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Materializing responsible futures: An interpretative phenomenological analysis of circular design experiences in construction

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A B S T R A C T

Reimagining design as a transformative practice for realizing a circular built environment is both urgent and important. Many of today's resource problems can be traced back to the way constructions are being designed. The adoption of circular design practices may alleviate these problems. Most previous research has either mapped the boundaries of contemporary circular design practices or pushed those boundaries with new interventions. The lived experiences of designers are, however, often overlooked. Little remains known about what it is like to be engaged in and how to 'live through' circular design. This study therefore seeks to understand the practice from the perspective of designers themselves. Through applying an interpretative phenomenological analysis to unstructured interview data collected from ten frontrunning Dutch designers, it explores both the what and how of circular design. Four emergent themes were found that illuminate the experience itself. Circular design is, accordingly, interpreted as a practice which: proclaims responsibility towards the Earth, materializes future-oriented solutions, deals with a multi-headed monster, and involves orchestrating a design ecosystem. These themes are illustrated with narrative accounts of designers' actual experiences. The rich, in-depth insights offer ample learning opportunities to better understand and facilitate unfolding circularity transitions. Circular design is, as such, theorized as a vital practice that can shape the built environment through materializing responsible futures.

1. Introduction

Learning from the experience of leading designers is invaluable to accelerate the transition to a circular built environment. Given that the construction industry keeps struggling with bringing down its significant share in resource consumption, waste production, and greenhouse gas emissions, the transformation of its practices has become a priority for environmental programs around the world (Gálvez-Martos et al., 2018; McDowall et al., 2017). Policies are being formulated that promote a cyclical, rather than linear, industrial economic approach "that is restorative or regenerative by intention and design" (Ellen MacArthur Foundation, 2013, p.7). For instance, the European Commission's Circular Economy Action Plan emphasizes sustainable building design and waste reduction (European Commission, 2020) and the Dutch National Circular Economy Programme 2023–2030 prioritizes construction in encouraging nationwide resource efficiency (Ministerie van Infrastructuur en Waterstaat, 2023). Such policies support the development of a circular economy that seeks to 'design out' waste through optimization of resource loops and recovered environmental integrity (Ghisellini et al., 2016; Korhonen et al., 2018). Applied to the built environment, this entails the use of practices to keep materials in a closed loop as long as possible to reduce the use of raw materials in new construction projects (Benachio et al., 2020). Adopting such practices in design represents a complex and multidimensional challenge (Joensuu et al., 2020; Pomponi and Moncaster, 2017). It can therefore be highly informative to understand how frontrunners in circular design have experienced it.

This is particularly important as many resource problems can be traced back to the way constructions are being designed (Van den Berg, 2019). Durmisevic (2019), for example, argued that waste is essentially a design error, caused by the fact that few buildings are designed to facilitate dismantling and reusing or recycling. The latter would require

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"taking account of the building's demolition during the design stage, when other issues take priority" (Sassi, 2004). Kibert et al. (2001, p.214) also argued that designers are reluctant to spend "intensive labor creating a building only to be torn down." Consequentially, there are limited opportunities to capture the value of existing materials during demolition, when buildings quickly turn from assets into liabilities (Leigh and Patterson, 2006). It furthermore seems challenging to design with any reclaimed materials, primarily because those "do not show up at the right time, in the right amount or the right dimension" (Gorgolewski, 2008, p.179). Designers tend to select new materials instead and, thus, the pressure on natural resource extraction persists (Tirado et al., 2022). Given the expected global population growth, rising income, and urbanization, Andrews (2015) argued that designers must now respond to these problems and change their design thinking and practice.

Changed practices are nevertheless rarely documented. A review of circular construction literature by Çimen (2021) revealed that the design stage was the least studied life-cycle stage (with only 26 out of 238 papers covering it). Other life-cycle stages are dealt with more frequently. Design-oriented studies generally aim to provide a better understanding of "the role of design in the construction value chain" (Munaro et al., 2020, p.12). Some of these studies do this through mapping the boundaries of contemporary circular design practices; others studies attempt to push those boundaries with newly developed interventions. Rios et al. (2021), for example, revealed that architects in the United States faced a wide range of barriers in circular building design, like "cost and schedule constraints" and "existing regulations and codes hindering reuse and repair". Whereas similar circular design barriers were reported elsewhere (Adams et al., 2017; Akinade et al., 2020; Kanters, 2020; Kozminska, 2019; Munaro and Tavares, 2023), other studies in this first group include works on standardization (Anastasiades et al., 2023b; Neaves, 2024) or design strategies (Eberhardt et al., 2022; Eberhardt et al., 2021; Motiei et al., 2024; Munaro et al., 2022). The second group proposes new design instruments and decision-support tools, such as material passports (Honic et al., 2019; Luscuere, 2017), life-cycle assessment methods (Eberhardt et al., 2019; Van Gulck and Steeman, 2024) or deconstructability assessments (Akanbi et al., 2019; Basta et al., 2020; Mahmoudi Motahar et al., 2024). These studies mainly aim to foster certain circular design practices (Cambier et al., 2020; Rexfelt and Selvefors, 2024). Both groups of studies, however, tend to ignore what it is like to be engaged in and how to 'live through' circular design: they overlook designers' lived experiences.

Understanding those lived experiences is critical though. Research into any particular phenomenon often prerequires understanding the experiences of others so that new insights can be gleaned. Before developing a treatment to a certain disease, for example, it can be highly informative to understand how that disease itself is experienced (see Carel, 2016). Van Manen (2016, p.71) argues that carefully deconstructing phenomena may also enable us to "thoughtfully and tactfully aim for the perfection [of those phenomena] in our actual personal lives." Some even consider such learning "the foundational premise of research" (Neubauer et al., 2019, p.91). As such, those willing to engage in circular design may learn from the experiences of individuals who practiced it before. The importance of learning from previous experiences is also widely recognized in transition management literature (Kemp et al., 2007; Loorbach et al., 2016; Rotmans and Loorbach, 2008). Firmly linked to ideas of experimentation and learning-by-doing, that literature stream often sees learning as a steering mechanism or governance tool for sustainability transitions (Van Mierlo et al., 2020). Schäpke et al. (2017) argued that "having experiences can be seen as an indicator for the creation of impacts" in those transitions. Trying to understand what actors experience and how they experience that appears a useful and increasingly robust strategy for accelerating and guiding transitions (Loorbach and Rotmans, 2010).

This paper therefore seeks to better understand circular design in construction through exploring it from the perspective of designers who have experienced it. It uses a variant of phenomenology, which is concerned with the study of an individual's lived experiences within the world, that is rarely used in sustainable construction research. The next section outlines the selected methodology, including its underlying philosophical beliefs and assumptions. Drawing upon unstructured interview data collected from leaders in circular design, we then develop new meanings and appreciations from the accounts of these experiential experts. The paper ends with a discussion and conclusion section in which we reflect on how those findings inform, or even reorient, our collective understanding of circular design.

2. Methodology

This phenomenological research explores how designers make sense of their circular design experiences. Phenomenology broadly refers to the study of phenomena as they manifest in conscious experience (Beck, 2021). It was originally developed by Edmund Husserl as a philosophical approach to describe those essential features (called 'essences') of certain phenomena that make them distinguishable from others. Husserl posited that the essences can be identified through a series of reductions, where phenomenologists attempt to set aside (or 'bracket') their own biases and disconnect (or 'transcend') from everyday life so that the phenomenon can be seen in purified form. This descriptive (or 'transcendental') phenomenology was further developed by Martin Heidegger into interpretative (or 'hermeneutic') phenomenology. Heidegger maintained that individuals are always already in an environing world and disputed the of idea of fully detached reflection (or bracketing) to articulate essences. He was, instead, concerned with the ontological question of existence and in particular the human experience of being, termed 'Dasein' (Luft and Overgaard, 2013; Sokolowski, 2000).

