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Towards a lifecycle of design methods

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Abstract: As the design discipline is expanding and increasingly contributing to solving complex, socio-technical challenges in society, its role evolves alongside this expanding scope. A significant contribution of the design discipline is its methodologies and the expertise to facilitate transdisciplinary work in these complex innovation arenas. This emphasizes the importance of design methods and, at the same time, puts higher demands on their efficacy, robustness, and usability. However, there is a lack of understanding of the method development process, the standards and norms constituting high-quality design methods, as well as the transfer and use of these methods and how they impact practice. More specifically, there is a need to understand the entire *lifecycle* of methods – across the research and practice communities. The literature is fragmented, and some aspect is only addressed in isolation. In this paper, we bring together existing research and propose an initial model of the lifecycle of methods in design. We discuss implications and recommendations for future research.

Keywords: design methodology; design research; method lifecycle; method quality

1. Introduction

Since the 1960s, the design field has been critical of the consequences of design in society (Niedderer et al., 2018). As a response, design has moved from a symbol and object focus to incorporating the interaction between objects, information, people, and society (Buchanan, 2001; Tromp & Hekkert, 2019). As such, the role of design can be described as changing one state of a system to another; rather than one problem with one correct solution, the designer operates with an existing system and possible future systems (Findeli, 2001). The goal of the design process thus becomes the change that occurs as the result of introducing a solution into the system (Frascara, 2017). As a response, designers are called to take greater ethical responsibility (Davis, 2017; Findeli, 2001; Fry, 2009; Meyer & Norman, 2020; Oppenheimer, 2020). Navigating this increased complexity by extension places a greater demand on designers' ability to collaborate across disciplines (Buchanan, 2001; Davis, 2017; Frascara, 2017; Norman & Stappers, 2015; Sanders & Stappers, 2008). As more specialized

knowledge needs to be integrated into the design process, it becomes necessary to imbue these carriers of knowledge, or what Sanders & Stappers (2008) refer to as *co-designers*, with a certain level of design knowledge and skill to ensure a more transdisciplinary design approach. Likewise, meaningful knowledge and practice from other disciplines should be integrated into the field of design.

As one of the main avenues through which design research impacts society and design practice (Blessing & Chakrabarti, 2009; Cantamessa, 2003; Daalhuizen & Cash, 2021), design methodology plays an integral part in facilitating this development.

This paper proposes an initial model of the lifecycle of design methods and describes how each stage of the cycle impacts our development and interaction with design methods. The contribution of this is twofold. First, a model of the lifecycle of design methods offers a structure for framing research into design methods and highlighting gaps in the current research – e.g., operationalization and adaptation of methods for and by transdisciplinary teams. In doing so, our model brings together previously fragmented literature on specific elements of the lifecycle of methods, providing clarification and potential avenues for future research. Second, in facilitating focused research into each stage of the lifecycle, the model allows us to develop a more differentiated understanding of interaction with methods and move beyond the process-focused view on methods criticized by Dorst (2008). A better understanding of the interaction with methods is crucial in developing efficacious, robust, and usable methods. This, in turn, is critical for the expanding scope of the design discipline, where methods must integrate new knowledge to reflect the added complexity of method use in transdisciplinary practices.

2. Design methods

Jagtap et al. (2014) identify three major categories that impact the lifecycle of methods: *method development*, *methods use*, and the *methods* themselves. As the primary phenomenon explored in this paper, design methods are front and center at every stage of the lifecycle of design methods.

