### (CO-) DESIGN FOR UNDERSTANDING: mediating between processes of multistakeholder value creation towards circular fashion and textiles

#### Authors

Freya Zaplata, Anja Köppchen, Theresia Grevinga and Daniëlle Bruggeman,

Freya Zaplata, ArtEZ University of the Arts / Radboud University

Anja Köppchen, ArtEZ University of the Arts / Inholland University of Applied Sciences

Theresia Grevinga, Saxion University of Applied Sciences

Daniëlle Bruggeman, ArtEZ University of the Arts

Corresponding Author: <u>f.m.zaplata@gmail.com</u>

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#### Abstract

In the transition towards a circular fashion and textile system, there is an increased awareness of the importance of interdisciplinary, multi-stakeholder collaborations and co-creation. Yet, this process is far from straightforward as navigating between interdisciplinary interests and mindsets demands relationships built on mutual trust and understanding. This paper argues that design can help to mediate between processes of multi-stakeholder value creation, by embracing *co-design for understanding* as a guiding design principle.

In this paper we discuss the results of the project Going Circular, Going Cellulose  $(GC)^2$ , which explored multi-stakeholder value creation from a design-driven perspective on textile development. Based on practice-based design research, field research and case study analysis, the project results show how a relational (design) approach between partners is an important precondition for co-design for circularity. We discuss two case studies that illustrate how

(co-)design can create a deeper understanding of circular design and textiles for multiple stakeholders, by finetuning communication, creating collective learning experiences and highlighting interdependencies between aesthetic, emotional, technical, and socio-cultural decision-making. (Relational) proximity between stakeholders helps to align different perspectives and different ways of working. Designing 'boundary objects' (Stompff, 2020; Stompff & Smulders, 2015) seems to be a way to create (relational) proximity, as these operate as a shared language and provide a common frame of reference. In this way, design facilitates dialogue and interaction, which is needed to create a shared vision among stakeholders, and to co-create new, circular systems.

The design research case studies have resulted in a new circular design principle: *co-design for understanding* shifts attention away from designing products and materials as end goal, towards designing processes and methods of mediation between multiple stakeholders to create a shared language and mutual understanding, driving the transition towards more circular value chains and systems.

## Introduction

In the transition towards a circular fashion and textile system, there is an increased awareness of the importance of interdisciplinary collaboration and co-creation. Several authors (cf. Bocken et al., 2016; Ellen MacArthur Foundation, 2020b; Hornbuckle, 2018) have emphasized the role of design and the designer as a potential key actor in making sustainable choices, by being more and more involved in material development and production processes. This requires developing more (technical) knowledge about processes of making and production methods, as well as more knowledge of the role of circular design principles in interdisciplinary collaboration and value creation. However, the exact role that designers can and should play and the challenges that designers face regarding their responsibilities and required competencies is an ongoing discussion (cf. Niinimäki et al., 2017; Sumter et al., 2018). In this paper, we propose to approach design as a way to mediate between processes of multi-stakeholder value creation.

We do so by presenting results of the project 'Going Circular, Going Cellulose' (2018-2020), in short  $(GC)^2$ , which explored multi-stakeholder value creation from a design-driven perspective on textile development <sup>11</sup>. Six fashion/product designers (or design duo's) collaborated with technical, industrial and research project partners, to research and develop innovative circular materials, concepts and ways of working (see Tables 1 and 2 for an overview of all partners). In this paper, we focus on our analyses of two case studies: the designers Hellen van Rees and Michelle Baggerman. Based on these case studies, we argue forthe importance of co-design in terms of shifting attention away from designing products and materials as end goals, towards designing processes and methods of mediation betweenmultiplestakeholders to create a shared language and mutual understanding.

We build our argument by first reflecting on existing literature on circular design principles and multi-stakeholder value creation. Second, we describe our methodology to introduce the design research case studies. Third, we present our analysis of the case study of Hellen van Rees and reflect on how a relational (design) approach including designers, technicians, and producers, is an important precondition for co-design for circularity. Fourth, the case of Michelle Baggerman highlights the role of design in mediating processes of multi- stakeholder collaboration and value creation even more, through designing 'boundary objects' (Stompff, 2020; Stompff & Smulders, 2015). In addition, Baggerman coined the term *design for understanding* as a guiding circular design principle, which also represents a shift in design practice from designing end products to developing new knowledge and insights through design processes and working *with* and *from* the materials.