Several phenomenological methodologies have been developed based on these two fundamentally different approaches. Examples include the descriptive phenomenological methodology by Giorgi (1997, 2005) and interpretative ones by Van Manen (1990, 2016) or Smith (1996, 2004). Such methodologies differ to some degree in their theoretical emphases and methodological commitments, but are all in broad agreement about the relevance of examining experiences and the meanings that individuals attribute to those (Gill, 2014). Yet where descriptive phenomenological methodologies assume that reality is internal to an observer and that phenomena can be understood bias-free through descriptive means, interpretative methodologies assume that the lived experience is an interpretative process situated in an individual's lifeworld that can never be understood bias-free and must, instead, be reflected upon (Neubauer et al., 2019). Phenomenology variants are thus rooted in different ways of conceiving of the *what* and *how* of human experience. Their applications are scarce in contemporary sustainability research but include works on embodied and artful design (Küpers, 2016), ethics in corporate research and innovation (Stahl et al., 2019), and user perspectives about product repair (Terzioğlu, 2021).

We selected interpretative phenomenological analysis (IPA) by Smith (1996) based on our shared epistemological and ontological assumptions, as well as the nature of our research aim. IPA is a relatively recent, yet increasingly popular, interpretative methodology that focuses on how individuals make sense of their personal lived experiences (Smith, 2004; Smith et al., 2022; Smith and Osborn, 2015). It assumes that people are 'self-interpreting beings', which means that they actively engage in interpreting the activities, objects, and people in their lives (Pietkiewicz and Smith, 2014). Designers of circular constructions are, in this light, seen as 'experiential experts' in circular design and their subjective experiences are treated as 'concernful involvements' with that practice (see Eatough and Smith, 2017). IPA can be used to understand what it is like to stand in the shoes of such experiential experts. This requires a dual interpretation (or 'double hermeneutic') process on the part of both involved designers and the researchers because, firstly, the designers must make sense of what is happening to them and, secondly, the researchers must make sense of their sense-making (Smith, 2011a). IPA is thereby strongly ideographic. It emphasizes examining individual perspectives in their unique contexts before producing any general statements (Smith, 2004). Such interpretative endeavors are guided by the 'hermeneutic circle' that encourages researchers to work with their data in an iterative fashion (Fig. 1), considering parts in light of the whole and vice versa (Eatough and Smith, 2017). IPA can thus offer a privileged view of the meaning of circular design experiences from the perspective of the designers themselves.

2.1. Data collection

Interviews with ten frontrunning designers comprise our primary source of data. Since IPA attempts to give full appreciation to each study participant's account (or case), sample sizes tend to be small. Many IPA studies have samples of 5–10 participants (Smith, 2004). Those participants are typically purposively selected so that an individual represents a perspective on the phenomenon being studied rather than a population (Smith and Osborn, 2015). We therefore selected participants with personal, firsthand experience in circular design. Those participants were identified via Platform CB'23, a community of practice in the Netherlands that has made national, industry-wide working agreements on several circular construction themes. The first three authors of this paper participated in one of the platform's so-called action teams that did this for circular design (Platform CB'23, 2021). We used that opportunity to connect with designers that were recognized as frontrunners among their industry peers. Seventeen practitioners initially agreed to participate in an interview when we made a call for participation during one of the platform's online meetings (with around thirty practitioners in total); seven of them were later excluded since they held other circular construction roles (such as policy-maker or contractor) and, therefore, did not meet the IPA requirement for a relatively homogenous sample (Smith et al., 2022). Consequently, we included interviews with ten practitioners who had circular design experience (Table 1). The projects these ten 'experiential experts' worked on received ample media coverage and some won industry awards, which arguably adds to the credibility of their selection here.

The interviews were unstructured, as recommended by Bernard and Ryan (2010, p.259). We asked every participant a single, open-ended question – "could you please tell us about your experiences in circular design?" – and then probed to let them run with it. Before each interview, we attempted to identify and set aside our own preconceptions

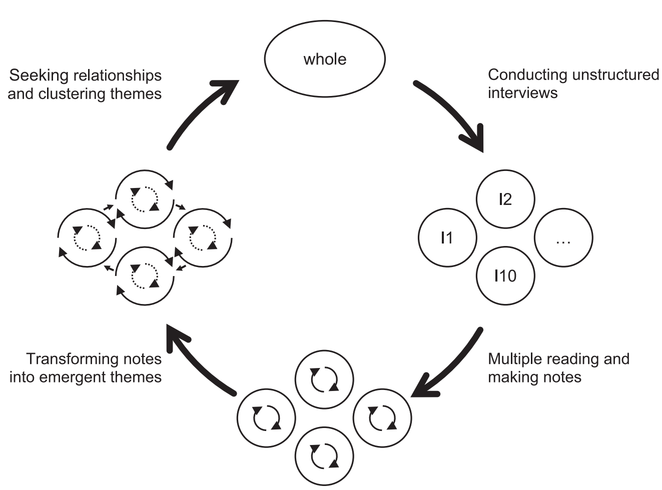

Fig. 1. Data collection and analysis activities positioned in the 'hermeneutic circle' that highlights that in the process of interpretation, understanding of a whole is achieved through understanding its parts, and vice versa (which takes place both at the research level and at the level of individual interview transcriptions).

Table 1
Background information of selected interviewees.

Participant	Design position	Company type (size)[a]	Professional experience[b]	Example project (type)
Interviewee 1	Consultant/ co-founder	Consultancy & engineering firm (small)	16 years	Office building (new-build)
Interviewee 2	Architect/ owner	Architectural firm (small)	15 years	Dwellings (renovation)
Interviewee 3	Architect/ developer/ researcher	Architectural firm (small)	23 years	Healthcare building (new-build)
Interviewee 4	Consultant/ developer	Consultancy & engineering firm (small)	35 years	Police station (new-build)
Interviewee 5	Consultant/ architect	Consultancy & engineering firm (small)	32 years	Town hall (new-build)
Interviewee 6	Developer/ director	Architectural firm (medium)	32 years	Provincial governmental building (re-build)
Interviewee 7	Consultant	Consultancy & engineering firm (small)	6 years	School (transformation)
Interviewee 8	Director/ co-founder	Consultancy & engineering firm (small)	29 years	Office center (new-build)
Interviewee 9	Consultant/ developer	Architectural firm (small)	34 years	Restaurant/ meeting space (new-build)
Interviewee 10	Architect	Architectural firm (small)	23 years	Sports club (new-build)

[a] Categorized into: small (<50 employees), medium (50–500 employees) and large (>500 employees).
[b] Dedicated to circularity principles in design (informed estimation).

about circular design as much as possible. Next to becoming self-reflectively aware, we reminded our participants to neutralize their thoughts about the aforementioned platform so that they could fully attend to the aspects of their circular design experience that mattered to them. These activities helped to become "a curious and attentive but 'naive' listener" during the interview (Smith and Osborn, 2015, p.29). We used gentle nudging techniques – like humming, summarizing answers and allowing silence – to encourage participants to keep talking about their experiences. The interviews, accordingly, unfolded in very diverse ways but all ended when the participants indicated (and we double checked) that they had shared all relevant aspects of their experience. As such, the interviews lasted approximately 1 h each. All participants gave informed consent to be interviewed. Since the interviews were conducted during one of the COVID-19 lockdowns at the end of 2021, they took place online. This format nevertheless enabled interviewees to share their screens, supporting their narratives with visual examples from their projects; about half of them used this functionality. All interviews were audio-recorded and transcribed verbatim. As such, we attempted to elicit rich, detailed, and first-person accounts of circular design experiences.

