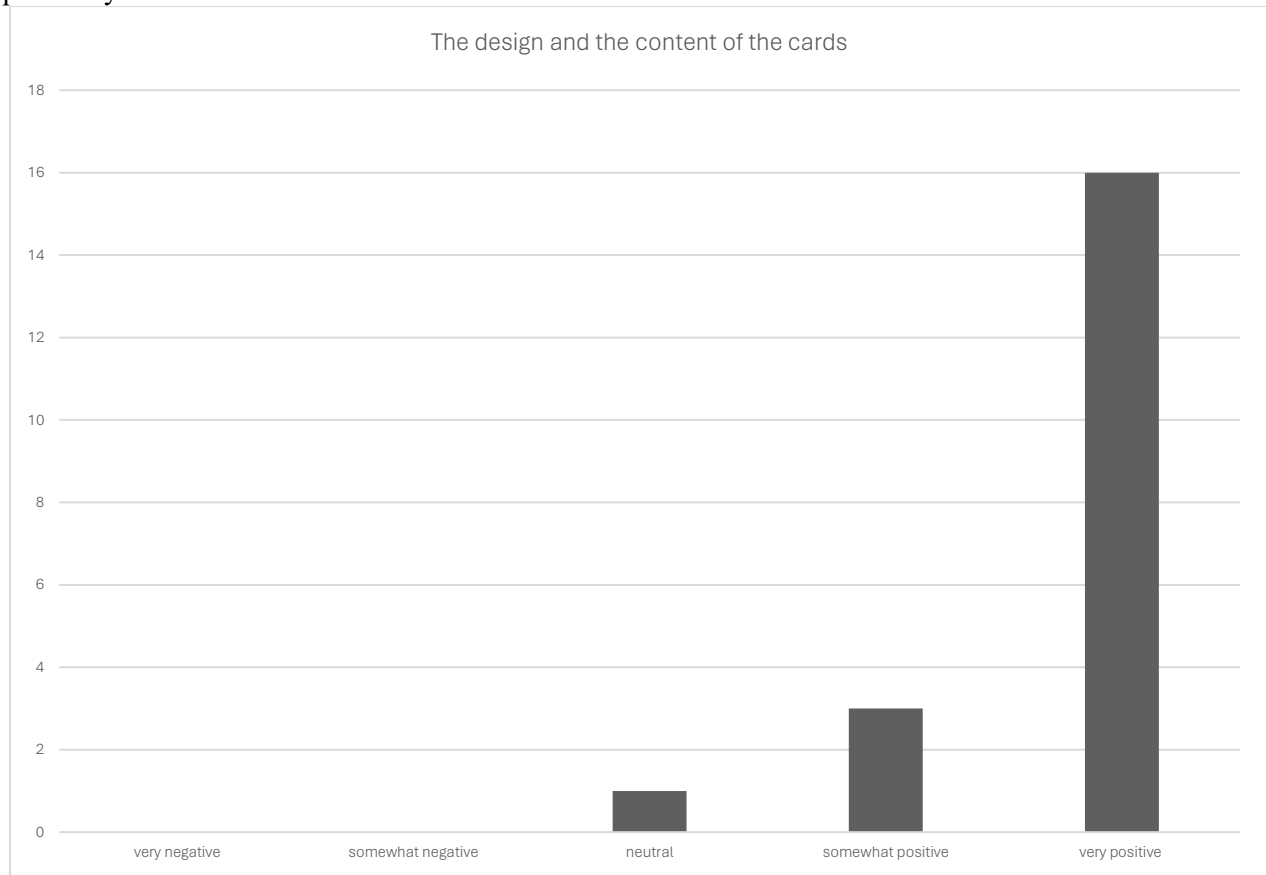


Figure 12. The rating of the design and content of the cards by the participants and facilitators.

The effectiveness of the tool has been evaluated according to adapted criteria for learning design by Tahir & Wang (2020), in which (1) Enjoyment, (2) Satisfaction, (3) Understandability, and (4) Usefulness are evaluated. For each criterion, both the participants and facilitators rated three sentences. The results are presented below in Figure 13.

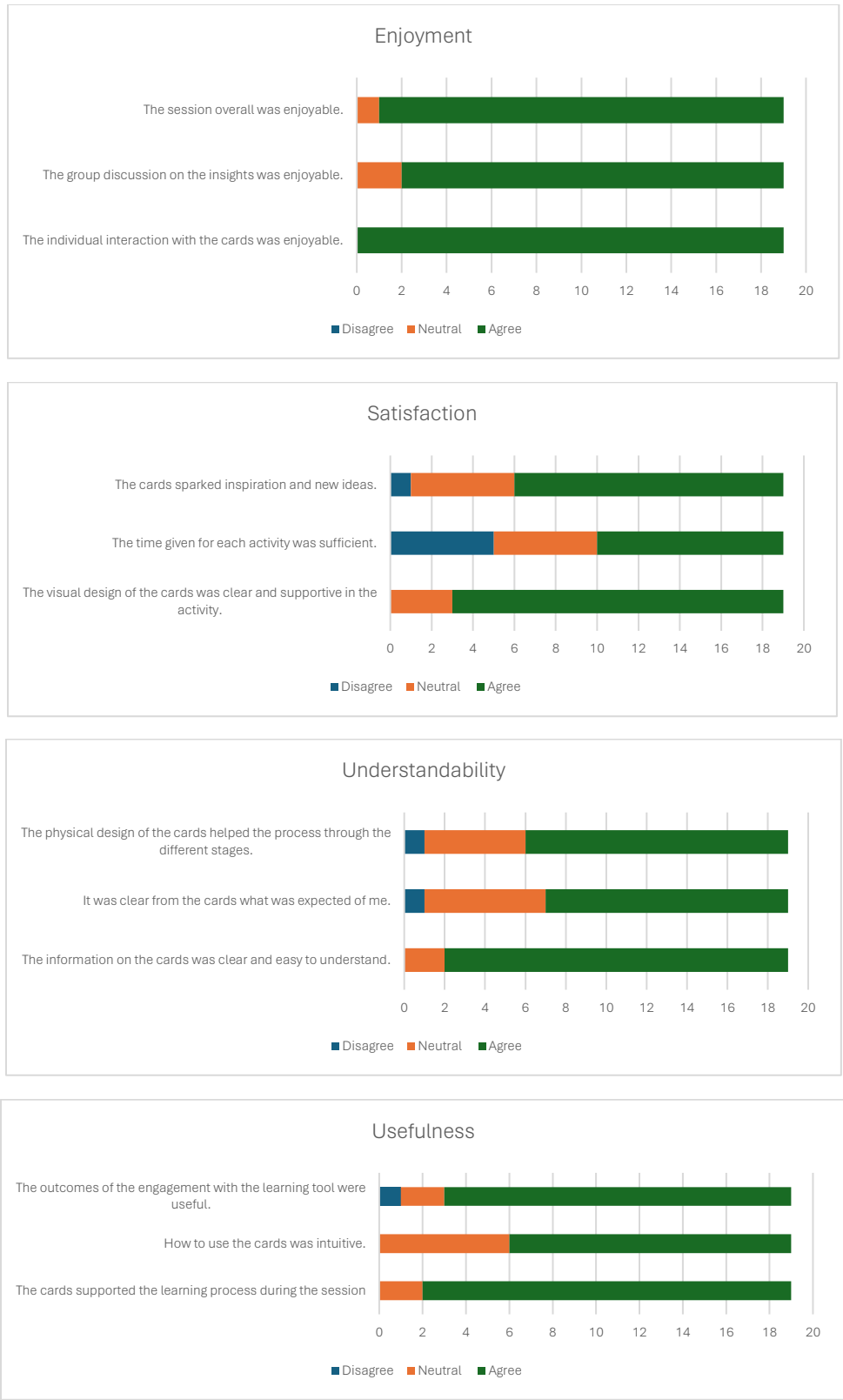


Figure 13. The effectiveness of the learning design according to criteria adapted from Tahir & Wang (2020).

Overall, the learning design scored positively across all criteria. The criterion “Enjoyment” scored most positively, whereas “Satisfaction” was rated lowest, mostly due to insufficient time given for the activity.

Although the tool was used and presented in a formal learning setting, the different cards were designed to be printed off a regular printer, therefore reducing costs and making it more viable to allow learners to take them with them after the workshop. A participant of the 2025 workshop reflected on this: “Following the workshop, I had a chance to further review the cards. There is a lot of rich content and I’m looking forward to seeing how we can apply this to specific challenges linked to our business.”. Together with the consensus that 2.5 hours was too little time for this activity, this shows the value of a post-workshop individual engagement with the tool.