Design methods come in many different types, ranging from general heuristics to algorithm-like templates (Daalhuizen, 2014) supporting every step of the design process (Daalhuizen & Cash, 2021). As such, the term *design methods* is used in various ways in the literature. From a catch-all term for anything facilitating the design process (Cross, 2008; Jones, 1992) – what Blessing & Chakrabarti (2009) call *design support* – to "A specification on how a specific result is to be achieved […]" (Gericke et al., 2017, p. 105). Among the definitions of design methods, the literature seems to agree that methods capture knowledge about design practice (Cross, 2008; Daalhuizen & Cash, 2021; Dorst, 2008; Gericke et al., 2020; Jagtap et al., 2014; Jänsch et al., 2005). Beyond that, there is variation in what is seen to be the purpose of design methods or the ways in which they might function. The most common view focuses on product development and optimizing the process and solutions (Blessing & Chakrabarti, 2009; Jagtap et al., 2014). Some focus more on changing the practice (Blessing

& Chakrabarti, 2009), like Daalhuizen (2014), who argues that design methods are thinking tools intended to alter mindsets and behaviors. As a central tool for communicating design knowledge, design methods are seen as an essential tool in the development of design competencies within design education (Dorst, 2008; Gericke et al., 2016). These perspectives are not mutually exclusive but point towards differences in framing and the different roles of design methods throughout their lifecycles.

This paper follows Gericke et al.'s (2017) distinctions of design methodologies, design processes, and design methods. However, to engage in the broadest discussion, this paper will not follow the distinction between design methods, design guidelines, design standards, and design tools.

3. The lifecycle of design methods

Design methods are much like the products or services we design; methods are designed, disseminated, if successful, taken into use, and at some point, end up being replaced or evolves into something new. To explore the phenomenon of design methods and the context in which it unfolds, we propose to look at them in relation to their lifecycle (Figure 1).

To illustrate how it plays out in practice, we use examples and quotes throughout this section provided by Fisker & Dømler (2021). As methods often referenced in the interviews conducted by Fisker & Dømler (2021), we use the methods from the book *Systematic design for industrial products* by Tjalve (1979) as an example of a lifecycle of design method. These methods were developed in industry and formalized and collected into a book. Over the years, they have been taught at the Technical University of Denmark. Thus students have been introduced to the methods and become familiar with their use. Entering the workforce, these methods add to organizations' possible ways of handling challenges. Through implementation and routine of practice, the methods can be internalized by practitioners, as exemplified by statements like: "I don't take out the Tjalve book, but many of the elements and basic ideas are there, and from there it's driven from the projects' individual needs". Here, the methods have evolved and become something else, thus, concluding the method lifecycle and potentially starting a new cycle.

As the point where methods are conceived, we take *method development* as the starting point for the lifecycle of design methods. The development stage is crucial for the rest of a method's lifecycle by virtue of the decisions embedded in the method at this point.

Method use is another central part of the lifecycle of design methods. Methods use is where a method is put to the test. It is where it proves its worth and ultimately makes its impact. It is primarily here a method interacts with other methods (design methodologies), users (designers), and the design context – each a complex area itself. To account for the diversity of interactions with methods in use, we have broken the use stage further down into the stages: *Method selection, Method adaption, Method use,* and *Method evaluation*. Each

aspect impacts the use in transdisciplinary teams and, by extension, how we should design methods for transdisciplinary use.

Bridging the gap between *method development* and *use*, we have placed *dissemination, method discovery and awareness,* and *method operationalization*. *Dissemination* of methods is comparable to the dissemination of any product or service. It is about generating awareness and buy-in from the market. *Method discovery and awareness* is the other side of the coin. Where *dissemination* is the push, *method discovery and awareness* is the pull. Here user needs and wants are in centrum. Method-users explore available methods in the hope of resolving problems or satisfying wants. In the process, they become aware of new methods and their value proposition. Statements like "I would rather ask my colleagues than search in the official toolbox […]" and "Most people don't open a book again after getting a job" point to a potentially problematic relationship between these two stages of knowledge transfer.

To be useful, methods must be operationalized; the user must understand it and feel confident in its use. We call this stage *method operationalization*. Education, implementation, and possible scale-up are part of this stage. One observed example of this is a practitioner adapting the method *User Requirement Specification* to secure input from the production team. A method that later was implemented as a mandatory deliverable in the development process at the company.