2.2. Data analysis

The interview transcripts were analyzed using IPA's flexible guidelines that explicitly encourage imaginative and creative thinking (Eatough and Smith, 2017). While adapting our analysis procedures to align with our specific research aim, we also actively endeavored to meet the evaluation criteria for "good" IPA studies (Nizza et al., 2021; Smith, 2011a, 2011b). The first author led the analysis and regularly discussed intermediate findings with the other researchers. Generally, this analysis involved an immersive approach that iterated through the following steps: multiple reading and making notes; transforming notes into emergent themes; and seeking relationships and clustering themes

(Pietkiewicz and Smith, 2014).

The analysis started with multiple reading and making notes. Working from case to case, this started with close reading of the interview transcripts. Each transcript was read a number of times. Some of the audio-recordings were also listened to a few times. This reading and listening was recommended to become as familiar as possible with the participants' accounts (Smith and Osborn, 2015). During this process, the first researcher made notes about his in-text observations (Fig. 2) using qualitative data analysis software (ATLAS.ti). These exploratory notes captured various aspects of the texts, including content, language use, context and initial interpretative comments. Distinctive phrases that stood out for their capacity to illuminate and enhance interpretation – conceptualized as "gems" (Eatough and Smith, 2017) – were also highlighted.

Transforming notes into emergent themes was the next step in the analysis. We started working more with the notes than the transcripts in this step. The leading researcher transformed the exploratory notes into concise themes which captured the essential quality of what was found in a text. The themes had a slightly higher level of abstraction. With these themes, we attempted to capture the participants' sense-making of circular design. They, accordingly, linked to aspects such as what design strategies were used and how and why they were selected. Two researchers furthermore summarized their overall interpretations from each interview in a separate document.

Seeking relationships and clustering themes was the last step. The emergent themes were rearranged by looking for patterns and connections. We thereby followed analytical steps such as described by Beck (2021), including abstraction (clustering themes in superordinate themes), numeration (making a frequency count) and contextualization (identifying contextual elements). Some of the themes were dropped at this point for their weak evidence base (Pietkiewicz and Smith, 2014). The remaining themes were presented in a coherent way, with each theme supported by extracts from at least three participants and an indication of its prevalence (Smith, 2011a). These qualitative insights began to provide, as far as possible, an insider's perspective on circular design.

3. Results

This study grasped circular design experiences as lived by designers in the field of construction. We found four 'super-ordinate' themes and ten 'sub-ordinate' themes (Table 2) that, altogether, capture the texture and qualities of the designers' lived experiences. The interconnected

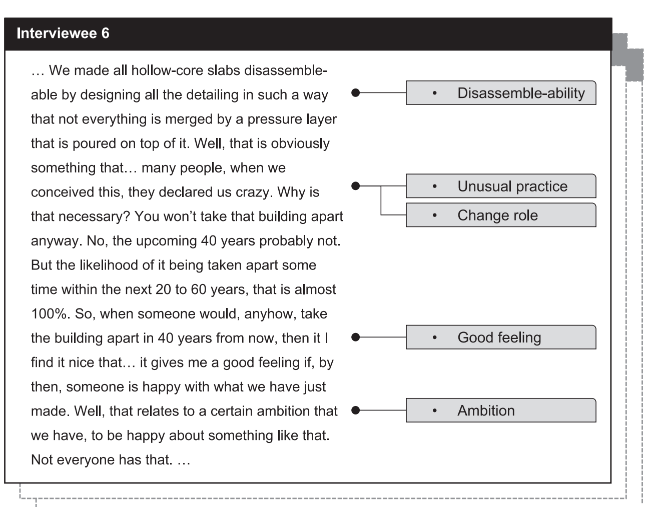

Fig. 2. Interview transcript split into meaningful chunks of text to which notes are assigned as a first step towards discovering emergent themes (illustrated example).

Table 2
Hierarchically clustered themes regarding circular design experiences.

#	Super-ordinate theme	Sub-ordinate theme	Exemplary quote
1	Proclaiming responsibility towards the Earth	Practicing resource responsibility	"we accept old toilet bowls, accept the old railing for the stairs, and so on." (Interviewee 5)
		Preaching resource awareness	"a preacher … who can clearly articulate circularity and why and how you do that in buildings" (Interviewee 3)
2	Materializing future-oriented solutions	Enabling multi-cycle materials usage	"Considering a future usage, so when a waste stream starts … and you know that you can reuse those things … is actually already sufficient." (Interviewee 8)
		Selecting appropriate design strategies	"In those contexts, I typically use bio-based materials, renewable materials. … That is for such cases my most important strategy." (Interviewee 2)
3	Dealing with a multi-headed monster	Measuring circular impact	"but if someone asks me for the definition of circularity and what percentage of this or that building is circular … then I can't say anything meaningful about that." (Interviewee 6)
		Complying with regulations	"for designers, it is very challenging to reuse materials when you are so tightly bound by all sorts of detailed regulations" (Interviewee 4)
		Managing information flows	"It's not without reason that I advocate … for making the materials passport mandatory, especially when issuing demolition permits, yes, making it a requirement." (Interviewee 1)
4	Orchestrating a design ecosystem	Co-defining circularity goals	"I realized that I got the skills to lead the design team and also the stakeholders at the municipality to realize those project goals" (Interviewee 9)
		Creating solutions with partners	"we want to involve suppliers much earlier, really during the preliminary design phase already, so that they can indicate what is possible and what not" (Interviewee 7)
		Integrating solutions into whole	"that sort of integral design will become the new default way of designing, so to speak" (Interviewee 2)

experiential features are described and illustrated with extracts from the interviews below. In line with the 'double hermeneutic' style of any IPA study (Smith, 1996, 2004), we also interpret these results (Fig. 3). That is, with our narrative accounts, we attempted to make sense of designers making sense of their circular design experiences.

3.1. Proclaiming responsibility towards the Earth

Circular design prerequires "some kind of basic attitude" that directs *practicing resource responsibility*. Interviewee 6 described how such a basic attitude for acting responsibly needs to be prevalent in design, so that one can come up with "things that meet people's needs in the present, but without limiting future generations to meet their own needs." The designer is, in his view, responsible for making sure that the Earth's resources are used at a sustainable rate. Almost all other designers felt such a responsibility towards the Earth. "This is very fundamental,

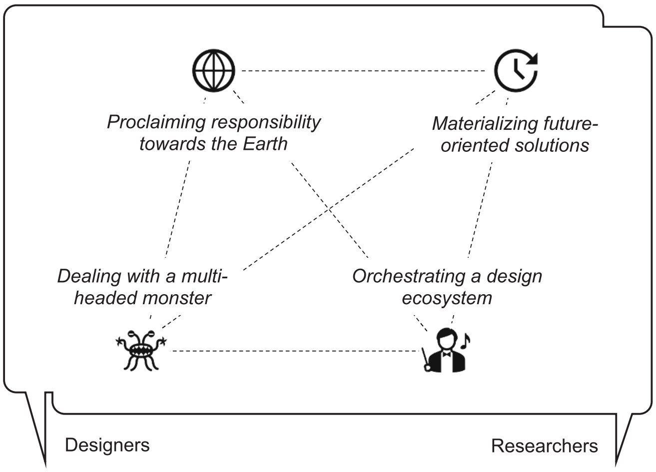

Fig. 3. Interpretation of designers' interpretation of their circular design experiences.

actually," said Interviewee 3:

> "*I think that is really revolutionary: saying that nobody can claim ownership of any materials. The Earth belongs to everyone … and the only obligation we have is to make sure that materials keep re-entering in a cycle. Nothing more and nothing less. That is the most radical standpoint, but … I think it is the essence.*"

Interviewee 3 here holds the position that materials belong to the Earth. Designers can use them, but without claiming ownership. He acknowledges that this is completely different from the status quo, the present linear design practice, by using words such as "fundamental," "revolutionary" and "radical." The essential difference is the (moral or ethical) obligation to ensure that materials, which are only borrowed from the Earth, can be kept in the loop.