5. Discussion

After the 2023 workshop, it was determined that all conditions for conceptual accommodation were met except for one: the fruitfulness of the conceptualisation of a circular economy as a forest. This refers to whether the new concept leads to meaningful new insights and discoveries (Posner et al., 1982). The tool was designed after the 2023 workshop and aimed to resolve the tension between the forest metaphor’s insights and the reality of businesses and organisations. It was expected that, through the tool, breaking up the heuristic of the forest metaphor into more digestible subdomains would reduce the tension by allowing participants to come up with more concrete and tangible ideas, leading towards meeting the final condition for conceptual accommodation (Fromberg et al., 2023b). The workshops were, in general, positively received by both participants and facilitators.

The participants were able to come up with more detailed and concrete ideas when engaging with the tool. The workshop was considered more enriching with the tool, compared to without the tool. However, rather than reducing it, engagement with the tool amplified the tension between the insights of the forest metaphor and the reality of businesses and organisations. While this increased tension could have led to resistance or disengagement, participants received it positively, suggesting that it was seen as thought-provoking. This finding could have important implications for CE teaching and learning. It suggests that this discomfort and tension could play a constructive role in learning and critical thinking rather than being perceived as an obstacle. This tension allowed the participants to reflect on current economic structures and re-evaluate their assumptions critically.

This challenges the notion that learning should be centred around learner comfort. Kavedzija (2019) describes this experience as learning discomfort and states that the role of the facilitator or teacher should be to find the optimal level of challenge. Vygotsky (1978) refers to this same phenomenon as the zone of proximal development. Conceptually, this aligns with the Goldilocks principle, which is commonly invoked across disciplines to describe the optimal conditions that are neither excessive nor insufficient. This type of approach also challenges the idea of seeing a learner as a customer to be satisfied (Kavedzija, 2019). McLay et al. (2023) explain that, especially for 21st-century challenges, teachers need to actively create room for such discomfort in the learning process. Ness & Riese (2015) elaborate that meaning, knowledge, and creativity emerge in the tension of different perspectives. In this case, that would be the contrast between the insights of the forest metaphor and the reality of the current linear economy.

Since, within this tension, the tool enabled the participants to generate clearer insights and more concrete discoveries, it appears to have made the forest metaphor more fruitful compared to engagement with the metaphor without the tool, meeting all four conditions for conceptual accommodation by Posner et al. (1982).

The main source of dissatisfaction with the tool among some participants and facilitators was the limited time available for the engagement. The 2.5-hour session did not allow enough time for satisfactory engagement, and several participants expressed that continuing to engage with the tool after the formal workshop session was beneficial to them. This suggests that incorporating a post-workshop individual reflexive exercise into future sessions could extend the learning process flexibly.

This study considers conceptual change as a precursor to a CE that works in a radically different way compared to the current linear economy. From a pedagogical perspective, the goal is not to prescribe action, but to support participants in rethinking the dominant assumption that may influence the solutions that they can come up with. In some cases, it may empower individuals to better advocate for regenerative ideas or recognise where their thinking aligns with ecological metaphors. However, the decision to act on these insights remains with the learner, always.

There are several limitations to consider when interpreting these findings. First, all participants who signed up for the study indicated a prior openness to an ecological conceptualisation of a CE. This suggests they may have been predisposed to engage with the forest metaphor more positively. Additionally, all participants met the main researcher during the workshop and were aware that they had designed the tool, which may have influenced their responses. However, as this was also the case for both the 2023 and the 2025 workshop, any potential bias would likely be present in both data sets, allowing for a comparable analysis. The language levels of the participants were not considered fully in this research. Also, during the 2025 workshop, the facilitators were more experienced with running an interactive session of this nature, which could have also impacted the more positive rating for this workshop.

This study explores the implications of the engagement with a relatively novel metaphor for CE discourse: an ecological metaphor. To understand its implications, the forest metaphor is employed as a figurative construct, intended as a pedagogical tool. It does not attempt to provide an exhaustive account of forest ecology. Its purpose is to serve as a heuristic that facilitates potentially novel understandings.

However, like any metaphor, the cluster of ecological metaphors can also bring a series of limitations (Lakoff, 2014). The absence of a singular, governing agent within a forest reflects its inherent wilderness. It is a notable limitation when deploying this metaphor onto CE discourse, since the role of the government is not conceptualised. Liu and Hanauer (2011) suggest the garden metaphor to cover this specific subdomain. Hodgson (1993) also identifies a significant limitation of employing “natural metaphors”: framing something as “natural” can render it unquestionable or inevitable, which could allow it to hide an ideological agenda.

6. Conclusion

This research aimed to address the research question: To what extent does the tool for ecological design thinking for a circular economy support participants in obtaining new insights and discoveries? The study conducts an exploratory comparative case study that analyses participant responses from two workshops held in 2023 (without the tool) and 2025 (with the tool).

This research found that the participants’ overall engagement with the forest metaphor was more positive with the tool. The engagement in 2023, without the tool, met three out of four conditions for conceptual change: (1) intelligibility, (2) initial plausibility and (3) dissatisfaction with the old concept. However, the fourth condition, “fruitfulness”, was insufficiently met and refers to whether the new concept leads to meaningful new insights and discoveries. The engagement with the tool led to more specific and concrete solutions. In addition, the participants reported a more enriching experience compared to the 2023 workshop and an increased tension between the insights from the forest metaphor and the reality of their businesses and organisations. This suggests that their engagement with the tool contributed to a more fruitful conceptualisation of the forest metaphor for a CE, meaning that it led to meaningful new insights and discoveries.

Beyond the impact on CE education, this study emphasises the potential of ecological metaphors in shaping CE discourse. While ecological metaphors have been used in mainstream CE discourse to understand certain themes of a CE, this study shows that the forest metaphor could challenge certain aspects of the broader mainstream understanding of a CE. It especially prompted critical reflection on the competitive nature of business and intellectual property rights, opening conversations about collaborative and open approaches in business. In a generative way, the metaphor allowed participants to focus on more community-led and place-based approaches to innovation, which allows businesses to tune in more to the context surrounding their supply chain and business model and consider both social and environmental dimensions simultaneously.

There is significant potential to further develop and refine the tool. First, there is a clear need for expanding the tool, considering elements of the forest metaphor that would allow participants to make sense of financial systems. In addition, future research could also draw insights from other ecosystems beyond a forest, such as rivers, meadows and the tundra. Also, this tool has the potential to be used on an individual level as well as in a group setting. Therefore, further development to make this tool more available for individual participants would increase its impact.

Ultimately, this research reinforces that metaphors are not merely the decoration of language but can also be a powerful learning tool. This can be used in a reflexive way, by challenging previously unquestioned assumptions, or in a generative way, by allowing new ways of thinking and developing novel solutions.

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Author Contributions **E.H.E. Fromberg:** Research design, decisions around methodology, data collection and analysis, the interpretation of the data, piloting of different approaches, writing the paper, workshop design and tool design. **C.A. Bakker:** Research design, decisions around methodology, data collection and analysis, the interpretation of the data, supervision of E.H.E. Fromberg. **D.P. Peck:** Research design, decisions around methodology, data collection and analysis, the interpretation of the data, supervision of E.H.E. Fromberg.

Data availability statement Anonymised and redacted data is available upon request.

Declarations

Competing interests The authors declare no competing interests.