Both case studies show how (co-)design can potentially create a deeper understanding of circular design and textiles for multiple stakeholders, enabling informed decision-making

<sup>&</sup>lt;sup>11</sup> 1 Going Circular, Going Cellulose (2018-2020) was a two-year project led by Saxion Universities of Applied Sciences (Enschede, The Netherlands) in collaboration with ArtEZ University of the Arts (Arnhem, The Netherlands), funded by SIA RAAK-mkb.

processes along the value chain, and mediating between different types of knowledge and ways of working.

#### **Circular Design Principles & Multi-Stakeholder Value Creation**

The role of design in the transition towards a circular economy has been explored predominantly within the fields of (industrial design) engineering, innovation management, and ecological and environmental sciences (Lofthouse & Prendeville, 2018: 460; de los Rios & Charnley, 2017). Focusing on products, services, business models, and/or systems, a varietyof conceptual frameworks, strategies, principles, guidelines, methods, and toolkits have been presented (e.g. Bocken et al., 2016; Moreno et al. (2016); Ellen MacArthur Foundation, 2020a). Most of these focus on product design and/or business models from a technical/industrial perspective. Despite the common agreement that circularity is a joint effort of multiple stakeholders within and between ecosystems (e.g. Hornbuckle, 2018: 27; Wennber & Östlund, 2019), there seems to be much less emphasis on the social, cultural, and relational dimensions of circular strategies (cf. Brink et.al. 2021). Furthermore, we have limited understanding of how such design principles work in practice and if and how these can provide practical guidance for designers and other stakeholders (cf. Brown et al. 2021).

To reflect on the practical implementation of circular design principles, the framework of Bocken et al. (2016) served as a starting point in our project. Building upon the work of Stahel (e.g. 2010) and Braungart et al. (e.g. 2008), Bocken et al. provide a comprehensive list of product design strategies (as well as corresponding business model strategies). They introduce two main overarching strategies "according to the mechanisms by which resources flow through a system" (Bocken et al. 2016: 309): (1) 'Slowing resource loops' and (2) 'Closing resource loops'<sup>12</sup> (see Appendix 1). The framework has been criticized for overlooking extant literature on Design for Sustainability (DfX) (Moreno et al., 2016)<sup>13</sup>, yet it offers a practical and still comprehensive overview of possible circular design strategies and principles. Questions remain about how these strategies and principles can be implemented in a complex multistakeholder environment. What is overlooked here is the social dimension of circularity needed for an actual implementation of material resource flow strategies. Put differently, *how* 

<sup>&</sup>lt;sup>12</sup> Bocken et al. (2016) further indicate a third overarching principle which is referred to as 'narrowing resource loops'. This particular principle aims at decreasing the resources used per individual product which has already been successfully implemented in linear production models. While this principle helps and is needed to improve efficient use of resources it does not address the "cycling of goods", i.e., resources are not looped back into the system and waste is inevitable.

Therefore, narrowing resource loops strategies are rendered less relevant in the context of (GC)<sup>2</sup>. Nevertheless, narrowing resource loops strategies may be implemented in circular models to improve resource efficiency (Bocken et al., 2016: 310).

<sup>&</sup>lt;sup>13</sup> The criticism of Moreno et al. also shows that the discourses of sustainability and circular design provide a plethora of literature on design principles and strategies. However, it also reveals how disjointed, as well as confusing at times, both discourses still are. Further, given the systematic complexity of creating circular products it is challenging to provide a comprehensive yet practical overview not too overwhelming for designers (and technical partners alike).

can different stakeholders collectively work with and towards these strategies, and how do such strategies work in practice in the context of fashion and textiles?



Figure 1: Circular strategies (Konietzko, Bocken & Hultink, 2020: 5)

In a more recent article, Konietzko, Bocken & Hultink (2020) further develop the framework of circular strategies by integrating an ecosystem perspective, and by providing a practical tool for firms to analyse and develop their circularity potential. Building on existing frameworks, they distinguish between five interrelated strategies: *narrow, slow, close, regenerate* and *inform* product, component, material, and energy flows (Konietzko et al., 2020: 4-5; see Figure 1). Each of these strategies comes with a set of (design) principles that differ in the required scope of the perspective to operationalize the principle: product, business model, or ecosystem.