The last stage of the lifecycle of design methods is *method internalization*. As users become familiar with a method, it becomes part of practice – either in its formalized form or more likely in a diluted and adapted form; exemplified by statements like this: "I never use an entire method; I use the essence. I don't look it up in a book, but I have an idea of approximately how to do it".

In the following sections, we explore each stage in more detail, zooming in on the interaction between the main stakeholders – method-developer and method-users – and the method, as well as the interplay between the different stages.

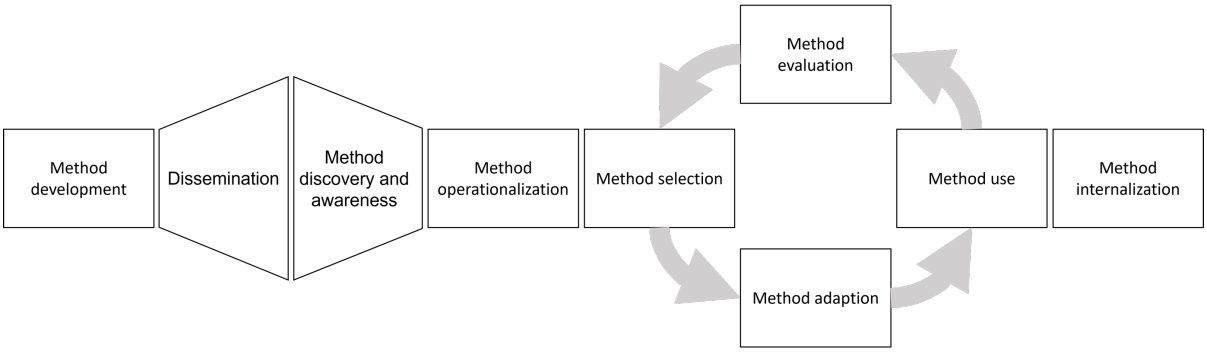

Figure 1. A model of the lifecycle of design methods

4. Method development

There are several motives behind *method development*: the professionalization of design (Jones, 1992), increasing control and mitigation of errors (Cross, 2008; Jagtap et al., 2014), and resolution of reoccurring problems (Jänsch et al., 2005). An important aim is to externalize design thinking and "[…] get your thoughts and thinking processes out of your head and into the charts and diagrams that commonly feature in design methods" (Cross, 2008, p. 47). Furthermore, methods are developed to easily share procedural knowledge and make what Wallace (2011) terms *design practice knowledge* accessible and processes repeatable, teachable, and open to improvement (Jones, 1992).

Method development can be rooted either in practice, theory, or a combination of these. That is, methods are developed based on the formalization of tacit knowledge of practitioners (bottom-up development), the application of formal knowledge (top-down development), or a hybrid of these processes.

4.1 Bottom-up method development

One form of bottom-up development happens when people involved in design processes – hereafter referred to as *designers* – develop methods themselves to systematize and share their practices (Dorst, 2008; Jänsch et al., 2005). Through reflection on or research into action – either by the designers themselves or by outside observers – tacit knowledge is formalized, and/or theory is applied. As tacit knowledge becomes articulated and structured, systematic approaches to situations and problems can emerge and be developed into formalized methods (Cross, 2008). Here, the designer is seen “[…] as the expert of their own design process” (Badke-Schaub et al., 2011, p. 188) and design context (Jänsch et al., 2005). In employing their expertise in new situations, new problems, new technology, etc., designers adapt their practice to reach their goals, which can give rise to new methods. This process is a natural part of developing expertise in any subject (Wallace, 2011) and, as such, connects the bottom-up approach to the tail end of the method lifecycle.