Other designers describe similar attitudes. Interviewee 7 used the word "responsibility" rather than "obligation" to describe his relationship with the Earth. For him, circular design "is eventually about CO_2 emissions and the prevention of resource exhaustion." He describes this as something that should come naturally:

> "*It is a certain responsibility … to be concerned with the environment and to keep our environmental impact as low as possible. That obviously applies to our personal situations, but also to building projects. Everybody has a certain responsibility, I think.*"

Interviewee 7 bases his professional work attitude on principles derived from his private life. To him, it is only logical to care about the environmental impact in everyday life and, thus, designers should do so as well. Think about the environment before you do, a mantra that also resonated in other interviews. Interviewee 8 described this responsibility as embedded in his DNA, whereas for Interviewee 1 "it was pure logic, a sustainable conviction to do so" and Interviewee 6 was "inspired by nature … where waste does not exist."

The attitude also manifested itself in a struggle to act responsibly. Interviewee 5 explained that one project for a large bank started with "some sort of soul-searching question: do we even need to make a new building?" It was at that time recognized that the bank could also occupy an existing building, which would save resources. However, the team had been tasked to prepare a design for a new-build. This awareness almost seemed to spur some sense of 'guilt' towards the Earth: it became a "soul-searching question" of whether the chosen course of design action was right.

Yet the act of circular design also enables designers to *preach resource awareness*. Interviewee 3 particularly illuminated this through his characterization of the architect "as a preacher … who can clearly articulate circularity and why and how you do that in buildings." This powerful metaphor (a *gem*) highlights the passionate communication of circularity, likening it to delivering a sermon. Several accounts indeed illustrate how designers can tell a story of sustainable resource usage through their work. Interviewee 5, for example, explained how a certain intervention, in which clothing was reprocessed as insulation materials, can make abstract circularity concepts more tangible. This sends a powerful message that can offset the fact that those materials may actually be of inferior quality:

> "*The story is almost as important as quantifying the impacts, such as when you can tell: 'your old clothes, the ones you need to throw away and that would be destroyed, … we make sure that they will be reused and come back as insulation material in the new building.' Drawing attention to certain* [*environmental*] *aspects in such a way is almost as important as the fact that you have indeed bought kilograms of lower quality insulation material.*"

Interviewee 10 similarly argued that "projects that use reclaimed products often have some sort of signal function as you can see how circular they are. That also has value. That's how you stir the debate and that is interesting." Interviewee 9, likewise, claimed that there are "over 100 stories" of circular (and sustainable) measures in a restaurant/meeting space project he worked on, including "reused inner walls from an office," "modular steel structure with dry connections," and "roof platans as natural parasols." The measures are publicly shared on an infographic and website, which reinforces the idea that circular design stories need to be told. Projects can so become vehicles that embody resource awareness.

The embodiment can even be exploited, though that seems contradictory in itself. Interviewee 1 advocated explicating economic savings "to convince the critical mass" on the value of circularity. In other words, she thinks that resource awareness can be promoted through sharing the word on any monetary benefits associated with circular design measures. She goes even further, claiming that this is only a start in completely rethinking the value of a building:

> "*When we're talking about value, then we actually take … the human being as focal point. But when you're talking about circular construction, then … I think that we must look broader … and also consider what the value of a building for the Earth can be.*"

Thus, circular design seems to proclaim a certain responsibility towards the Earth, which appears from both practicing resource responsibility and preaching resource awareness.

3.2. Materializing future-oriented solutions

Designers are also concerned with materializing future-oriented solutions. Circular design can be approached in several ways, each of which deals with solving a problem through *enabling multi-cycle materials usage*. The interviewees consistently argued that they looked beyond the project scope. Interviewee 6, for example, said that: "one actually needs to make a building for the first user, your client, but simultaneously also for the second and third user, for the fourth user, or for the user of that building on another location." Interviewee 8 similarly explained: "linear is about making a snapshot and then we'll see. With circular you need to think across those snapshots if you want to maximize reuse." It so seems that these designers are concerned not only with one, but with multiple possible futures at once.

Multi-cycle material usage means that materials are only temporarily at a certain location. The construction then becomes a temporary storage, a material bank. Interviewee 10, for instance, interpreted his circular design work as "about storing materials in a product or in an object. Storing of the material is really of central importance and the object or product is essentially some sort of temporary storage." This is different from the currently dominant linear design practice, as Interviewee 6 argued: "many designers are actually more concerned with creating a monument for themselves" instead. Interviewee 6 here uses the word "monument" to critique designers who perceive their creations as permanent and take no action to ease future disassembly. He furthermore appears to condemn their intentions as egocentric: the monument would secure such designers' long-term legacies. Circular design, contrarily, seems to view a construction only as a temporary storage.

This view affects how designers *select appropriate design strategies*. Interviewee 7 suggests that this differs per project: "we always check what the client's ambitions are, what the possibilities are?" Interviewee 5 confirmed that "there are indeed different ways to approach circular design and that is very much demand-driven … but also location-driven, context-driven, et cetera." Supported with pictures and drawings, he went on to illustrate different focal design strategies in three of his projects: 'design for disassembly' in a temporary town hall; 'design with reclaimed materials' in a network operator's office; and 'design with renewable materials' in a bank's head office. These three strategies were each selected in response to local needs. They largely correspond with the strategies deployed by other interviewees, which suggests that there is not a one-size-fits-all circularity solution for design problems at hand. Designers must select appropriate strategies instead.

Design for disassembly, the first key strategy, means that a construction is optimized for disassembly and future reuse. This strategy was most often mentioned by the interviewees. "Anticipation is a keyword," argued Interviewee 4. "When you can disassemble [rather than demolish] buildings, then that could be very profitable." Interviewee 9 even went as far as to say that "it is simply old-fashioned to paste everything together" so that buildings cannot be taken apart without damage. The strategy also seemed logical for Interviewee 5's town hall project:

> "*That is because … it was a tender in which the temporality of the building really stood out. Temporality is always very clear; that was 15 years, initially.*"

The town hall was planned to be removed after fifteen years and thus it made sense, in the words of Interviewee 5, "to serve that temporality." The building was, accordingly, "elaborated in such a way that large parts are 'disassemble-able', as we would call it nowadays, and that those big chunks could go back to the supplier." Interviewee 6's design office also embraces this same strategy, but he uses the term "circular ready" to indicate that reuse is (only) foreseen in the future:

> "*One is essentially always looking for ways to make a building as futureproof as possible. We sometimes call that 'circular ready'. … Our buildings are easy to take apart or, well, the materials are at least easily accessible.*"

The quote highlights that designers pursuing this strategy need to take into account the accessibility of materials, next to the reversibility of connections. Interviewee 4, finally, articulated this strategy as "designing with the eyes of a demolisher." He recognizes that a third party, the demolisher, will need to take any building apart at some point in the future and, thus, that designers should take that party's viewpoint into consideration now.