While we didn't test this more elaborate framework within our project, it provides a valuable contribution to our analysis of how circular design strategies and principles work in practice. Konietzko et al. define *principles* as "solution-oriented guidelines that can achieve a desired result" (2020:2). In our project, *design principles* served as a tool for reflection in and on action. By explicitly reflecting on designers' practices in relation to (theoretical) design principles, we came to understand how such principles often serve as sub-conscious guidelines to inform and assess design decisions, rather than explicit, practical guidelines of what to design. Furthermore, Konietzko et al. (2020) help us to go beyond the technical aspects of circular design. In line with the Ellen MacArthur Foundation (2020b), Konietzko et al. define *circularity as a systemic property*, which "emerges out of changes in how different actors, products, components and material interact with each other" (2020: 3). In this paper, we argue that this interaction could be mediated by design.

The (changing) role of the designer has gained increased interest in several disciplines, especially in relation to tackling complex, societal challenges (e.g. Irwin, 2015; Manzini, 2015). When taking a systems-perspective, multi-stakeholder collaboration is needed, not just to bring in different knowledge and expertise, but also to negotiate and align agendas and interests

(Pedersen & Clausen, 2019: 3373). In the field of fashion and textiles, aesthetic, emotional, and socio-cultural value is intertwined with technical, functional, and commercial value. Designers supposedly play a vital role in this multi-layered value creation (e.g. Sanders & Stappers, 2008). Co-design and co-creation of aesthetic, technical and functional values through multi-stakeholder collaboration seems to be a crucial factor in the transition towards circular value chains in textiles and fashion (cf. Tubito et al. 2018). However, questions remain about the exact role of designers in this transition and how co-design works in different contexts.Circular design principles in the literature primarily focus on *what* to design (in terms of materials, products, services, business models, systems), but less so on the *process of design*. How to actually align all the different stakeholders, which is so much needed in the transition towards circularity?

## Methodology: Design Research

In the (GC)2 project, a design-driven approach on textile development was central to developing insights into the ways in which designers put circular design principles into practice and how multi-stakeholder value creation works between designers, and engineering and industrial partners. The key methodologies were:

(1) Research-through-design by the participating designers, to develop sustainable textiles and new insights into circular design principles and their underlying values. This research- through-design could be understood as a form of 'constructive design research': "design research in which construction—be it product, system, space, or media—takes centre place and becomes the key means in constructing knowledge" (Koskinen et al., 2011: 5). The research-through-design was guided by the designers' expertise and backgrounds, and their different approaches to collaborating with industrial and research partners. Each research- through-design project thus followed its own logic and methodology in collaboration with the project partners (see Tables 1 and 2 for an overview of all partners).

We selected six designers/ design researchers in the fields of textile, fashion and/or furniture/interior design (Table 1). These designers represent different approaches ranging from a focus on knowledge development, to a systems approach, a focus on production processes, the relationship with the consumer, the aesthetic dimension of textiles, or a focus on material/product development and technical yarn development.