When developing methods for transdisciplinary use, this highlights the importance of understanding the operationalization, use, and internalization of methods in the context of transdisciplinary practice. Using their practice knowledge, designers imprint methods with context-specific aspects, reflecting the design problems, workflows, and culture; typically developing rather context-specific and specialized methods (Jänsch et al., 2005). Formalizing knowledge requires some degree of interpretation by the method-developers (Dorst, 2008). Relying on abstractions and generalizations, method-developers can attempt to detach a method from the context of use where it was developed. However, the characteristics of the method-developer, their understanding of the problem, their knowledge of the context, even their preferred modes of thinking and working will influence the manifestation of the method (Jänsch et al., 2005).

Researchers often take part in the bottom-up development of methods as interpreters (Vermaas, 2016), studying best practices and abstracting methodological knowledge (e.g., Lawson & Dorst, 2009).

4.2 Top-down method development

A second form of method development happens when researchers develop methods based on formalized knowledge. The method-developer – be it a designer, a researcher, or organization – develop methods based on theoretical or logical models. Imploying theoretical or logical models to develop methods for transdisciplinary use requires solid foundational knowledge of the interaction with design methods within transdisciplinary practices.

In top-down method development method-developers 'experiment' with practice by applying formalized knowledge – be it *design practice knowledge*, theory, research, or knowledge from outside the design field (Cross, 2008) – in the hope of achieving new or better output and outcomes. As such, top-down methods are by nature more prescriptive. Building on the formalized knowledge, abstractions, and generalizations, the method-developer arrives at a hypothesis (Badke-Schaub et al., 2011), an idea for how things could be done smarter or better, conceptualized in the form of a design method. An essential part of this development process is testing these hypotheses and further developing and tweaking the method. Through such processes, methods developed top-down can still match with the context of practice (Jänsch et al., 2005). However, many methods developed in academia have been criticized for lacking connection to the context of use:

> "This total ignoring of the design content, the designer and the design context allows us to claim that we are constructing models, methods and tools that will be valid for every designer, dealing with every possible kind of design problem, in any situation" (Dorst, 2008, p. 5).

4.3 Method validation

Design methods are often introduced without systematic evaluation, neither in terms of their ability to achieve the intended effects nor against existing methods they might replace (e.g., Blessing & Chakrabarti, 2009; Wallace, 2011). When methods are derived from practice (bottom-up development), they are typically justified through the claim of representing 'best practice'. Vermaas (2016) argues that this is not a sufficient justification and points to the importance of empirical validation as an essential step. Method validation is an integral part of method development and should be a continuous process throughout the lifecycle of methods.

Validation can happen in terms of *efficacy* and *effectiveness* of a method (Daalhuizen & Cash, 2021; Flay et al., 2005; Gottfredson et al., 2015). *Efficacy* refers to the ability of a method to achieve its intended effect and is typically evaluated under controlled conditions. Efficacy thus provides a measure of the quality of the method itself and its content elements. *Effectiveness* refers to the ability of a method to be used in real-life conditions and

is evaluated in practice. Effectiveness thus provides a measure of the context-sensitive nature of the method (Daalhuizen & Cash, 2021; Flay et al., 2005; Gottfredson et al., 2015). As such, validation must be conducted initially in the development stage to validate efficacy and again doing the use stages to validate effectiveness.

In line with calls for scientific rigor in design research (Blessing & Chakrabarti, 2009; Cantamessa, 2003; P. Cash, 2019; Dorst, 2008; Meyer & Norman, 2020), we need a more rigorous process for validation of methods in design. Some methods for method validation exist, like the validation square (Seepersad et al., 2006). However, general theories of why and how design methods work are scarce (Daalhuizen & Cash, 2021; Dalsgaard, 2017; Dorst, 2008), and methods validation is rarely robust as a result (P. J. Cash, 2018; Daalhuizen & Cash, 2021; Dorst, 2008; Gericke et al., 2020). As methods come in various forms, the need for validation varies depending on the type of method, method-developer, the context of development, and eventually the context of use. For example, validation of methods that need to secure compliance or safety and those intended to facilitate creativity needs to focus on vastly different criteria.