Design with reclaimed materials, the second key strategy, focuses on reuse in the present. During the transformation of a former head office of a large bank into a school, Interviewee 7 and colleagues strived to preserve the existing value of the icon building. "We then typically investigate how we can keep the existing materials best, how we can reuse those best." Interviewee 2 also pursued the strategy during the renovation of a dwelling from the 1970s, as exemplified:

> "*One of my ideas was to reuse the existing beams located in the roof – we were going to deconstruct the roof completely and add a completely new floor with a flat roof – to reuse those beams in the new load-bearing system for that floor.*"

During Interviewee 5's network operator's design project, new opportunities for the existing materials were also sought. This went as far as a visit to the waste collection facility in the city to investigate "what kind of waste is actually collected here and what can we do with that?" Reclaimed materials may so also be sourced elsewhere. "We went ahead with [such] reclaimed materials," said Interviewee 4, for example.

Design with renewable materials, the third strategy, implies that materials are used that belong to the so-called biological loop. Such materials can follow a cascade of uses before returning to the biosphere. Interviewee 7: "bio-based materials are obviously primary materials, but also … regenerative." "Wood is the best known example," added Interviewee 10. Since trees can grow back, wood is regenerative and, to the interviewees, this makes it an attractive material. Interviewee 7 furthermore mentioned that one also needs to prevent using building materials with chemicals listed on the banned list of Cradle-to-Cradle "because those are really harmful to the environment." Yet using regenerative materials is mentioned more often. Interviewee 5 illustrated this as follows:

> "*At the start of the project, there was still this idea to make the structural cores … from concrete. Yet at a certain time, we said that … if we are using biobased materials for structural purposes, then those would also need to* [*be made from timber*]. *Then we also took a next step there.*"

Given that the Earth can regenerate wood and other bio-based materials over a certain amount of time, this strategy considers the future availability of those materials.

Summarizing, circular design is concerned with materializing future-oriented solutions. This implies that designers select appropriate strategies – such as design for disassembly, design with reclaimed materials, and design with renewable materials – which facilitate multi-cycle material usage.

3.3. Dealing with a multi-headed monster

The circular design practice also appears to be formidable, like, in the words of Interviewee 4: "a multi-headed monster." That is, the designers responded to many challenges in their (pioneering) projects. Three such challenges stood out – related to measurements, regulations, and information – and these "dare one to perform design iterations" (Interviewee 9). Through exploring the solution space in an iterative fashion, the designers sought for appropriate responses to their challenges.

The first 'head' (challenge) concerns *measuring circular impact*. Interviewee 3 explained how important it is "to provide evidence" that any design solutions meet the client's requirements. This appeared troublesome for circularity as that is "obviously a super ambiguous concept," argued Interviewee 7. "So when clients say they want to 'do something with circularity' … then it remains very vague what they actually want." Interviewee 8 similarly said that people tend to "expect some kind of circularity scale, ranging from 1 to 10, for example, which is nonsense." Such a measurement method does not exist yet, although Interviewee 10 explained that this may soon change as "many different market parties are trying to develop tools for assessing whether something is really circular." Interviewee 6 admitted "joining the hype" in talking about circularity:

> "*We say that our courthouse is a very circular building, the most circular one. Somebody said that once and we thankfully use that phrase. But I also feel somewhat embarrassed every time I tell this, because … is that really the case? What do I actually mean with that? It is very difficult to provide evidence for that.*"

Interviewees so often fall back on guiding principles to make sense of circularity. Interviewee 5 explained that, in response to the client's ambition to "be minimally 80% circular", he sat down with his team to "make this [ambition] more SMART [i.e., specific, measurable, achievable, realistic, and time-bounded]. Because what does that actually mean?" They then formulated some rules to make sense of the concept, such as that they treated "reuse from the past" – i.e., all materials that were kept in the (to be renovated) building – as "100% circular" and classified only the parts of new materials that are reusable in the future as circular. "When 60% of one kilogram of gypsum can be reused … then we only consider that part [as circular]." Such operationalizations helped to make sense of circularity impacts.

Other interviewees shared similar experiences. Interviewee 8 perhaps had the most radical stance, claiming that "a circular building does not exist. A building is just a building. It may only meet certain circular characteristics." Hanging onto an absolute definition is, in his view, only restrictive. Instead, he suggested:

"*Keep it as simple as possible. Build something without waste. … Use fewer chemical products: they have a larger impact on our environment than our natural products. Something that you can disassemble is better than something that you cannot disassemble. Knowing what you use is better than not knowing what you use. These are very simple principles.*"

And also Interviewee 6 argued that measuring circularity was difficult, but that his design projects "at least have some circular aspects. … Our buildings score high on the waste hierarchy, because they use materials very efficiently, and we also typically use dry connections so you can easily take them apart or apply different building configurations."

The second 'head' relates to *complying with regulations*, which are subject to change and so require the designers' anticipation and/or adaptation. Regulations, such as stipulated in the Building Code, are regularly updated which impacts the reuse potential of certain building components. Changing regulations can render existing components obsolete when those components can no longer meet the new legal standards. "Every rule that sets a new norm or that poses a new requirement effectively implies an enormous destruction," summarized Interviewee 4 this problem. Both he and Interviewee 10 illustrated this in reference to a norm that specifies the minimum height of a door, which has increased over the last few decades. Interviewee 4:

"*The door height is a true phenomenon that always makes me laugh out loud.* [*The Dutch government*] *pretends like we grow about 10 cm taller every ten years. Meanwhile, the doors are reaching the ceiling! That means that all those old doors … are no longer allowed, even though people are still very well able to pass through them. That is really a big problem, because there are plenty* [*reclaimed*] *doors available. … They are easy to reuse, because their specifications are no hocus pocus or whatsoever. And still they are all being destroyed, because the government refuses … to lower the norm back.*"

Changes in regulations can sometimes be foreseen and anticipated for. Interviewee 3, for instance, argued that existing building regulations are still based on traditional materials and regulations for renewable ones are only a matter of time. It then makes sense to the interviewees to prepare accordingly. Interviewee 6 characterized this as a "continuous search for ways to make a building as future-proof as possible" which involves "making fairly open structures that can become a breeding ground for complexity." Interviewee 2, similarly, advised "putting as few restrictions as possible" in a design, since one needs to "realize that a building is, by definition, not permanent and will change eventually. … So, make sure that you make it your future colleagues as easy as possible [to change things]."

Other changes in regulations cannot be foreseen and demand adaptation. "Suddenly there was a pandemic," exemplified Interviewee 6, "and all stairs had to be widened" for social distancing. Interviewee 7, likewise, was restricted in reaching new heating, ventilation, and air conditioning requirements during the transformation of an existing building. His team adapted by "giving in on those energetic ambitions, but then instead fully committing [themselves] to circularity." Adaptation so involves, according to Interviewee 8, some "creative input" and "out-of-the-box thinking" to make sense of how changed regulations impact a project.

The third 'head' concerns *managing information flows*. The interviews show numerous accounts where designers struggled to process circularity-related information. Reuse of existing materials brings about significant uncertainty, particularly related to "the quality, quantity and location of materials" (Interviewee 1). "We know pretty little about the materials that are now being reclaimed," said Interviewee 4. "In reality things are often different from the drawings." This is even applicable to Interviewee 6's courthouse that had been designed specifically as a temporary building: "No doubt that we will encounter all kinds of things that will cause problems [when relocating it]." Digital methods are still insufficiently available to deal with this information gap, according to Interviewee 1, and therefore "you need to make a rough design … and only materialize it when you know which materials are available and which need to become available." Designers hence need to deal with uncertainties about reclaimed materials' quality and availability, which implies that rough designs can only be finalized when relevant information is processed.