Designer	Expertise	Desired Impact	Co-design Partners	Applied Circular Design Strategies
Hellen van Rees	Contemporary handmade wearable or fashion products with a sustainable	Utilise (mass) production 'flaws' for circular design opportunities	Alcon Advies; Enschede Textielstad	<ol> <li>Design for Dis- &amp; Reassembly</li> <li>Design for Emotional Attachment</li> <li>Trust; Design for a Technological Cycle</li> <li>Design for Ease of Maintenance</li> </ol>
	angle			& Repair; Design for Physical Durability
<b>Bureau</b> Baggerman (Michelle Baggerman)	Design research, Research & prototyping	Explore and better understand the complexities of sustainable design (decisions)	Alcon Advies; professional designers; Enschede Textielstad; Saxion Textile lab.	<ol> <li>Design for Understanding</li> <li>Design for Emotional Durability, Attachment and Trust</li> <li>Design for Physical Durability, Design for a Technological Cycle, Design for a Biological Cycle</li> </ol>
UNSEAM (Bas Froon & Karin Vlug)	Technologically driven, specialised in development of manufacturing and production techniques	Explore the possibilities of laminating technology (new) cellulose-based materials in combination with the 3D UNSEAM technology	Permess; Enschede Textielstad.	<ol> <li>Design for Reshoring</li> <li>Design for Impact, Design for Durability, Attachment and Trust</li> <li>Design for Standardization and Compatibility, Design for a</li> <li>Biological cycle, Design for Dis- and Reassembly</li> </ol>
Buro Belén (Brecht Duijf & Lenneke Langenhuijsen)	Material research, natural materials, focused on colours and light in clothes, objects and spaces	Create attractive wearables protecting against the sun, use aesthetics as facilitator to wear sunscreen alternatives	Alcon Advies; Enschede Textielstad; Saxion Textile lab.	<ol> <li>Design for Emotional Durability, Attachment and Trust (aesthetic usability effect, emotion memory link, persuasive emotion)</li> <li>Design for Physical Durability</li> </ol>
Milou Voorwinden & Suzanne Oude Hengel	Textile research, Woven textile design and three- dimensional structures, knitwear & footwear	Exploring textiles as construction material with the ultimate aim to make the industry look different at material qualities and production technologies	Saxion Textile lab; Alcon Advies; TU/e.	<ol> <li>Design for New Production Process Techniques</li> <li>Design for Upgradability and Adaptability, Design for Physical Durability</li> <li>Design for Standardization and Compatibility, Design for Dis- and Reassembly</li> </ol>
Tous les Chéris (Els Bugter)	Baby clothes, branding with a special eye on the relationship with consumers	Understand and visualize complexity of textile industry's ongoing transition towards sustainability; position different stakeholders within these processes, to contribute to a better synergy in cooperation.	all project partners, including design researchers/ designers, researchers, industry partners, as well as external experts and industry stakeholders.	<ol> <li>Design for Understanding, Design for Upgradeability and Adaptability</li> <li>Design for Emotional Durability, Attachment and Trust</li> </ol>

Table 1. (GC)2 Participating designers & projects

(2) Field-research: monitoring the design projects with regular check-in meetings and semistructured interviews. Between March 2019 and March 2020, we conducted seven (monitoring) meetings (two full consortium, five designer meetings) and 18 semi-structured interviews with the designers and the key project partners. These meetings and conversations aimed to critically reflect on the design process in relation to the circular design principles, to articulate, frame and define the designers' circularity challenges, to capture their collaboration practices and intentions, and to reflect on their (different) roles within the (GC)2 project.<sup>14</sup> Additionally, we conducted three semi-structured interviews with key technical and industrial partners (see Table 2) in November 2021, to gain new insights into the impact of this project – and specifically the collaboration with the designers – on the partners' work towards circularity.

	Expertise		
Alcon Advies	Textile consultancy advising companies and		
(Anton Luiken)	organizations in making (sustainable) choices regarding textile materials and products.		
Enschede Textielstad	A small-scale industrial weaving mill in Enschede,		
(Annemieke Koster)	the Netherlands that produces garment and interior textiles with local and/or recycled yarns.		
Permess	Textile company specialised in high quality		
(Evert-Jan Berenpas)	interlining products		
Saxion Textile Lab	An educational research lab with machines on a		
	small, "pilot", scale used for the production of		
	fibers, yarns, and fabrics as well as the analysis of		
	technical properties. Students, teachers, researchers, and industry work together are able to work together on challenges in the short and long term.		

Table 2: (GC)2 Participating technical partners

(3) Based on the empirical data collected through participatory observation, interviews, and the designers' own process documentation, we conducted *a qualitative analysis of the case studies* (the research-through-design projects), comparing and reflecting on the various design-driven approaches and multi-stakeholder interactions. Our case study analysis was thus an explorative and iterative process of literature study on circular design principles, collecting empirical data through observation and interviewing the designers about these principles, and cross-case comparative analysis.

In the following two sections we will present the case studies of Hellen van Rees and Michelle Baggerman. Both cases illustrate how (co-)design can create a deeper understanding of circular design and textiles for multiple stakeholders by finetuning communication, creating collective learning experiences and highlighting interdependencies between aesthetic, emotional, technical, and socio-cultural decision-making.

<sup>&</sup>lt;sup>14</sup> For these co-reflection sessions, we drew from the framework for design-driven material innovation as developed and applied in the European project Trash-2-Cash (Niinimäki, 2018; Tubito et al., 2018), as well as from creative tools from the Circular Design Guide developed by the Ellen MacArthur Foundation and IDEO (https://www.circulardesignguide.com/).