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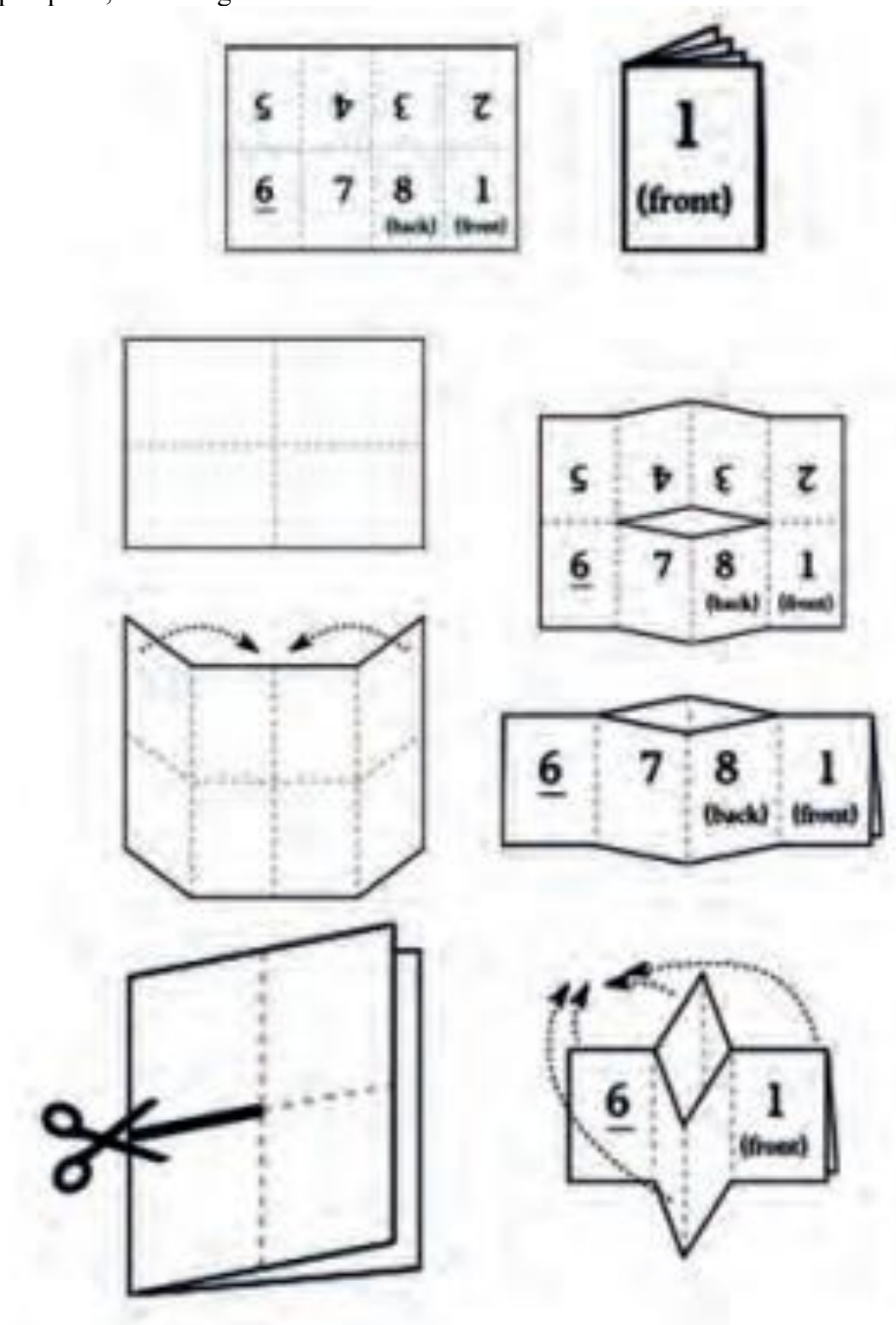
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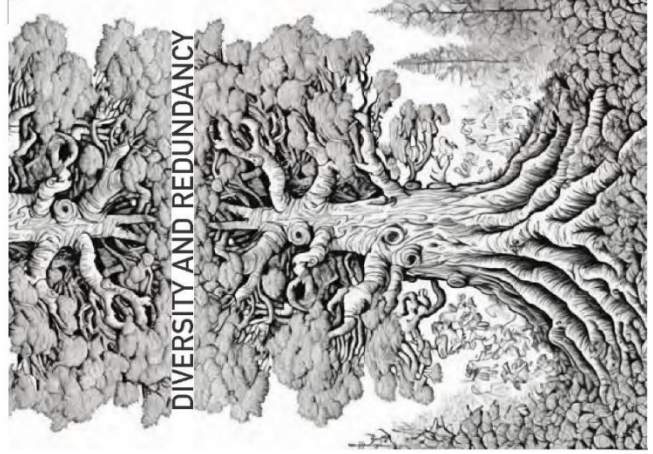
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Appendix 1

This is the learning tool that was used during the 2025 workshop. All pages can be printed on A4 and folded as an origami pamphlet, following the instructions below:



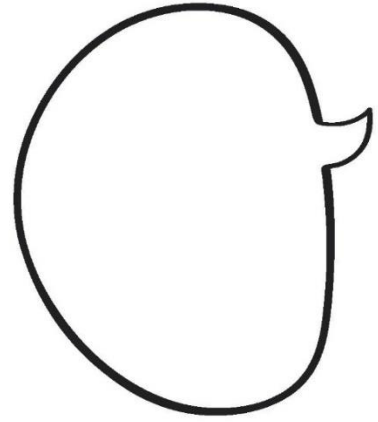


2

Diversity and redundancy

Diversity can lead to functional redundancy where multiple entities fulfil the same role in the ecosystem – such as the many leaves on one tree. If some are lost due to a disruption, there may be enough left to maintain functions.

Another way how diversity contributes to the resilience of a forest is in a complementary way where entities are slightly different and therefore dependent on, for example, different resources.



What features could contribute to a diverse, resilient and healthy economic ecosystem?

Share:

8

7

3

4

Think of an example of diversity in a forest and reflect on how this contributes to the overall health and resilience of the wider economic ecosystem.

Reflect on how your business contributes to a diverse, resilient and healthy ecosystem.



Southwestenglandfibreshed.co.uk

Southwest England Fibreshed is part of a global movement of regional clothing producers. Each “Fibreshed” creates its own local textiles system that relies on the strengths of the local community and the availability of infrastructure and resources. The Southwest England Fibreshed focuses a wool-economy. All the different Fibresheds work together by sharing their learnings with the wider community and offering their advice and experience

Are you able to use a diversity of inputs?
 How flexible is your business model? Are there elements that have a variety of purposes that they fulfil (healthy redundancy)?
 Is there spare capacity available in case of disruption (for example disruption in the supply chain)?
 Are the people in your ecosystem building diverse sets of skills and capabilities?

5

9

THINK OF:

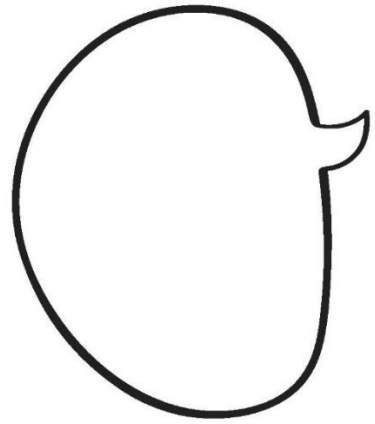


2

Open nutrient networks

Mycelium networks in the forest floor connect tree roots and facilitate the exchange of nutrients and information.

These mycelium networks can help young seedlings to connect to mature trees. Through this mature tree, they can access necessary nutrients



What would be the benefits of an open nutrient system?

Share:

8

7

3

4

Madaster is an online registry for materials and products – offering a product passport service. The registration of every component offers insights into the degree to which an object can be dismantled and reused.

It allows companies to make their information transparent and usable for external parties.



Madaster.com

Ways to enhance the standardisation or interoperability of products, components and materials.

9

Offering transparency of information such as details on material contents or open-sourcing product blueprints to enable user-repairs.

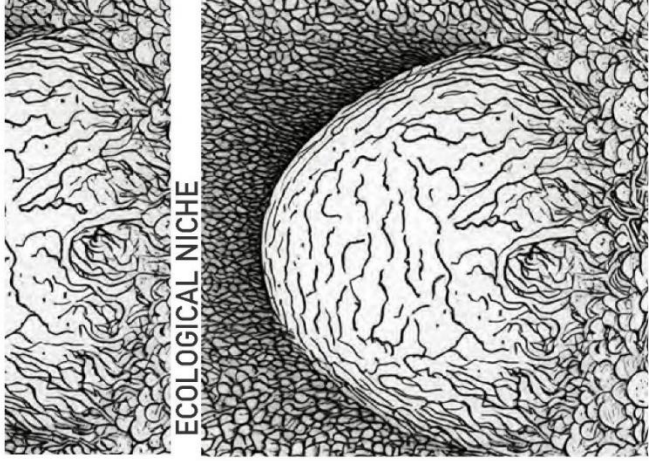
Ensuring that learning and knowledge sharing is supported between different entities in the system.

5

THINK OF:

Instead of being like a tree, asking for your leaves back after they drop, try to think of ideas that ensures that these “leaves” (or product, components/materials) are useful in an open system.

Reflect on how these structures allow the redistribution of nutrients – when a tree requires nutrients, or when there is an excess of nutrients in certain parts of the system.

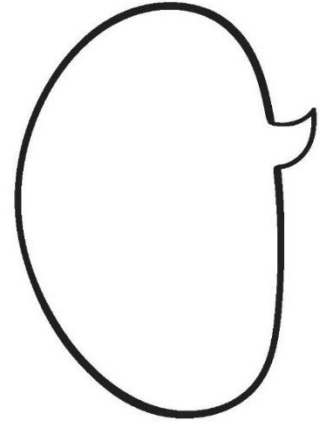


2

Ecological niche

Many factors determine the right size of a single entity in nature. One factor that influences this is the niche: different entities may occupy different roles and positions in a forest.

Imagine the largest or the smallest entity that you can think of in a forest.



Share:
 What ideas would contribute to economies of scope – and distributive systems? What ideas would be more appropriate for economies of scale – aimed towards efficiency?

8

3

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4

Processes on a micro-level such as nutrient cycling can influence meso-level dynamics (think of plant growth and interactions between species) and even macro-level (such as the role that it plays in the global carbon cycle).

Reflect on how micro-, meso-, and macro-systems in a forest are deeply integrated.



Rotterzwam.nl

RotterZwam collects the coffee grounds from local shops and uses these to cultivate mushrooms using the basement of an abandoned swimming pool.

There are functional limitations, such as the size of the basement where they can grow their mushrooms and supply restrictions such as limited coffee grounds that can be collected from the city's coffee shops.

Therefore, economies of scale would not be a suitable model to increase impact. Instead, economies of scope could be; many similar (but separate) initiatives can pop up in other regions.