Digital innovations for closing information chains are more often applied to facilitate reuse in the future. Almost all interviewees mentioned material passports as a promising solution; some of them had also pioneered with this innovation. Interviewee 5, for example, explained how "a lot of energy was invested in the making of a material passport" based on IFC, an interoperable file format for Building Information Modeling (BIM). "About 38 IFC files were delivered by various sub-contractors to make the material passport." Such passports list, among others, which materials are located in a certain building and what their maintenance cycles are. The interviewees widely agreed that this would ease future reuse as it could close the aforementioned information gap. Interviewee 8, taking the client's point of view: "So when I would start demolishing later, then I do not need to invest in inventorying everything again. … If I register [all materials used], then I will know for sure that everything I bought is also documented and that I can show it. Well, that is certainly worth something."

Taming the multi-headed monster is thus an adventure during which designers respond to challenges related to measuring circular impacts, complying with regulations, and managing information flows.

3.4. Orchestrating a design ecosystem

The adventure is far from a solitary process. Almost all interviewees somehow described their work as a goal-directed co-creation process, starting with *co-defining circularity goals*. "Obviously, it begins here, with [understanding] the initiative and the design brief," said Interviewee 9, because then "you can challenge people to search for better solutions … that contribute to reaching those goals." Circularity goals give direction and help to prioritize, it appears. They are most often directly derived from client needs, such as specified in tender documents (Interviewee 5 & 7), but sometimes need more interpretation. For instance, in a renovation project for a homeowner, Interviewee 2 understood some of the client's wishes as circularity goals:

"*The client had never heard of the concept of circularity, but they still asked me, like, 'this is actually a pretty nice dwelling. The materials are quite okay. It is not our taste, so we want to renovate and adapt it for sure, but can we also see that value back in one way or another? Because it would be such a waste if everything simply disappears in the garbage container.'*"

As such, maintaining certain valuable materials became a goal within this project. Interviewee 6 went a step further, claiming to uphold circularity goals – centered around disassemble-ability – even when clients do not explicitly specify these:

"*When a client doesn't ask for it, then it doesn't mean that we don't do it. I mean, it is the same with sustainability nowadays: you would also no longer design single-glazing … but simply go for double-glazing even when the client doesn't explicitly asks for it.*"

The circularity goals that are defined early on in projects guide the design process. They direct designers in *creating solutions with partners*.

Interviewee 9, for instance, claimed to "explain to people, based on the ambitions, what to achieve and to guide them in doing things more circular." Most interviewees used similar words to argue that designers have a key role in coordinating this creative process. "As an architect, it is important that you have basic knowledge about the construction, building physics, etc. but also that you involve independent advisors," argued Interviewee 2, for example. "The architect thus has the role of director in that whole process … and needs to mobilize [other] expertise at the right time."

Much of the required expertise is sourced at, particularly, various suppliers. Existing (circular) products can sometimes offer suitable solutions for a certain design problem. Interviewee 10 mentioned wood-based panels as an example: "then you can see, well, which one shall we use for this solution?" Many interviewees mentioned that suppliers nowadays offer all kinds of (innovative) products labeled as circular or sustainable; designers can then choose among those. In other cases, they need to "start triggering" innovations when "certain products or building connections do not exist yet." Interviewee 10 illustrated this with a wood-processing partner with a pioneering reputation:

"*When I, as an architect, get to know about* [such a partner] *and can have a conversation with him, then he just starts making new things. And that's how you progress together.*"

For Interviewee 10, it appears effective to search for suppliers that are willing to think along and, based on a certain question, "return with something useful." Interviewee 7, likewise, tried to "involve suppliers much earlier, really during the preliminary design phase already, so that they can indicate what is possible and what not." The creation of part of a design solution, then happens at a supplier. But in other cases, suppliers may initially be reluctant to create such solutions and a breakthrough must be triggered, such as Interviewee 6 exemplified. His team designed a new disassemble-able precast hollow-core slab "with wonderful detailing," but could not find any supplier that was willing to produce it. At least, initially:

"*It appeared that those parties were not interested in a disassemble-able hollow-core slab, because they just wanted to sell large quantities of hollow-core slabs and were unwilling to take them back* [at the end of the life-cycle]. *Consequently, we ordered the hollow-core slabs as unfinished products from the factory and added the detailing on the construction site. Quite strange and not so efficient, but it was the only way for us to get this done. But, when the project was finished, all those suppliers started queuing to* [produce those hollow-core slabs]. *They saw all the publicity and that it was actually pretty smart to think about your materials in this way.*"

The example illustrates how designers and suppliers learn in a solution-finding process. Collaboration around a circular innovation was initially difficult here, but successful outcomes, along with the associated publicity, fostered further uptake of the solution. Interactions through bringing factory visits can also help "making a better product together," explained Interviewee 6 in another example. "We regularly encounter that we then change our design, because their production process is structured in a certain way, or … that they change their production process, because our design is a bit smarter than what they did." Learning also happened during Interviewee 5's project concerning a circular (disassemble-able) town hall. He explained that suppliers "suddenly started putting forward requirements or started thinking about the second usage [of any disassembled building components] and their value." This, accordingly, led to a remarkable change in the design: larger timber beams were chosen so that it would be easier to reuse those after the planned service life-cycle.

Designers are, finally, concerned with *integrating solutions into a whole*. The specific solutions that partners bring to a project need to be combined altogether. This appears to demand quite some organizing. Interviewee 9, in this regard, called for an ecosystem based on collaborative principles such as equality, a willingness to help each other, and early involvement. Yet Interviewee 4 explained that partners "are typically busy with their own thing" and "do not always realize their position in the entire system, how their perspective is related to the overall picture." Designers must, accordingly, take an "integral approach," argued the majority of the interviewees, and view any co-created solutions in coherence with other solutions and with other project goals. "When you take decisions about your energy system, then this has consequences for your material usage," elucidated Interviewee 5. Interviewee 7 also had this same concern during the renovation of building where the (circular) preservation of an existing indoor climate system would have a negative impact on the energy performance. But interviewees also mentioned relationships with other sustainability aspects, for example regarding biodiversity (Interviewee 3), climate-neutrality (Interviewee 1 & 5) and future-readiness (Interviewee 2, 6, 7 & 8). Given this multitude of partners, co-created solutions and project goals, designers must "make trade-offs" (Interviewee 9) and "work very thoroughly to solve problems … in an integral manner" (Interviewee 4).

Circular design is, thus, about orchestrating a design ecosystem through co-defining circularity goals, creating solutions with partners to reach those goals and, finally, integrating the solutions into a whole.

4. Discussion

This paper offers an in-depth understanding of circular design in construction from the perspective of those who have experienced it. Given that circular design is a significant but uncommon phenomenon, phenomenological research is particularly suitable to illustrate the experience of engaging in and living through it. This type of methodology is generally rarely applied in sustainable construction research. As a result, our collective understanding of the circular design experience has been incomplete thus far, lacking deep, user-centric insights into and theorization of how circularity is lived through by participants. Our study addressed this important gap. We conducted unstructured interviews with ten designers at the forefront of circularity and applied an interpretative phenomenological analysis to the resulting transcriptions. This involved making sense of the designers making sense of their experiences, which is in line with the 'double hermeneutic' nature of the selected phenomenology variant (Smith et al., 2022). Our findings grasp the designers' lived experiences in four themes, illustrating circular design as a practice that: (1) proclaims responsibility towards the Earth, (2) materializes future-oriented solutions, (3) deals with a multi-headed monster, and (4) involves orchestrating a design ecosystem. This section contrasts these experiential features with extant literature before linking them together into a conceptualization of circular design practice; it ends with an overview of implications and limitations.