#### **Case Study 1: Hellen van Rees**

Dutch fashion and textile designer Hellen van Rees owns a small-scale business, specialising in creating "contemporary, customized, handmade products with a sustainable angle."<sup>15</sup> Within (GC)<sup>2</sup>, Van Rees' research focused on errors in traditional textile productions, by exploring the possibility to repurpose this form of pre-consumer (waste) textiles for small- scale productions or limited series products within her own practice. By working with what would traditionally be viewed as production 'flaws', she aimed to add value to the material and to transform the perception of 'flawed' textiles or 'waste' into circular design opportunities.

#### Upcycling 'flawed' pre-consumer (waste) textiles into modular garments

Van Rees started the project by focusing on technical errors in textile production guided by the principle *design for a technological cycle*. In close collaboration with Annemieke Koster (Enschede Textielstad), she assembled an inventory of common production 'mistakes' and 'errors' that usually end up as waste (Figure 2). She reframed the perception of those waste textiles and scraps by reworking/upcycling them into new products and unique details. Value was added by repurposing them for high quality garment design enabling the textiles to be looped back into the system and thus a (more) circular flow of material resources.



Figure 2: Examples of production mistakes (©Hellen van Rees)

The close collaboration with technical partners in the form of company visits, face-to-face conversations and work sessions, were a prerequisite for Van Rees to be able to look beyond a

<sup>&</sup>lt;sup>15</sup> www.hellenvanrees.com

more "traditional design approach", drawing attention to the real-life complexity of textile production, bridging knowledge gaps regarding technical limitations, and as such to take in a system perspective on circularity. Her process and reflections strongly illustrate how interwoven choices in material, aesthetics, technical aspects, as well as user needs are:

It's always responding to new knowledge and then improving the processes. The more I learn about it, the more I learn that to really be (...) sustainable (...), you have to transition from having your design being informed by the aesthetics, to being able to combine that with all the technical limitations. The more sustainable something is, the more you have to be informed by the technical possibilities and limitations and adjust the design to that

(Hellen van Rees, December 2019)

Through the interaction and technical knowledge exchanged with Koster as well as Anton Luiken (Alcon Advies), she realised she had to take further steps and extend her initial approach to truly be able to develop a (more) circular product. Hence the principle *design for dis- and reassembly* combined with *ease of maintenance and repair* gained in importance and Van Rees decided to develop a small collection with modular garment parts (Figure 3). This decision had impact beyond the project context as working with a modular approach requires to also rethink her business model in terms of selling and recollecting modular pieces.



Figure 3: Prototypes of modular garments (©Hellen van Rees)

## Mediating different ways of working

What stands out in Van Rees' case is her relational design approach manifesting itself in several ways. Throughout the process, interdependencies between her design approach, including different circular design principles, technical limitations and challenges in textile production, and the corresponding business model became more and more noticeable. Through the close dialogue with Koster (Enschede Textielstad) and Luiken (Alcon Advies), in which design and technical knowledge were very much intertwined, Van Rees' awareness of the intimate connections between different principles increased. This dialogue was further enhanced by Van Rees' way of working with and from the material at hand, as the textiles 'flaws' provided by Koster were taken as the starting point for further conceptual and aesthetic explorations. Likewise, by utilising the features of the reworked waste textiles as design elements, the material helps to create a unique product identity and thus to facilitate greater emotional attachment to the product as well as personally engaging with her clients.

Van Rees started with a very open-ended process, approaching manufacturers from the very beginning to let her design be inspired by potential 'flaws' and production errors. 'Flaws' are only considered 'flaws' within a specific context, and designers' ability to change perspectives can thus help to reduce 'waste' by providing a valuable tool to reflect on and understand each other's visions, capabilities, and ways of working:

The way of working and approach is completely different. (...) designers start from a subjective goal, not from a concrete idea. Totally the opposite how technical textile engineers work. Furthermore, the designers are more emotionally involved, the textile engineers are at a distance

#### (Anton Luiken, November 2021)

However, we have to be careful to claim that these abilities or competencies can only be assigned to designers. It needs a certain openness to re-frame and see different opportunities, which is also key to the approach of Koster. Koster and Van Rees share a similar vision and approach towards sustainability, but bring in different types of knowledge regarding technical possibilities, design opportunities and consumer needs. Their collaborative process of understanding and refining each other's vision (in terms transforming textile 'flaws' into design features) worked very well, due to a shared (open) mindset and creative approach, but also facilitated by their (physical) proximity and (frequent) direct contact. The equal, open and curious dialogues demonstrate how both designer and manufacturer are learning from each other and change their perspectives. Through close dialogue in different stages of the process, technical limitations thus become design opportunities. Van Rees' aim to *design for dis- and reassembly* furthermore became part of the dialogue with technical partners, including Koster and Luiken. In this way, circular design principles foster understanding between different ways of working, functioning as a common frame of reference, or shared language, to align interests, values and ambitions, facilitating stakeholders' learning and reflection capacities.