As a business, how would you describe your “ecological niche”?

Whether your business is attuned to diverse local conditions or whether it prefers a “one-size-fits-all” approach.

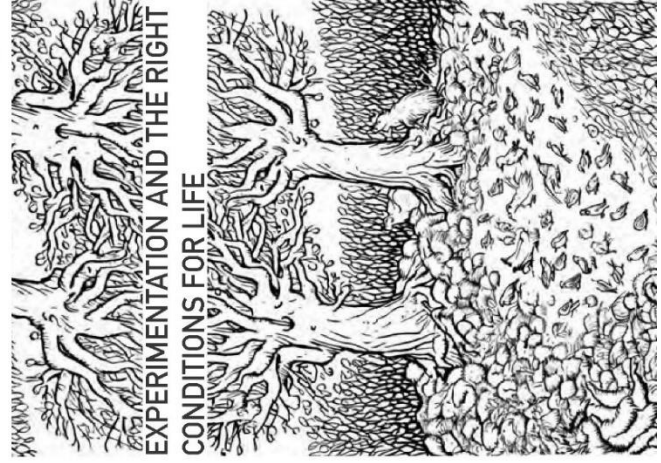
9

Reflecting on the business operations, what scale would allow the most effective response to the needs of the system (micro-, meso-, or macro-level)?

How aware is the business of the positive and negative impacts of its core activities on a micro-, meso-, and macro-level?

5

THINK OF:

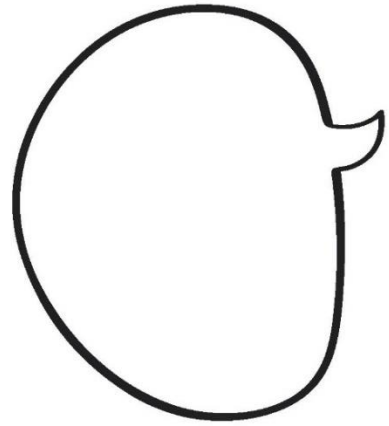


**CONDITIONS FOR LIFE
EXPERIMENTATION AND THE RIGHT**

2

Experimentation and the right conditions for life

When trees disperse their seeds, only a couple make it to an adult tree – if any. Many fall prey to birds, rodents, and insects or they could face environments that are not conducive to life. The dynamics of the forest floor act as a ground for experimentation.



Share:
What business-led systems conditions would support a circular economy?

8

7

3

4

Reflect on the nature of a successful succession, which requires the right conditions for life to come together. This may entail sufficient light, water, and nutrients, for example, as well as protection against external threats.

How does your business attune to the systems conditions and participate in shaping them?

Superblocks is a built environment project in Barcelona, and was originally commissioned to reduce noise pollution.

However, the designers went to the root of the problem, and it ended up as an infrastructural project that allows for more sustainable ways of transportation, thriving local communities and enhanced green spaces.

These interventions resulted not only in reduced noise pollution, but also cleaner air, healthier residents and improved economic activity.



<https://www.citiesforum.org/news/superblock-superilla-barcelona-a-city-redefined/>

How do you allow room for business ideas to fail as well as thrive?

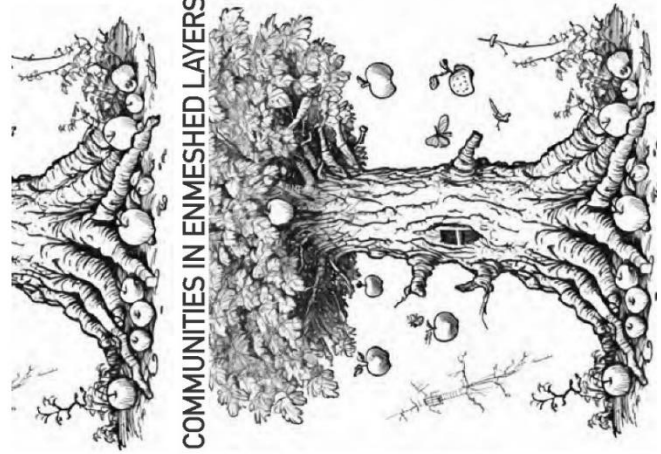
In what ways do you allow your core activities to be shaped by the context and availability of local resources, infrastructure and expertise?

How do you take part in the creation of the right conditions for circular activities to arise?

5

9

THINK OF:

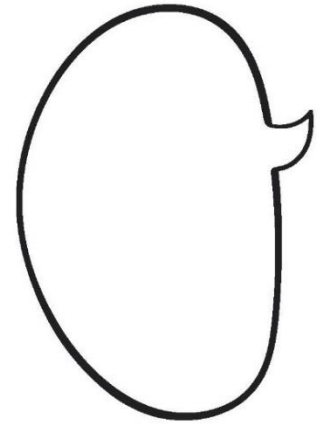


COMMUNITIES IN ENMESHED LAYERS

2

Communities in enmeshed layers

When leaves fall on the forest floor they can create a rich layer of organic matter. Decomposers break these down, releasing nutrients that can be taken up again by other entities. Community is built around nutrient availability, and this makes social and material dimensions deeply intertwined.



Share:
How might you engage local communities and leverage social capital around product life extension or the re-utilisation of materials, components and products?

3

8

4

7

Fairphone manufactures sustainable mobile phones using ethical mining practices as well as sustainable design principles such as design for disassembly.

Through their repair community, users can support each other in maintaining and repairing their phones.

Fairphone supports this type of activity through its design and support model.



Fairphone.com

—Celebrate the skills and expertise that are present in communities.

—Making the opportunities to engage in decentralised supply chains and/or value chains accessible and inclusive.

—Utilising and supporting the Commons and publicly owned assets and infrastructure.

5

9

THINK OF:

Reflect on how you can support a thriving local community around your business activity:

Reflect on how social activity has the potential to enhance and direct nutrient flows. What would happen in an ecosystem if there was not this social activity?

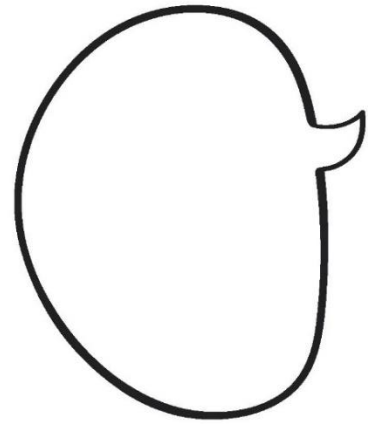


2

Emergence and gap dynamics

Imagine a tree falling in a forest. This event leads to a series of consequences also referred to as “gap dynamics”. This is because a gap in the canopy appears which allows juvenile trees to race towards this light.

The temporary increase of light on the forest floor also allows for increased growth of the understory (plants that live closer to the forest floor) which typically receives less light. The decomposing tree releases nutrients into the forest floor which creates unique conditions for pioneering species and new growth to thrive.



Share:
What kind of market gaps could be framed as opportunities for circular business models?

3

8

4

7

SoJo is a London-based startup that is focused on promoting sustainability in the fashion industry through connecting customers with local tailors. They also call themselves: “the Deliveroo of clothing repair” because they utilise a bicycle courier network to facilitate the transport.

Where previously users would dispose of their damaged clothes or clothes that did not fit them well anymore, SoJo’s service allows them to keep these garments utilised for longer.



Sojo.uk

What kind of transformational events could create positive knock-on effects for circular businesses to thrive?

THINK OF:

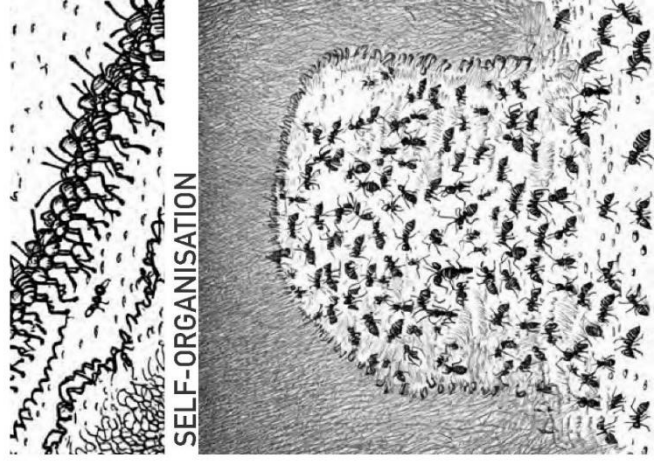
5

9

Ways to engage with policy makers to change the “rules of the game”, and open up new circular business opportunities.

Opportunities where the current linear economy is failing to deliver.

Engagements with users and the wider public that could allow for a cultural shift to a different, circular model through awareness.