4.1. Experiential circular design features

The first feature of circular design experience – proclaiming responsibility towards the Earth – suggests that designerly practices in line with transition goals are guided by fundamentally different mindsets. The participants felt responsible for minimizing environmental impacts through ensuring sustainable material usage. This sense of responsibility appears rooted in the designers' core belief that the Earth's resources are finite and can only be consumed at a rate so that future generations are still able to meet their own needs. The belief resonates with ideas of forward thinkers such as Boulding (1966) and, more recently Rau and Oberhuber (2022), who argued that our Earth resembles a "spaceship" in which mankind must find its place within a cyclical ecological system. This kind of environmental awareness appeared very strong among the participants. They view design not just as a profession, sanctioned by paying clients, but as an attitude (see Chick and Micklethwaite, 2011; Crocker and Lehmann, 2013). Their design outcomes reflect this mindset. Some participants later revealed to pursue circularity goals even when clients do not explicitly request them. This new insight is relevant for promoting the circular economy. Whereas many studies argue for top-down prescribing specific circularity goals (Atta, 2023; Dams et al., 2021; Densley Tingley et al., 2017), our insight, instead, highlights the importance of targeting designers' attitudes from the bottom up. In other words, we revealed how intrinsic motivation, rooted in a deep sense of responsibility, can drive circular design practices – an insight that, we argue, can only be uncovered through phenomenological research, rather than more quantitative methods like surveys. Cultivating attitudes with more environmental awareness involves higher order learning which can, in turn, benefit both circular building projects and the transition at large (Leising et al., 2018).

The second circular design experience feature – materializing future-oriented solutions – highlights designers' dealings with selecting design strategies that enable multi-cycle material usage. There are multiple ways, or strategies, to incorporate circularity in design (see Moreno et al., 2016; Rahla et al., 2021). So far, such strategies have remained "little explored in projects and constructions" (Munaro et al., 2022, p.566), with most studies being primarily conceptual and generally overlooking the perspectives of designers themselves. We help fill this gap. Our findings show that the designers made use of a variety of strategies, depending on the specific problem at hand. We found sufficient empirical support for the application of three main strategies: design for disassembly (see Crowther, 2018; Durmisevic, 2006; Ostapska et al., 2024), design with reclaimed materials (see Gorgolewski, 2008, 2018), and design with renewable materials (see Konietzko et al., 2020; Yang et al., 2024). While literature also lists other potential circular design strategies, such as design for light weighting, design for easy maintenance and repair and design for repurposing (Aguiar and Jugend, 2022), these were less prevalent in our data. Only one participant described the latter strategy, for example. All found strategies nevertheless acknowledge temporality. They enable construction materials to be used multiple times, either through the technical or biological loop, which corresponds with the broader restorative and regenerative resource flow approaches (Bocken et al., 2016; Çetin et al., 2021). We reveal that any strategies are selected mainly in response to particular design problems rather than, for example, participants' preferences. For instance, the design for disassembly strategy suited temporary buildings best. Since empirical evidence for incorporating circular design strategies has remained rather limited so far, our study contributes by explicating those strategies as inherently future-oriented and their selection process as highly contextual.

The third circular design feature – dealing with a multi-headed monster – evocatively points to additional efforts that designers face in pursuing circularity. This reoccurring theme illustrates why focusing on circularity often "extends the length, costs, and overall scope of design projects" (Dokter et al., 2021, p.697). Design projects are becoming more complex, posing challenges uncommon in traditional linear practices. We borrowed the vivid 'multi-headed monster' phrase that one of the participants used to illustrate this point. Three main challenges were found across the interviews: measuring circular impacts, complying with regulations, and managing information flows. Although similar challenges have been reported elsewhere (see Kanters, 2020; Rios et al., 2021), our contribution also lies in illustrating how the participants attempted to navigate those. That is, the designers made sense of the persistent ambiguity about what circularity entails and how to measure it in construction (Abadi et al., 2022; Anastasiades et al., 2023a) through following guiding principles like limiting the use of chemical products and ensuring disassemble-ability. They also relied on their creativity to navigate already changed building regulations on one hand and promoted adaptability and open structures on the other hand to anticipate potential regulatory changes in the future. Our narrative accounts uniquely link the designerly efforts to changes in regulations. Furthermore, the designers pioneered with novel digital methods in response to uncertainties, especially associated with the quality and availability – or as-is conditions – of reusable building elements (Arora et al., 2021; Markopoulou and Taut, 2023; Van den Berg, 2024). The participants viewed material passports linked to BIM as particularly promising. These methods essentially document material inventories to inform designers and other construction stakeholders about reuse potentials (see Honic et al., 2021). In the absence of such methods we also show that the designers adopted a more flexible attitude, finalizing a design only when they know when and where what materials can be reclaimed from the exiting built environment. Other theorized challenges, such as insurance issues (Munaro and Tavares, 2023), were mentioned by three participants or less and, therefore, excluded. Though each of the main challenges identified warrants further research to develop more systemic responses, the pragmatic approaches we uncovered for dealing with the multi-headed monster of circular design can offer inspiration for projects elsewhere.

The fourth circular design feature – orchestrating a design ecosystem – underscores the collaborative and coordinative practice of designers within an extended network. Collaboration between multiple design stakeholders has earlier been listed as a "prerequisite" to achieve circularity goals (De Feijter, 2023, p.105). Sgambaro et al. (2024) posit that service providers could act as the focal point of a circular business ecosystem, particularly within fragmented industries such as construction. Our study, alternatively, showcases that designers could also be a focal point, initiating and managing circularity efforts across a wide range of project stakeholders. We illustrate how the designers collaborated with clients (to understand their needs), suppliers (to create solutions for specific problems), and other partners (to integrate solutions into a complete design). Those collaborations appear to go beyond the ones typically seen in design projects. As illustrated with the example of disassemble-able precast hollow-core slabs, some design efforts questioned or affected the very business models of partnering firms as well. This insight complements work by Bocken et al. (2016) that related product design and business models within the same, rather than across different, firms. Given that circular business models literature in construction predominantly relies on review methodologies (Otasowie et al., 2024), our empirical work also fills a gap. The expertise required to design circular outputs for construction is widely distributed and, as our findings suggest, this implies that designers must mobilize other expertise at the right time. The designers interpret themselves as coordinative in facilitating collaborations; we termed them 'orchestrators'. This new role complements six archetypical roles that De los Rios and Charnley (2017) proposed for designers in other industries, such as the 'block-building designer' or 'green fixer'. Like conductors of an orchestra, designers must harmoniously coordinate the diverse inputs from stakeholders within a design ecosystem.

4.2. Towards theorizing circular design practice

Having identified the essential features of circular design in construction, we can begin to theorize what and how the practice actually is. From our findings, it appears that circular design is above all inherently future-oriented. All designerly efforts and thinking are directed at creating a realizable course of action to intervene in an existing design problem situation. Imagining such interventions and giving form to preferred futures has been theorized as 'future making' (Durante et al., 2024; Thompson and Byrne, 2022; Wenzel, 2022). This perspective treats the future as a problematic, open-ended category in organizational life that cannot be delineated through planning practices alone, but is instead actively made into being through a plurality of collaborative practices (Wenzel et al., 2020). Design practices were, as such, conceptualized in terms of making and enacting imaginings of the future (Comi and Whyte, 2017). We can now sharpen this conceptualization for the context of circular design. An important finding of our study is, namely, that our interviewees were all committed to bridging end-of-life solutions with the beginning of new cycles of use. In other words, they considered not one, but multiple possible futures simultaneously. The designers enabled construction materials to be used for multiple times, essentially through applying strategies that enable systematic adaptability, disassembly, and reuse (see Ottenhaus et al., 2023). This is in itself significant given that applications of such strategies are mostly found in architectural magazines and "are not represented sufficiently within the scientific literature" (Ostapska et al., 2024, p.393). It also reflects a deep commitment to sustainability and recognition that design must account not just for the immediate future, but for the long-term impact and potential of circular systems and components.