#### **Case Study 2: Michelle Baggerman**

With an MA in Design Research, Michelle Baggerman considers herself a design researcher, rather than a product designer, with a strong interest in "social, ecological, and economical sustainability."<sup>16</sup> Baggerman's research within (GC)<sup>2</sup> focused on what it takes to create a sustainable product by exploring a tea towel as an example of a "simple" and "functional" product. Her main challenge constituted to explore and better understand the complexities of sustainable design, to help designers, buyers, producers, and other stakeholders in the textile industries to make informed sustainable decisions:

We all think that we know what circularity means, because there are rules to follow. But following the rules in practice is extremely complex. It is crucial to be aware of this complexity to be able to make the 'right' decisions

(Michelle Baggerman, October 2019)

## Unravelling complexity

By "unravelling" a tea towel and subsequently re-designing/re-engineering it, Baggerman first developed a 'decision matrix' (Figure 5), illustrating the choices designers and product developers are confronted with in the design and production process: from selecting raw materials and yarn thickness to the density of the fabric and the type of weave, and most importantly how these decisions do not only affect the outcome but also each other.

Baggerman involved a wide variety of partners in the development of her matrix throughout several iterations, including Anton Luiken (providing technical knowledge), external designers and researchers (to test the comprehensibility of early matrix versions), Saxion Textile lab (to produce first tea towel prototypes), and Annemieke Koster (providing technical knowledge & producing final tea towel prototypes based on sustainable yarns). As a result, several tea towel prototypes were produced according to a decision matrix specifically tailored to Enschede Textielstad's production possibilities (Figure 4). The final prototypes illustrated different 'degrees of sustainability' and how decisions taken during the design and production process influence functionality, aesthetics, and circularity of the end product.

<sup>&</sup>lt;sup>16</sup> www.bureaubaggerman.nl



Figure 4. Tea towel prototypes (©Michelle Baggerman)



Figure 5: Decision matrix (©Michelle Baggerman)

#### Design for understanding

Baggerman felt that the essence of her approach was not captured in the provided framework of Bocken et al. (2016), which led her to coin a new circular design principle: *design for understanding*. Her key focus was the industry's lack of transparency, aiming to open up and communicate the complexity of technical and design choices that inform and structure the production process. By opening up the design and production process to all actors within the

value chain (designers, suppliers, manufacturer, users), complexity was no longer a black box but became part of a shared learning process about (technical) limitations and possibilities.

The ability to make informed decisions means being able to design according to different circular design principles more effectively, such as *physical durability* and *technological/biological cycles*, by choosing appropriate material and production techniques.

Communication of the design and production process alone does not automatically affect material resource flows. *Design for understanding* rather serves as an underlying principle to contribute to circularity as it conceptually addresses fundamental issues of sustainable fashion and textile production on a systems level. From transparency and information can (ideally) follow trust into the product, according to Baggerman's vision: "In order to understanding as a guiding principle can also positively influence emotional attachment to the product.

## Designing boundary objects

*Design for understanding* does not necessarily involve the production of market-ready endproducts. Baggerman's decision matrix and tea towel samples rather served as boundary objects (cf. Stompff, 2020; Stompff & Smulders, 2015) to facilitate dialogue and shared learning experiences: "I am not designing a tea towel really to dry dishes. I definitely design as a way to learn (...and to show...) alternatives" (Michelle Baggerman, February 2020).