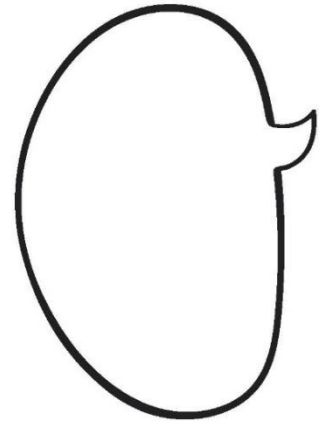


2

Self-organisation

Art colonies have organised social structures that allow the group to work together to sustain the colony. The behaviour of each art is influenced by local information and simple rules.

For example, ants lay down pheromones which create a pathway that other ants can follow (internal communication). There are also specialisations in different roles such as foragers and waste managers – led by environmental cues that allow the colony to adapt to changing conditions.



What areas within a circular economy would lend itself well to the self-organisation of (business) communities and more spontaneous types of business activities?

Share:

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Reflect on how this form of self-organisation is influenced by communication and environmental cues that allow the colony to stay in tune with novel and changing conditions.



Codydock.org.uk

The Cody Dock Partnership is an enterprise formed to act as a vehicle for the community-led regeneration of a London industrial dock and its waterways.

It celebrates the industrial heritage, allows the community to enjoy the River Lea, and acts as an incubator for creative enterprise and supports cultural and educational programmes.

It is managed and maintained by local volunteers and regular community meetings ensure that the local residents can influence the development and management of the site.

How does your business engage in the self-organisation of the wider system?

THINK OF:

9

The role of pre-competitive collaboration to create standards that allow a wider system to move towards circularity.

5

Engagement with industry-wide initiatives to create a large-scale movement of change at once - and the ability to prepare for this.

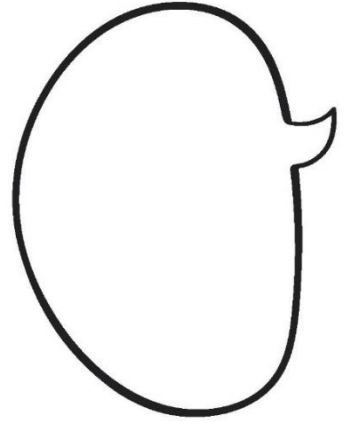
Collaboration and engagement with local residents and communities that could benefit from your business activity.



2

Opportunism and enhancing utilisation

Some animals can support the transportation of seeds by, for example, eating fruit and defecating the seeds often far from the original location. Alternatively, seeds can attach themselves to certain animals' coats and hitch a lift to a completely new ecosystem.



What type of design features would promote the increased utilisation of already-existing assets?

Share:

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4

Reflect on other opportunistic relationships that you could find in natural systems.



www.peerby.com

Peerby promotes collaborative consumption and resource sharing through its peer-to-peer sharing platform.

The app facilitates a connection between users who have items to lend and those who need them, increasing the utilisation of existing items.

How can you do more with what is available and already there? Or how can you enable others to utilise and repurpose what you put out in the system?

THINK OF:

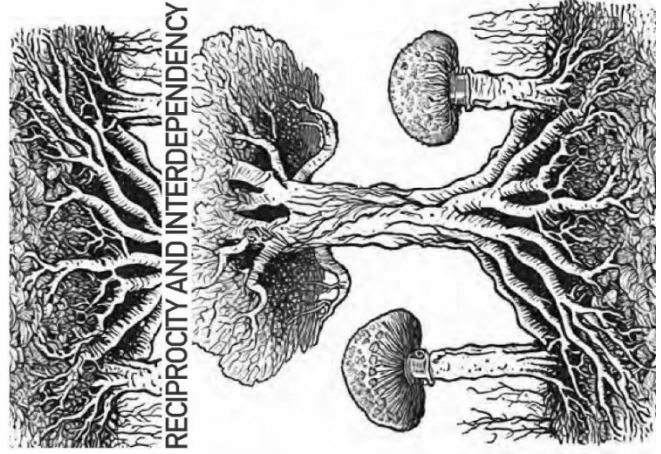
9

Seeking opportunities to use existing resources as input for your system.

Ensuring interoperability and transparency of what you put out in the system.

Designing your outputs in a way that allows others to use and reuse them in different ways.

5

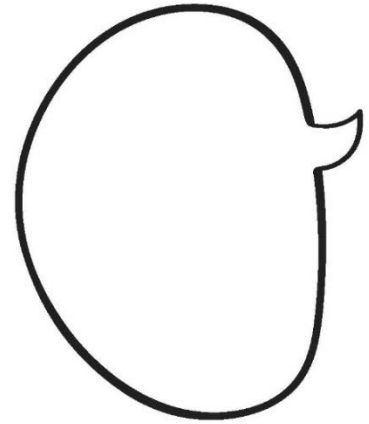


2

Reciprocity and interdependency

There is a symbiotic association between the roots of a plant and the mycelium structures in the soil – these are two separate entities, but deeply and evolutionary entangled.

In this relationship, trees provide the fungi with carbohydrates (sugars) produced through photosynthesis. In return, the fungi enhance the trees' ability to absorb water and nutrients.



Share:
Where, in a circular economy, do you believe creating partnerships and mutual benefits is most critical?

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Interface produces flooring and aims to reuse and recycle all its materials. They have worked together with an Italian company called Aquafil for over two decades. They specialise in producing nylon yarns from regenerated waste.

Through a durable partnership, they can both evolve their design and production to ensure enhanced benefits for both.



<https://www.aquafil.com/magazine/secrets-for-circular-supply-chain-partnerships-from-interface-and-aquafil>

How can you create mutual benefits and reciprocal relationships within your ecosystem of economic activity?

THINK OF:

5

9

–Creating benefits and value outside of the transactional nature of the supplier-customer relationship.

–The reciprocal partnerships with entities that the business depends on and how these can be deepened.

–Exploring the opportunities for more place-based partnerships which leverage what is already there.

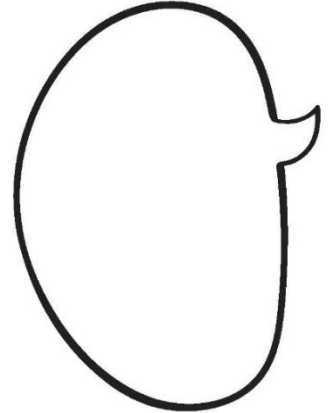


2

Cooperation and co-evolution

Pollinators such as bees, butterflies and birds visit flowers to obtain food by seeking nectar. Flowering plants benefit from this visit by transferring pollen from the male parts of one flower to the female parts of another.

This important process contributes to the genetic diversity of the plant species. Therefore, flowering plants and pollinators have co-evolved with adaptations that enhance this cooperation.



Share:
 What kind of opportunities could be unleashed when multiple entities within a supply chain decide to co-evolve towards a circular economy?

3

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Reflect on how deeply the survival of both pollinators, as well as flowering plants, relies on this cooperation.

How can you tune into the needs of the wider business ecosystem around you and adapt to this?

The Forest Stewardship Council (FSC) and its certification system were established after recognising the need to address deforestation and regenerative forest management.

This initiative was led by diverse stakeholders such as NGOs, timber industry representatives, and Indigenous peoples' organisations and shaped the future of sustainable forest management.



<https://fsc.org/en>

How you can respectfully acknowledge dependencies and power dynamics that come with cooperation and co-evolution.

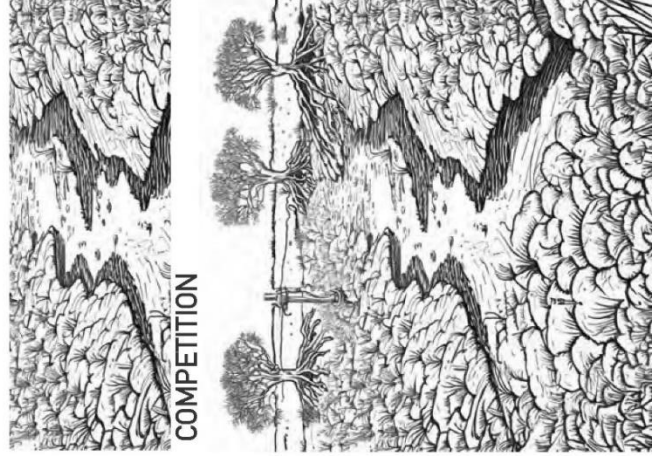
5

9

THINK OF:

Building spaces to openly engage in the evolution of the wider economic ecosystem and its change towards circularity.

Anticipating and evolving to utilise inputs that may be considered by-products or "waste" by other entities.

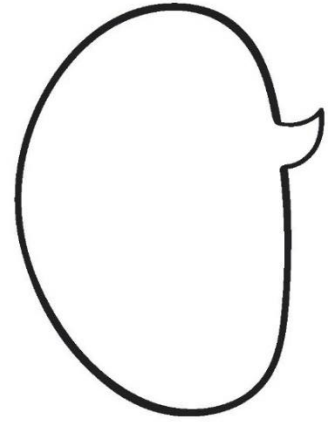


2

Competition

During dry seasons, plants compete for the limited available water resources. Some deep-rooted entities may be able to access groundwater, whilst other entities with more shallow roots could rely on surface water and puddles.