5. Dissemination

Once developed and validated, methods need to be disseminated to reach their intended audience and maximize the chance of being taken into use, both in practice and education. Depending on the development process, the dissemination of methods varies. Bottom-up methods typically emerge in practice, and dissemination strategies are based on internal sharing, professional networks, etc. In contrast, top-down methods typically require more effort to reach their target audiences and convince them of their value.

Top-down methods originating from academia are mainly disseminated through academic publications or textbooks. These dissemination channels are suited to reach the educational arena based in universities or similar research-oriented institutes; however, they are less suited to reach practice (Gericke et al., 2017; Wallace, 2011).

Arguably, methods need to be treated similarly to products that need distribution, marketing, and servicing to succeed in the market. Like most products, design methods must fulfill a need or want. Often they need to be marketed to reach the right gatekeepers, customers, and end-users. Reflecting the lack of attention to these aspects of dissemination, the literature often accredits the quality of design methods for poor industry uptake. For example, commonly cited reasons for poor uptake include the level of abstractions or complexity of the method, perceived lack of benefit, method-user fit, cost of implementing, and lack of training and support (Wallace, 2011).

In some cases, methods are developed in close collaboration with the industry. Yet, these are typically smaller-scale, relatively local efforts in which researchers or research groups establish collaboration with partner companies (Gericke et al., 2020). Alternatively, a more 'passive' dissemination happens through teaching, when students enter practice after

graduation, bringing knowledge and expertise of methods with them (Wallace, 2011). Although effective, this is a slow process and restricted to the limited set of methods offered for each specific design program.

The lack of focus on method dissemination is problematic, as it leaves a gap in the supply chain of methods. To move the discussion of method dissemination forward, inspiration might be found in fields like marketing and concepts like *Crossing the Chasm* (see Moore, 1999). This transdisciplinary approach might help shed light on why some methods are successfully disseminated while others never succeed in making an impact.

6. Method discovery and awareness

From the opposite perspective, we can argue that practitioners and industry are responsible for actively searching for new methods and transferring them into their practices. However, this is not straightforward, as method discovery is a time-consuming and challenging task and often at odds with the primary focus and time pressure of the design process at hand (Wallace, 2011).

If dissemination corresponds to the logic of 'market push' and is the responsibility of the method-developer, method discovery and awareness corresponds to 'market pull' and is comparable to the *consumer buying process* described by Kotler (2003). Gericke et al. (2016) identify two primary motivations for engaging in method discovery: 1) A motivation to develop individual practice and competencies through the discovery and adoption of new methods, and 2) a motivation to solve specific problems at hand through the discovery and adaption of specific methods.

Method discovery can happen in many ways and may include sources like industry peers, coworkers, professional working groups, academic contacts, consultancies, web-searches, web repositories, online communities, books, and customer recommendations or requirements (Gericke et al., 2016). Particularly when searching in databases, searching can be challenging, as practitioners are often not aware of the terminology needed to find methods (Gericke et al., 2016). Moreover, methods are often chosen based on personal preferences and prior experience with a method or recommendations from colleagues (Jagtap et al., 2014). Even when methods are found and considered, they are typically at a disadvantage. They need to prove their superiority and potential impact compared to known methods, which is generally difficult to do (Badke-Schaub et al., 2011).

7. Method operationalization

Method operationalization is all about making methods accessible and employable in the context of use. Here we are in the borderland between dissemination and method use. The activities of method operationalization both impact uptake and the use of methods.

Once methods have been discovered and selected for implementation, they need to be operationalized and made ready for use. Method-users need to review a method's

effectiveness, relevance, convenience, familiarity, and criticism (Jones, 1992) to assess to what extent the method might be used 'as-is' or whether it needs to be adapted.