To collaborate and co-design effectively, stakeholders need to mediate between different ways of working, knowledge, expectations, and mindsets:

The fun AND difficulty are that you deal with curious designers, who want to dive deep into the whole process. Therefore, you must fine tune the communication to prevent ambiguities about how to proceed, who is responsible for what, and what can we do together. It is sometimes frustrating that you cannot fulfil the designer's expectations because it is technically not possible

#### (Annemieke Koster, November 2021)

Baggerman's curiosity and capacity to translate (abstract) knowledge with and for different stakeholders by making it tangible, visual, understandable, and usable is key here. It is in coreflecting on her visualizations and the test results of her samples with other stakeholders (fellow designers, textile researchers and manufacturers), that a shared understanding was created. Interdisciplinary reflection and interaction within Baggerman's design research was a necessary condition to learn and create new knowledge, as for instance about the technical possibilities at Enschede Textielstad. Yet, at the same time, the visual and tangible knowledge that Baggerman created through this interaction, is what actually facilitated co- reflection and co-visioning. Baggerman's diagrams and prototypes thus served as boundary objects to bridge (potential) knowledge gaps between designers, manufacturers and researchers. Ultimately, the result of this design research was a (communication) tool to create a shared language and shared understanding and thus facilitate a circular co-design approach.

## Co-design for understanding

In aiming to unravel complexity and to facilitate and increase shared understanding among different stakeholders along the textile value chain, Baggerman engaged in a co-design and co-learning process with technical partners and designers and (design) researchers. The boundary objects that were created within this process were both facilitating and facilitated by this collaborative approach. *Design for understanding* served as a guiding principle and tool for collective learning and knowledge creation. In this way, design – and more specifically *co-design* – facilitates dialogue and interaction, as well as a common frame of reference among stakeholders. Put differently, *co-design for understanding* as a guiding principle can help to mediate between different types of knowledge and practice.

#### **Discussion & Conclusions**

This paper explored (co-)design as a way to mediate between processes of multistakeholder value creation in the transition towards circularity in textiles and fashion. There is common consensus in the literature that circularity is a joint effort within and between ecosystems. Circularity goes beyond technical aspects, emerging out of changes in how different actors, products, components, and material interact with each other. The role of design has gained increased interest in relation to tackling such complex, societal challenges. Multi-stakeholder collaboration is needed, not just to bring in different knowledge and expertise, but also to negotiate and align agendas and interests. However, current approaches often have a limited understanding of the socio-cultural and relational dimensions of circularity, respective circular design principles, how such principles work in practice, and what role design(ers) can or should play in multi-stakeholder collaborations, especially within the textiles and fashion industries.

Based on the case studies of the  $(GC)^2$  project, we conclude this paper by reflecting on the potential of circular design principles – and more specifically *(co-)design for understanding* – in mediating between processes of multi-stakeholder value creation. We discuss the role of a relational (design) approach, as a condition for interdisciplinary collaboration, and how(*co-)design for understanding* as a guiding principle can facilitate and build (relational) proximity.

#### Relational proximity in interdisciplinary collaboration

Integrating aesthetic, technical, and functional values through multi-stakeholder collaboration seems to be a crucial factor in the transition towards circular value chains in textiles and fashion. This demands for interdisciplinary collaboration based on mutual trust, transparency, and understanding. While textile value chains are often globally dispersed, our research has shown that physical proximity between stakeholders is beneficial in developing a shared understanding, as frequent direct contact contributed to more effective dialogue and collaboration (cf. Köppchen, 2014). Yet, while physical proximity helps, *relational* proximity might be even more important for such co-design processes. To collaborate effectively, and to really *understand* each other and work towards a shared goal, stakeholders from different

disciplines need a common frame of reference. Such common frames of reference include ways of understanding AND doing, and could be anything from shared routines and practices, rules, values, norms, vocabulary, tools, cultures, techniques, methods, etc. (e.g. Aspers, 2010;Knoben & Oerlemans, 2006). Knowledge is thus not only shared, but needs to be translated, and new knowledge is being created in the process. Our analysis indicates that some form of (relational) proximity between partners indeed helps to increase designers' and technicians' agility or capacity to adapt to and to co-create new knowledge. It facilitates mutual understanding of interdependencies between circular design principles, defining a common goal and building a collaborative interdisciplinary practice.

# Circular design principles as tools for reflection and learning

Within the  $(GC)^2$  project, designers were challenged to critically reflect on the role of circular design principles within their research, practice, and their collaboration with (technical) partners. For designers, circular design principles initially played a role only on a subconscious level. They indicated that they often work quite intuitively, which can be very different from the technical partners' way of working. However, especially in the early stages of the design process, reflecting more consciously and deliberately on circular design principles together with different partners proved to be a valuable tool for communication, reflection, and learning. In this way, circular design principles are not necessarily determining *what* to design, but as a tool for reflection they can help to guide the interdisciplinary interaction between stakeholders, making the more subconscious and intuitive (design) decisions more explicit and thereby providing a shared language for collaborative innovation and value creation.