The process of competition could prompt plants to grow different root systems – with specialised relationships between plants and fungi to ensure reliable access to essential nutrients.



What markets within a linear economy would be challenging to compete with as a circular business? And which markets would be easier?

Share:

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4

Reflect on how competition is everywhere in a forest where there are limited resources.

How can you ensure that competition is used for good?

THINK OF:

5

9

Seeking to compete with unsustainable products and services and aim to replace these with solutions in line with a circular economy.

Supporting emerging entities to compete fairly with established entities – such as renewable energy sources replacing heavily subsidised fossil fuel-based energy.

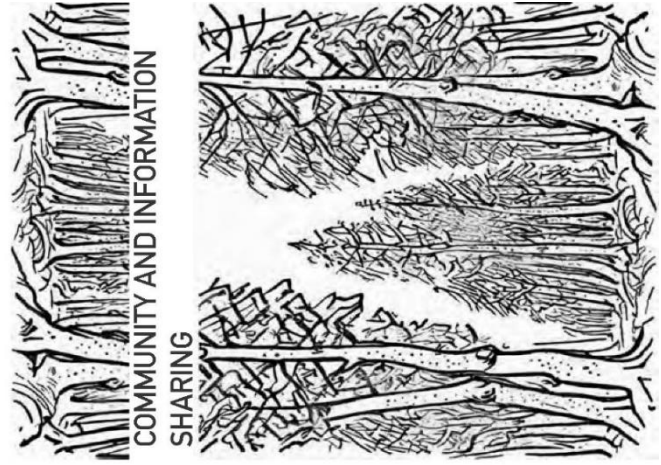
Avoid using similar scarce inputs that other businesses rely upon (for example: ensure the production of biomaterials is not food competitive).

Tony's Chocolonely is a chocolate company that challenges the existing chocolate supply chain directly by addressing issues of exploitation, child labour, and unfair trade practices.

The company's mission is to make 100% slave-free chocolate the norm, not just for its own brand but for the entire chocolate industry.



tonyschocolonely.com



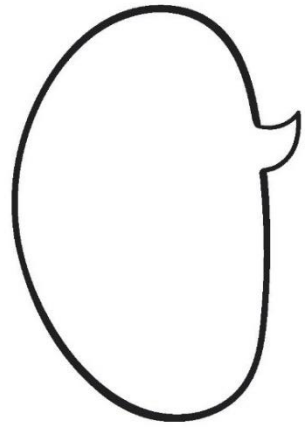
COMMUNITY AND INFORMATION SHARING

2

Community and information sharing

When trees are under attack, for example by an insect or parasite population, they can send distress signals to their neighbouring trees to warn them about this threat.

These trees can then start to produce enzymes to protect themselves against this threat, which could result in enhanced stability of the forest ecosystem - including the likelihood of survival for the signalling tree.



Share:
 What design principles and business models can businesses implement to empower their customers to repair and upgrade their products independently?

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Reflect on this "invisible" sense of community, the wealth of information shared between trees and how, at first sight, trees seem to operate as individual entities.



Materiom.org

All information is freely available and for anyone to use, modify and distribute, fostering a culture of open innovation and collaboration.

Materiom is a start-up that provides open-access resources and data to foster innovation and development in the field of biomaterials.

Through their open-source material recipes, including step-by-step instructions and ingredient lists, they empower the general population to experiment with these biological materials.

How can you invite and empower external stakeholders into your ecosystem of economic activity?

9
 5

THINK OF:

_Enable community spaces and repair cafes to allow citizens to repair their own projects as well as learn new skills or share their skills with community members.

_Ensure that materials, components and products stay local whilst information is shared widely and in an accessible way.

_Open up information that is considered intellectual property to serve the good of society.

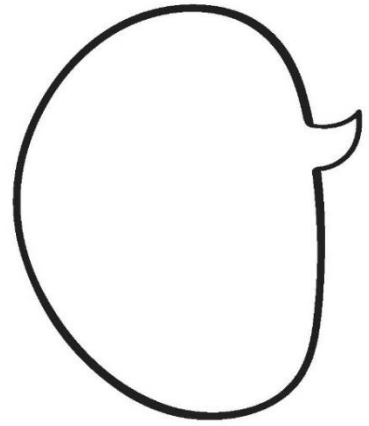


2

Invasion and conflict

Invasive species are non-native organisms that are introduced to a new environment and could cause harm to this ecosystem. Often, they grow rapidly due to the lack of natural predators, and this can displace or reduce native plants and animals.

Some invasive species can alter nutrient cycling processes. For example, invasive nitrogen-fixing plants like the black locust can increase nitrogen levels which further disrupt some native plant communities.



Can you think of any more examples of “invasive” circular or sustainable solutions that disrupted unsustainable systems?

Share:

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Oatly is redefining the dairy industry by offering a plant-based, more sustainable alternative to traditional dairy. Through bold marketing and advocacy, they challenge the industry to reevaluate its environmental and ethical standards.

Oatly's success highlights rising consumer demand for sustainable choices, compelling the dairy sector to adapt or face the risk of losing market share.



www.oatly.com

How can you disrupt unsustainable systems through your business activities?

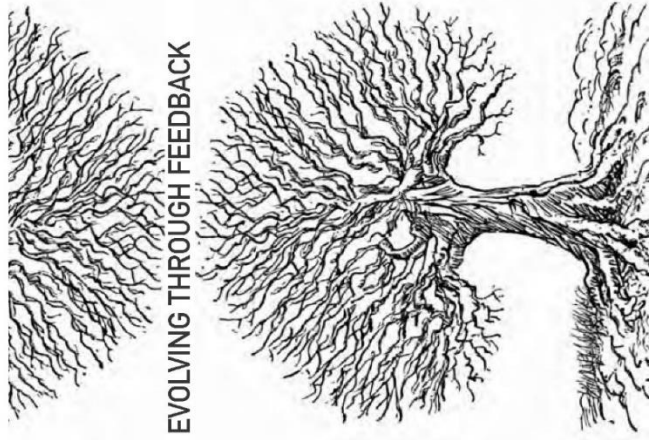
THINK OF:

5

9

Positioning the business against an unsustainable industry and seeking direct alternatives for popular and unsustainable products.
Exploring how you can use different business models such as selling performance or access allowing you to offer high-quality or more sustainable products in an accessible way.

How you could allow thriving second-hand markets to disrupt first-hand markets and enable higher utilisation of already-existing assets.



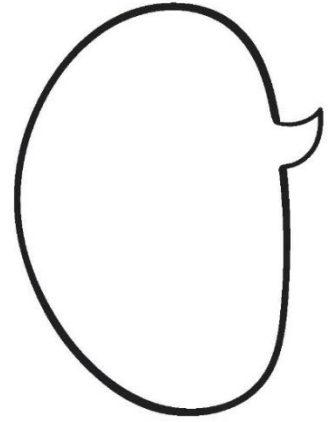
EVOLVING THROUGH FEEDBACK

2

Evolving through feedback

Certain stressful events for trees can create a change in the DNA of the tree. Experiences such as droughts, diseases, and extreme temperatures have the potential to affect certain genes and therefore allow the tree to adapt to its unique circumstances and challenges. These changes in DNA are called epigenetic changes.

Reflect on of form of feedback allows the tree to learn lessons from the past and shape itself to fit better in the wider system.



In what ways can you enhance the feedback that you receive – especially the more qualitative insights that are not easily expressed as numbers?

Share:

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Patagonia encourages their customers to return their items for repair and maintenance through their Worm Wear Programme. This provides the business with valuable information on how to improve the quality and durability of their products.



wornwear.patagonia.com

How can you make your business, product, idea or supply chain more context-specific?

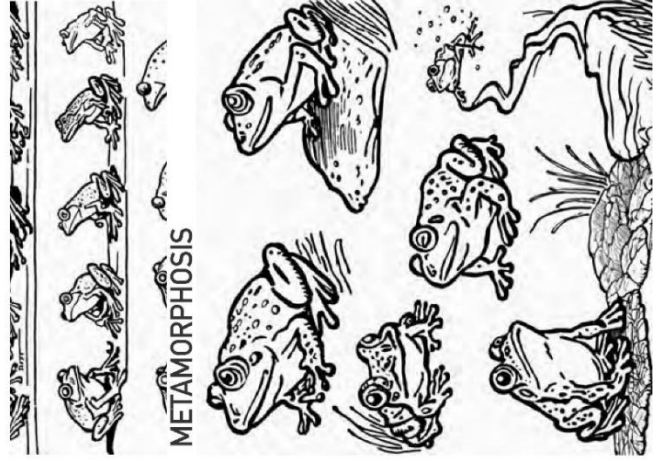
THINK OF:

5

9

How do contexts such as the local community or the wider supply chain affect how the business operates?
 What kind of feedback is available and how this could allow the business to evolve?
 What kind of information is currently guiding the business?

Tuning into place-specific that require businesses to respond in creative ways.