The operationalization of a method is vital in the successful application of methods; and thus their perceived quality. If applied successfully, a method is more likely to be perceived as good. Therefore, operationalization should consider all the different variables that impact method application (Badke-Schaub et al., 2011; Daalhuizen & Cash, 2021). Overall, there are two approaches to method operationalization: adapt to the method or adapt the method. Often both are necessary to implement a method successfully.

Adapting to a method might require changes to the organization around method use, as well as training to secure the necessary skill to implement it. The method-user needs a certain level of expertise and knowledge to understand and successfully implement a method. Ideally, the method should provide sufficient context knowledge for appropriate application (Daalhuizen & Cash, 2021; Jagtap et al., 2014); however, it is not always so. Relating back to the method development stages, tacit knowledge central to the correct application of a method is likely to remain implicit or be omitted – to the detriment of especially novices (Jänsch et al., 2005). This is especially problematic in the context of transdisciplinary practice, where team members without design experiences have no basis for evaluating the appropriateness of a method or assessing their ability to apply it successfully. The role of designers as facilitators (Sanders & Stappers, 2008) likely emerged partly in response to lacking skills for assessing design methods.

If the method needs to be adapted, the process also includes recontextualizing, where the method content is adapted to a new context of use. Recontextualizing brings us back into the method development mindset. Building on the scaffolding of the method content, the method is customized or adapted. Here, operationalization not only impacts the potential effectiveness of a method might even impact the efficacy. With few of the design methods in use today explicitly developed for use in a transdisciplinary context, they likely have to be adapted to be successful, potentially making earlier validation of a method void.

8. Method use

Arguably, method use is at the center of any method's lifecycle. Until this point in the lifecycle, methods are primarily reactive, but now they become the active player, impacting the world around them.

Method selection and *Method adaption* follow similar patterns as *Method operationalization* but at a more specific level – selecting methods from a repository of operationalized methods and adapting them to the particular context of use.

Method use has been described as a phenomenon in which a method-user processes the information a method contains (method content) to direct their behavior accordingly and thus change the way they engage a situation or problem. Methods use is contextual and includes the method-user, use context, object of design, and design task/goal as integral

factors (Badke-Schaub et al., 2011; Dorst, 2008; Lawson & Dorst, 2009). Our understanding of the interplay of these factors is still limited, especially so in the expanded realm of method use within transdisciplinary practices. Employing design methods in new contexts with inexperienced design practitioners only add to the complexity of method use. As such, method use is sensitive to human error and bias. Even though human error has been highlighted as a design problem (Norman & Stappers, 2015; Norman, D.A., 2013), method development does not typically address this issue explicitly, and existing theory and frameworks inadequately explain why methods fail.

Schønheyder & Nordby (2018, p. 45), in their analysis of method use in a Norwegian design company, describe how methods over cycles of use are adapted to fit: "situational needs, design practitioners' skillset and the organisation of design activities." As the use of a method is evaluated, method use becomes part of a continuous operationalization of the methods used.

9. Method internalization

Method internalization is an under-explored stage of the lifecycle of design methods. It is recognized that methods impact design practice (Blessing & Chakrabarti, 2009; Cantamessa, 2003; Daalhuizen & Cash, 2021). However, the focus seems to be on the use stages and the use of the formalized method and its effect on the design process (Dorst, 2008), and less on how methods impact the way designers think, work and structure their design activities (Daalhuizen, 2014). Understanding what happens at this stage of the lifecycle of design methods might shed light on the ways methods are used in practice and the tendency of experienced designers not to rely on formal methods. Understanding what designers internalize through the use of methods might inform our understanding of what constitutes the core aspects of a method. In this context, it is insightful to turn to cognitive science and, more specifically, dual processing theory to help explain how methods might be internalized through repeated practice and become part of the 'mindware' of practitioners (Daalhuizen, 2014).

10. Discussion

In this paper, we bring together research regarding design methods and synthesize this into an initial model of the lifecycle of design methods. We offer two main contributions to the design literature that we discuss here.