#### Co-design for understanding as a tool for mediation

Michelle Baggerman coined the principle *design for understanding* as a way to address challenges in production complexity and lack of transparency, by using design to identify and visualize interdependencies between aesthetic, material, and technical decisions. The 'products' of this design (research) process serve as 'boundary objects' (Stompff, 2020) in a shared learning process among different stakeholders. Ultimately, the aim is to enable stakeholders to make more informed (design) decisions, which helps to transform technical limitations into design opportunities for circular innovation and the development of concrete circular practices and solutions.

The role of boundary objects in facilitating mutual understanding has been extensively explored by Stompff & Smulders (2015; 2020) in the context of team design, supporting our observations in both case studies that diagrams, samples, and prototypes can facilitate interaction and dialogue, thus shaping a shared vision between stakeholders. Furthermore, Niinimäki et al. (2017) found that when dealing with contradictory aims and knowledge gaps between disciplines, an intermediator might be required in (material) innovation processes.

Both Baggerman and Van Rees have taken this role of (inter-)mediation by not only designing boundary objects as such, but by actively engaging in an equal dialogue with different

stakeholders to facilitate processes of co-learning and co-reflection. The emphasis then is no longer on designing new products or materials, but on *co-designing* a shared learning experience. The boundary objects that were created within this process were both facilitating and facilitated by this collaborative approach. Mutual trust and understanding are built within this relational process. We therefore propose *co-design for understanding* as a guiding principle and tool for mediation, to facilitate dialogue and interaction, which is needed to create a shared vision among stakeholders, and to co-create new, circular systems. As a tool for mediation, *co-design for understanding* thus contributes to creating relational proximity. It shifts attention away from designing products and materials as end goal, towards designing processes and methods of mediation between multiple stakeholders.

## *Limitations and further research*

While our findings showed the potential of design(ers) as mediator between different stakeholders to align interests, and to create mutual understanding and awareness for interdependencies between circular design principles, technical project partners have consistently drawn attention to questions of impact and upscaling. The case studies we have presented are small-scale and highly context-dependent. Questions remain in how far our findings from these small-scale experiments can be translated to other contexts and situations, and to create impact on a larger scale.

Furthermore, the concept of relational proximity requires more theoretical and methodological exploration. The concept is being discussed in economic geography and organization sciences to understand knowledge exchange and creation between economic actors (e.g. Amin & Cohendet, 2004; Gertler, 2008). Diving deeper into these different strands of literature goes beyond the scope of our paper, but it could provide new insights into how relational proximity works on different levels in more complex value chains.

We do see the potential for *co-design for understanding* to be developed further into a concrete tool, to enable informed circular decision making in different contexts. With an emphasis on processes, mediation and relations based on trust and mutual understanding, *co- design for understanding* also relates to existing frameworks and concepts such as *empathic (co-)design* (cf. Mattelmäki et al. (2014); Smeenk, 2019). Combining and comparing respective existing tools and frameworks could then be a next step to further assess and validate both the potential impact and the practical usability of the principle and tool.

Especially in the context of education, it could be worthwhile to further explore the role of circular design principles in helping upcoming designers to consciously reflect on their practice and role in the process (cf. De Brouwer, 2020).<sup>17</sup> We invite designers, (design) researchers, practitioners, and industry professionals to further explore, experiment and adapt this principle

<sup>&</sup>lt;sup>17</sup> As part of the project, researcher Zinzi de Brouwer developed the report "Recommendations for a Circular Design Practice: Reflections on Designing for a Circular Textile and Fashion System for Students and Emerging Designers" (2020). The report aims at starting designers who are invested in designing for the circular economy and in turn wish to incorporate and adhere to key circular design principles in their design practice.

as a mediation tool in different contexts. Based on our case study analysis, *co- design for understanding* seems a promising way to re-imagine and, perhaps more importantly, to *put into practice* mediating interactions between different actors in the value chain – ultimately, hopefully, contributing to the transition towards more circular fashion value chains and systems.

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# Appendices

Appendix 1: Circular strategies and principles based on Bocken et al. (2016)