The practice thereby subscribes to the notion of a material bank, which views a building as a temporary storage of materials (Debacker and Manshoven, 2016; Geldermans, 2016; Oliveira et al., 2024). While the actual environmental impact savings of building components or materials that are used over several cycles is sometimes debated (Lausselet et al., 2023; Toniolo et al., 2021), our findings clearly indicate that designers view materials not as waste but as resources and that they feel responsible for reintegrating those into future regeneration or restoration cycles. Circular design is thus also very much material-oriented and deeply rooted in a sense of responsibility. One of our key findings is that the selected designers all felt responsible for using materials in ways that would minimize harm to the environment. They recognized the need for system thinking approaches, such as proposed by Iacovidou et al. (2021), but prioritized revaluing materials in making sense of circularity. Such a narrow view on circularity, primarily focusing on materials rather than other types of resources such as energy or water, can be understood against the backdrop of calls for clearer and practically actionable conceptualizations of the circular economy (Kirchherr et al., 2023). Our study's participants adhered to guiding circularity principles, as explained elsewhere (see Ellen MacArthur Foundation, 2019), in their pursuit of making a positive impact. Focusing on reclaimed and reusable materials in design projects seems well-suited to overcome common definition and measurement misconceptions that, as Ababio and Lu (2023) have shown, often hinder other practitioners from implementing circularity. We hence complement our conceptualization of circular design practice by positing that it entails responsible 'materializing' in both a literal sense (focusing on materials to create a design) and an abstract sense (focusing on turning imaginings into reality). Circular design practice can thus be understood in terms of materializing responsible futures.

4.3. Learnings from experience

This phenomenological study theorizes circular design practices through illuminating its experiential features so that it can inform ongoing circularity transitions. Whereas previous research has focused mostly on the so-called macro- and meso-levels of transitions (capturing socio-economic and cultural systems respectively organizational and institutional structures) (Markard et al., 2012), we address the micro-level through documenting the lived experiences of frontrunning designers in construction. The insights are derived from the Netherlands and must be understood accordingly to hold relevance somewhere else. According to Marino and Pariso (2020), the Netherlands is one of the leading countries in the transition towards a circular economy, mainly due to a multitude of roadmaps and formative strategies for both private and public sectors. Other European countries that were identified as driving, supporting and operating the transition are Austria, Belgium, Denmark, Finland, Germany, Ireland, Luxembourg, Sweden, and the United Kingdom. These countries share a relatively high gross domestic product when measured in terms of purchasing power standards (GDP in PPS) and a high economic output compared to investments in circular economy initiatives (GDP/CEI) (ibid). While governmental support and industry actions still lag behind in many other countries, they are likely to face similar transition barriers (see Giorgi et al., 2022). Furthermore, significant gaps between circularity ambitions and efforts also persist in the Netherlands (Hanemaaijer et al., 2023). These earlier findings underscore the importance of learning from the lived experiences of circular design practitioners from this context. Antwi-Afari et al. (2021, p.1) amplify this argument with their finding that design is a key influential area in circular construction yet "narrowly covered" in existing studies. Documenting the experiences can thus guide broader circularity transitions.

Other practitioners may benefit from firsthand learning from the experiences. Illuminating circular economy practices in construction is internationally recognized as a means of "futureproofing" the built environment (Kofod-Svendsen and Sinkjær, 2024, p.13). Our generalized insights into circular design are grounded on specific experiences, which, in line with the idiographic nature of any IPA study, must be valued on their merits. Among other findings, we demonstrated: how designers can make sense of ambiguous circularity goals, what particular challenges they may encounter, and how they could deal with those. Other designers can draw learnings from our participants' individual experiences. The operationalizations of circularity of Interviewee 5 and 8 can be readily adopted in other projects, for instance. Likewise, while the changed minimum door height (or clearance) example is characteristic for the Dutch context, our general insight to design open, adaptable structures that are future-proof will also hold relevance for designers in other countries. This is because changes in building regulations are often listed as a barrier to reuse (Mahpour, 2018) – with limited practical support on how to navigate it. Furthermore, pragmatic approaches to circularity appeared to be driven not only by client demands but, importantly, also by designers' own, deep sense of responsibility towards understanding resources as finite and the environment as precious. We therefore recommend raising more awareness of the latter through education and professional training. Promoting awareness can also be done through the designed solutions themselves, as exemplified by visible insulation made from recycled clothing. Given that designers will need to integrate numerous such (sub-)solutions into their designs, we recommend they adopt more holistic design approaches that optimize material usage across not one but multiple cycles. Finally, building on Havinga et al. (2023), we suggest orchestration roles and mechanisms for designers to align partner inputs in future circular construction ecosystems. Consequently, our research offers practitioners valuable insights into previous experiences of frontrunning designers.

4.4. Limitations and future research

This study's insights and contributions are subject to several limitations which, in turn, inspire new research directions. One limitation is that the interpretations of the data are influenced by our own perspectives and biases. Though we attempted to set aside those as much as possible, IPA assumes this is never completely possible. In line with the approach, we focused on experiential themes with a strong evidence base across the cases, but acknowledge that other studies may reveal slightly different themes. Another limitation is that the themes only relate to the circularity experiences of frontrunning designers working in the Dutch construction industry. Their experiences can differ from those of others. For example, certain experiential circular design features may be more or less relevant in other industries or in other countries. While we hope that our findings have relevance there as well, any wider generalizations to other settings must be made with caution. It would nevertheless be interesting to study and compare the selected phenomenon in such other settings. Finally, this study informs circularity transitions with insights from one construction industry discipline only. Our focus on design overlooks circular practices of other industry actors, like contractors or suppliers. We recommend more phenomenological studies to illuminate such practices from the perspectives of those actors themselves.

5. Conclusions

Circular design is a transformative practice that reimagines life-cycles of the built environment to create a more sustainable future. This study offers rich and in-depth insights into the practice from the perspective of frontrunners. We explored the designers' lived experiences in detail through applying an interpretative phenomenological analysis to unstructured interview data collected. The circular design experience is, accordingly, illuminated through four emergent themes. Firstly, circular design proclaims a responsibility towards the Earth that involves practicing resource responsibility and preaching resource awareness. Secondly, it is concerned with selecting design strategies that allow multi-cycle material usage, such as design for disassembly, design with reclaimed materials, and design with renewable materials. Thirdly, the practice resembles a multi-headed monster, requiring designers to deal with key challenges related to measuring circular impacts, complying with regulations, and managing information flows. Fourthly, it comprises orchestrated efforts, within a design ecosystem, to co-define circularity goals and to create and integrate solutions together with partners. These themes are supported with ample narrative accounts of the practitioners themselves, providing in-depth insights and learning opportunities. Our study, thus, theorizes circular design as a vital practice for shaping a more sustainable built environment through materializing responsible futures.

CRediT authorship contribution statement

Marc van den Berg: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Daan Schraven:** Writing – review & editing, Investigation. **Catherine De Wolf:** Writing – review & editing, Investigation. **Hans Voordijk:** Writing – review & editing, Methodology, Formal analysis.

Declaration of competing interest

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