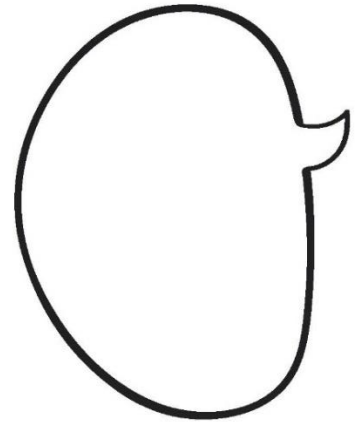


2

Metamorphosis

Tadpoles undergo a process of metamorphosis to transform into adult frogs. Through the different stages of the metamorphosis, the tadpole undergoes profound changes orchestrated by hormonal signals.

This transformation enables the entity to thrive in different ecological circumstances throughout its life.



What types of changes could prompt businesses to undergo a “metamorphosis” towards a circular business?

Share:

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Reflect on the profoundness of the changes that suddenly happen, from a metabolic shift (from herbivorous to carnivorous) as well as the development of hind legs and lungs to function successfully above water.



www.bcorporation.net

B Corp certification is designed to help businesses align their practices with sustainability through a structured framework. In many cases, B Corps are required to embed social and environmental considerations into their legal structures. This ensures that sustainability is deeply integrated into the company's core operations and decision-making processes.

How can the business contribute to abrupt and sudden changes in the economy?

THINK OF:

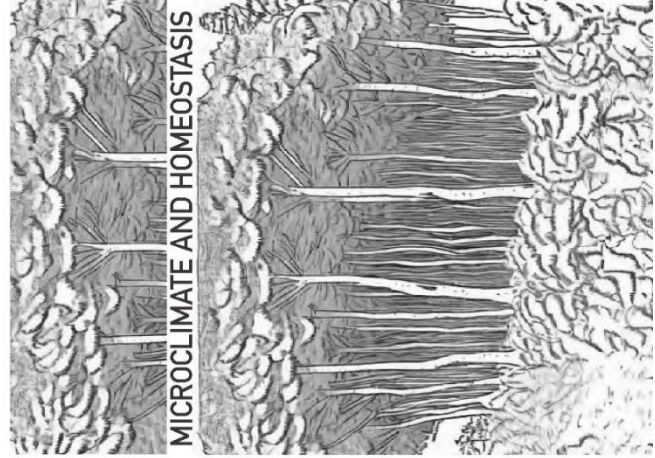
“Take part in a wider movement of activity to contribute towards a “tipping point”.”

9

“How can business models and wider industry collaboration be in service of a changing economy?”

5

“Engage with governments to set the right conditions to make a circular economy the new status quo.”

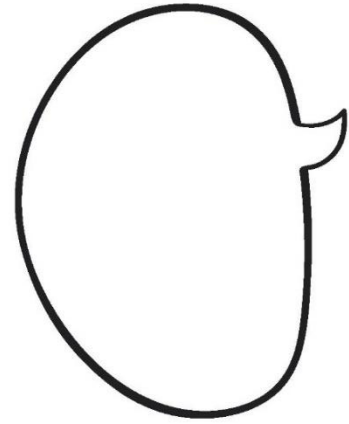


2

Microclimate and homeostasis

A microclimate is a localised climate that differs from the surrounding regional climate. This can be due to the influence of factors such as vegetation and bodies of water. Microclimates play a crucial role in helping a forest to self-regulate and maintain homeostasis.

The canopy cover is a natural insulator, moderating temperatures by providing shade. This allows a forest to be cooler in the summer and warmer in the winter in comparison to areas that do not have this cover.



If you had access to a progressive “microclimate”, what would be a circular idea that you wish to test?

Share:

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Reflect on how you experience the microclimate of a forest when you enter and leave the forest during a hot day.



<https://amsterdamsmartcity.com/>

Amsterdam Smart City is an urban development initiative that harnesses innovations for a more resilient and inclusive city. One of its components is the living lab – which allows the testing, piloting and refining of solutions in a real-life context.

What would you consider a progressive “microclimate” for your business to exist in?

9

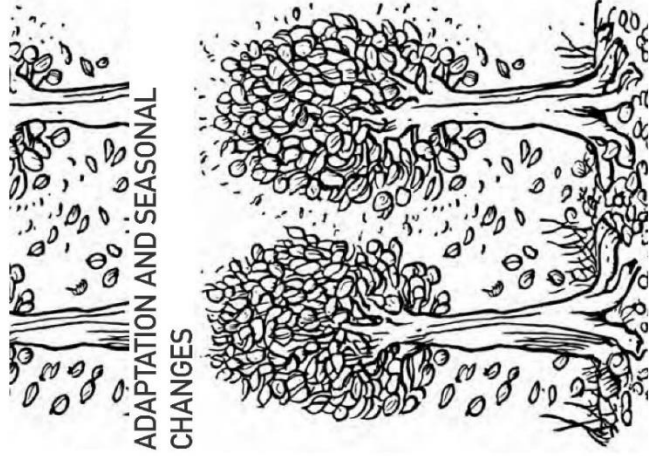
What kind of contexts would be safe for experimentation and learning to happen?

How can policymakers, (local) government, and municipalities support the environment where new varieties of value can emerge?

What type of community-maintained infrastructure (the Commons) would support these creative endeavours?

5

THINK OF:



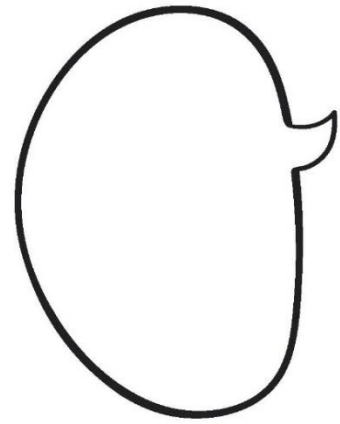
2

Adaptation and seasonal changes

In the Northern Hemisphere, when fall approaches, deciduous trees begin the process of leaf abscission, where the leaves change colour, die and eventually fall off. This process is triggered by environmental cues such as decreasing daylight hours and cooler temperatures.

This allows the tree to conserve water and energy over the winter and avoids the risk of damage that could affect the overall health of the tree.

Similar environmental cues signal to the tree when it is time to promote leaf growth in the spring.



What types of products would lend themselves well to dealing with flexible, unpredictable and diverse inputs?

Share:

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Reflect on the effect of climate change on these seasonal changes which may prompt trees to drop leaves too late or grow them again too early.

Dock to Dish has a fishery model that connects local fishermen directly with restaurants. They operate on a "catch of the day" basis which allows them to work with whatever fish are sustainably caught, including bycatch.

These restaurants have the ability to adapt to the different species of fish that they were able to catch and adjust their menu to accommodate this.



docktodish.com

How flexible and resilient is your business model when facing changing circumstances?

9

5

- Policy changes or requirements.
- Changes in supply such as supply disruptions or price volatility.
- Changes in demand such as trends, changing customer behaviours or purchasing power.

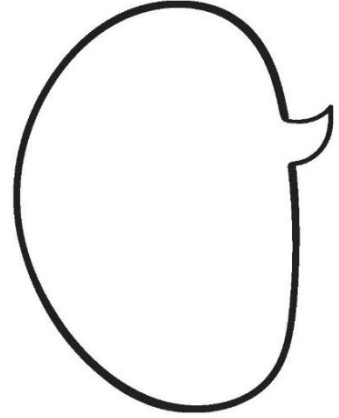
THINK OF:

2

Reactive change to disruption



When a wildfire occurs, this can destroy trees, understory and other vegetation. Immediately after the event, the ecosystem appears barren and charred. However, shortly after the fire, pioneer species – which are often well adapted to disturbed environments, begin their colonisation. These could be grasses or certain types of shrubs. Some trees like certain pine species, have seeds that require the heat of a fire to germinate. Over time, the initial colonisers are replaced by other species that allow more complex structures to emerge within the ecosystem.



Share:
Come up with ideas that could have a business case in times without disruption but could also support during a disaster response.

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Reflect on different stages of recovery and the reaction to disruption

What role could your business play in the recovery after a major disruption?

THINK OF:

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9

- _How can you use your core competencies as a business to support the response to disruption such as disasters and population displacement?
- _How are you contributing to a diversity of business activities in the wider economy to ensure resilience - and avoid fragility?
- _Building in multi-purpose uses for your products, components and materials.

IKEA developed a flat-pack emergency shelter that can be used to respond to population migration. They are designed for transportation and rapid deployment and can be easily transformed and assembled. This adaptability ensures that displaced individuals can receive immediate, practical housing solutions.



<https://ikeafoundation.org/stories/flat-pack-refugee-shelter-wins-design-of-the-year-2016/>

Appendix 2

This is the participant-facing pre-programme survey.

Thank you for taking part in this research.

Please be reminded that this is a voluntary activity. You may withdraw your consent at any time before 11/04/2025. After that, your data will not be traceable anymore to you as an individual in the database and the researchers will therefore not be able to delete your contribution. If you have any questions, please don't hesitate to contact the lead researcher.