First, the proposed model supports the clarification, disambiguation, and positioning of research into methods. We bring together and position fragmented work on design methods following the logic of the stages that methods go through as they are being developed, tested, and finally taken into use. The model also aims to facilitate the identification of research gaps, pointing to potential explanations for the current problems as well as promising areas for future research.

In terms of method development, the model differentiates between *bottom-up* and *top-down development.* This affords distinction between the naturally occurring and informal method development in practice (Daalhuizen et al., 2019) and the more prescriptive and formal method development by a method-developer (Gericke et al., 2020). This, in turn, points to the importance of studying the interplay of the two types of development and stakeholder roles in the lifecycle of methods, providing an extra dimension to contributions like that of Jänsch et al. (2005).

In terms of validation, the model differentiates between efficacy and effectiveness of methods, pointing to two distinct stages in the lifecycle where each ought to be validated and the different needs of stakeholders at each type of validation. We will return to the importance of validation later in this section.

In terms of dissemination, the model differentiates between *dissemination, method discovery and awareness,* and *method operationalization.* This highlights three different areas that impact method uptake in the industry, providing nuance and insight to the ongoing discussion on method transfer (Gericke et al., 2020, 2021). This also offers new explanations for the lack of method uptake, which mainly have been explained by the lack of quality of methods themselves (see, e.g., Stetter & Lindemann, 2005; Wallace, 2011), ignoring dissemination as an activity separate from method development, and crucial for successful uptake.

In terms of method use, the model differentiates between use and internalization. We emphasize methods-users as central actors in these stages; because the users are both the ones that are directly affected by methods – changing their behaviors and mindset – and pivotal in adapting methods to the specific context of use. At the same time, this is a call for more research into this interaction with methods as it directly affects the perceived quality and success of methods.

This leads us to the second contribution. A common theme throughout the paper has been the different interactions between methods, stakeholders, and users that happen across the stages of the lifecycle. Here, we add to Dorst (2008) argument that design research needs to move beyond the process-focused view on methods and explore how users and stakeholders interact with methods. The lifecycle of design methods offers a step forward by providing a more nuanced distinction of stages and interactions, allowing us to investigate methods in more detail than just the effectiveness and output of method use.

Overall, the lifecycle of design methods shows that the development and successful implementation of methods is complex, non-trivial, and an important area of future research. By supporting clarification, disambiguation, and positioning of research into methods, it is our hope that the lifecycle of design methods can help inform our understanding of design practices. As a general model for framing design methods, it might help highlight differences in disciplinary practices across the design field. Understanding our methods and the interaction with them is the first step in enabling us to successfully and

systematically integrate the knowledge and practices from other disciplines into the very core of design methods and design practice.

Last, this also brings the paper into the broader discussion of scientific rigor in design research. Arguably, the field of design operates with many underdeveloped core phenomena ripe for more rigorous theory development (P. J. Cash, 2018; Daalhuizen & Cash, 2021; Dorst, 2008; Gericke et al., 2020). The lack of scientific rigor not only impacts the quality of design research and the methods building on this research. Framed in regard to the dissemination, this insufficient validation hinders the dissemination of design research into other fields of research (P. J. Cash, 2018). Considering how fundamental design is to human activity – Heskett (2002, p. 6) names it: "[…] a defining characteristic of what it is to be human." – it is problematic that design research does not seem to make an impact outside the field of design. The lack of knowledge transfer among disciplines is detrimental to the transdisciplinarity of design (Gericke et al., 2021). To enable productive transdisciplinary collaboration, it is crucial that the individual disciplines involved in such work recognize and acknowledge the quality and contribution of design research and can thus accept the methods that designers bring to the fore to enable and facilitate such work. As long as methods are not accepted – or even adopted – outside of the field of design, our ability to contribute to addressing complex societal challenges is at stake.

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