We ask for your consent on the following statements:

- I have read and understood the study information. I have been able to ask questions about the study and my questions have been answered to my satisfaction.
- I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.
- I understand that taking part in the study involves the completion of two questionnaires.
- I understand that I will not be compensated for my participation.
- I understand that the study will end at 11.04.2025.
- I understand that taking part in the study also involves collecting potentially personally identifiable information (through open-ended questions in the questionnaire), with the potential risk of my identity being revealed.
- I understand that the following steps will be taken to minimize the threat of a data breach, and protect my identity in the event of a breach: pseudonymisation of collected data.
- I understand that personal information collected about me that can identify me will not be shared beyond the study team.
- I understand that the identifiable personal data I provide will be destroyed.
- I understand that after the research study, the de-identified information I provide will be used for an academic publication
- I agree that my responses, views or other input can be quoted anonymously in research outputs.

Please state your name, or participant number:

When are you due to participate in the workshop?

Please state the location of the workshop:

Please state your main role:

- Business
- NGO
- Academia and Research
- Education
- Policy
- Advisory
- Other:

What is your age?

- 20s
- 30s
- 40s
- 50s
- 60s
- 70s
- 80s

Is English your first language?

- Yes
- No, but I am proficient
- No

Are you familiar with a circular economy?

- Yes
- Not sure
- No

How would you describe the level of your knowledge and competencies in relation to the topic “circular economy”?

- Beginner
- Moderate
- Competent
- Expert

Could you please explain in your own words what the idea of a circular economy means to you?

How does the idea of a circular economy relate to your profession, business or organisation?

Which sentence resonates most with you?

- The circular economy is a way for businesses to stay ahead of the competition.
- The circular economy is a way for businesses to build connections with other businesses.
- By implementing circular economy, businesses can increase their performance.
- By implementing circular economy, businesses can create a flourishing ecosystem to thrive in.

Please elaborate on why you selected this sentence in comparison to the others:

Do you think most individuals in your organisation would agree with you?

- Yes
- No
- Not sure

Please elaborate on why you think this:

Would you like to make the researcher aware of any problems with the survey?

Thank you for participating in part 1 of the research. If you have any questions, please contact the lead researcher.

Appendix 3

This is the participant-facing post-programme survey.

Thank you for taking part in this research. Please be reminded that this is a voluntary activity. You may withdraw your consent at any time before 11/04/2025. After that, your data will not be traceable anymore to you as an individual in the database and the researchers will therefore not be able to delete your contribution. If you have any questions, please don't hesitate to contact the lead researcher.

Have you completed Part 1 of the study?

- Yes
- No

Please state your name or participant number:

Please rate your overall experience of the workshop:

	Very negative	Somewhat negative	Neutral	Somewhat positive	Very positive
The overall experience.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The design and the content of the cards.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The quality of facilitation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please rate the statements below:

	Completely disagree	Somewhat disagree	Neutral	Somewhat agree	Completely agree
I am satisfied with the teaching methods that were being used.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt motivated throughout the session.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I learned during this session.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt comfortable during the session.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Optional: please elaborate on your answers above:

Please rate the statements below:

	Completely disagree	Somewhat disagree	Neutral	Somewhat agree	Completely agree
Engaging with the forest metaphor was enriching for my understanding of a circular economy.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The forest metaphor brought insights or made me look differently at what I currently know.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel a tension between the insights from the forest metaphor and the reality of businesses and organisations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How did the workshop affect your understanding of a circular economy?

- It deepened my understanding of a circular economy.
- It changed my understanding of a circular economy.
- It did not affect my understanding of a circular economy.
- Other:

Upon reflection, and after the workshop, how does the idea of a circular economy relate to your profession, business or organisation?

What was the most interesting or exciting idea that you came up with during the workshop?

Which sentence resonates most with you?

- The circular economy is a way for businesses to stay ahead of the competition.
- The circular economy is a way for businesses to build connections with other businesses.
- By implementing circular economy, businesses can increase their performance.
- By implementing circular economy, businesses can create a flourishing ecosystem to thrive in.

Please rate the statement below:

	Completely disagree	Somewhat disagree	Neutral	Somewhat agree	Completely agree
I will be able to implement some of the insights from the forest metaphor in my profession, business or organisation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

What insights from the forest metaphor are realistic to implement in your profession, business or organisation?

What insights from the forest metaphor are not realistic to implement in your profession, business or organisation?

Please answer the following questions:

	No	Not sure	Yes
Do you find the current mainstream conceptualisation of a circular economy limiting?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do the insights of the forest metaphor resonate with you?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do you think the ideas resulting from the forest metaphor are plausible?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do you find the forest metaphor allows you to	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

develop different ideas?

Please evaluate the following statements:

	Disagree	Neutral	Agree
The individual interaction with the cards was enjoyable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The group discussion on the insights was enjoyable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The session overall was enjoyable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please evaluate the following statements:

	Disagree	Neutral	Agree
The visual design of the cards was clear and supportive in the activity.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The time given for each activity was sufficient.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The cards sparked inspiration and new ideas.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please evaluate the following statements:

	Disagree	Neutral	Agree
The information on the cards was clear and easy to understand.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It was clear from the cards what was expected of me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The physical design of the cards helped the process through the different stages.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please evaluate the following statements:

	Disagree	Neutral	Agree
The cards supported my	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

learning process during the session.

How to use the cards was intuitive.

The outcomes of the engagement with the learning tool were useful.

Would you like to make the researcher aware of any problems with the survey?

Thank you for participating in the study. If you have any further questions, you can contact the lead researcher.

Appendix 4

This is the facilitator-facing post-programme survey.

Thank you for taking part in this research. Please be reminded that this is a voluntary activity. You may withdraw your consent at any time before 11/04/2025. After that, your data will not be traceable anymore to you as an individual in the database and the researchers will therefore not be able to delete your contribution. If you have any questions, please do not hesitate to contact the lead researcher.

We ask for your consent on the following statements:

- I have read and understood the study information. I have been able to ask questions about the study and my questions have been answered to my satisfaction.
- I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.
- I understand that taking part in the study involves the completion of one questionnaire.
- I understand that I will not be compensated for my participation.
- I understand that the study will end at 11.04.2025.
- I understand that taking part in the study also involves collecting potentially personally identifiable information (through open-ended questions in the questionnaire), with the potential risk of my identity being revealed.
- I understand that the following steps will be taken to minimize the threat of a data breach, and protect my identity in the event of a breach: pseudonymisation of collected data.
- I understand that personal information collected about me that can identify me will not be shared beyond the study team.
- I understand that the identifiable personal data I provide will be destroyed.
- I understand that after the research study, the de-identified information I provide will be used for an academic publication
- I agree that my responses, views or other input can be quoted anonymously in research outputs.

Please state your name:

When did you facilitate the workshop using the tool “The Clearing – Ecological Design Thinking for a Circular Economy”?

Have you facilitated this workshop (or a version of this workshop) before?

Is English your first language?

- Yes
- No, but I am proficient
- No

Please rate your overall experience of the workshop:

	Very negative	Somewhat negative	Neutral	Somewhat positive	Very positive
The preparation and facilitation notes were clear and descriptive.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The overall experience delivering the workshop.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The design and the content of the cards.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Participant engagement	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please state any feedback on the preparation notes of the workshop:

Please state any feedback on the cards (content and design):

Please rate the statements below:

	Completely disagree	Somewhat disagree	Neutral	Somewhat agree	Completely agree
Engaging with the forest metaphor was enriching for their understanding of a circular economy.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The forest metaphor made them look differently at what they currently know.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

They felt a tension between the insights of the forest metaphor and the reality of their profession, organisation or business.

○ ○ ○ ○ ○

Please state any feedback on the engagement with the content:

Did you observe any change within the learners (for example, how they thought of CE or engaged with some of the concepts)?

- Yes
- No
- Not sure

What was the most interesting idea that was presented in your group?

If you had the chance, would you use this tool again in your teaching?

- Yes
- No
- Not sure

Optional: please elaborate on why you would or would not use this tool again in your teaching:

Please evaluate the following statements:

	Disagree	Neutral	Agree
The individual interaction with the cards was enjoyable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The group discussion on the insights was enjoyable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The session overall was enjoyable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please evaluate the following statements:

	Disagree	Neutral	Agree
The visual design of the cards was clear and supportive in the activity.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The time given for each activity was sufficient.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The cards sparked inspiration and new ideas.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please evaluate the following statements:

	Disagree	Neutral	Agree
The information on the cards was clear and easy to understand.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It was clear from the cards what was expected of me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The physical design of the cards helped the process through the different stages.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please evaluate the following statements:

	Disagree	Neutral	Agree
The cards supported their learning process during the session.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How to use the cards was intuitive.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The outcomes of the engagement with the learning tool were useful.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Would you like to make the researcher aware of any problems with the survey?

Thank you for participating in the study. If you have any further questions, you can contact the lead researcher.