Method content theory: Towards a new understanding of methods in design

Daalhuizen, Jaap; Cash, Philip

Published in:
Design Studies

Link to article, DOI:
10.1016/j.destud.2021.101018

Publication date:
2021

Document Version
Peer reviewed version

Link back to DTU Orbit

Citation (APA):
METHOD CONTENT THEORY: TOWARDS A NEW UNDERSTANDING OF METHODS IN DESIGN

Jaap Daalhuizen*,1, Philip Cash1

Highlights

- Proposes and tests a Theory of Method Content.
- Synthesizes fragmented literature to explain how methods function in context.
- Proposes key method content variables and relationships.
- Demonstrates the predictive power of method content for method performance.
- Presents a research agenda towards a theory of methods in design.

Affiliation: 1 Technical University of Denmark, Denmark *Corresponding author

METHOD CONTENT THEORY: TOWARDS A NEW UNDERSTANDING OF METHODS IN DESIGN

ABSTRACT

Design methods capture key procedural knowledge, central to design process, practice, and education. However, a more robust explanation of the method phenomenon is needed. We move towards answering this need by proposing, and quantitatively testing, a Method Content Theory; addressing i) how methods function in context; ii) the elements of method content i.e. Method Framing, Method Rationale, Method Goal, Method Procedure, and Method Mindset; and iii) predictors of method performance. We provide initial quantitative validation for the proposed theory demonstrating strong predictive power for methodological performance indicators. We build on this to define a future research agenda. Our results have implications for research, education and practice, along with the potential for actionable insights in design methodology, method development and validation.

Keywords: design methods; design methodology; design tools; design theory; Method Content Theory

Methods capture key procedural knowledge about design, and are one of the major means through which design research impacts education, industry, and society (Blessing & Chakrabarti, 2009; Cantamesa, 2003; Daalhuizen, Person, & Gattol, 2014). Design research has a long tradition of method development (Andreasen, 2011; Daalhuizen, 2014; Gericke, Eckert, & Stacey, 2017), which continues to grow in importance as designers face ever more complex technical and social challenges (e.g. Tromp & Hekkert, 2018; Meyer and Norman, 2020). Methods form one of the central pillars of design research.

Despite this centrality, little is actually known about how and why methods function (Daalhuizen, 2014; Dalsgaard, 2017), let alone what factors predict their success or failure (Daalhuizen, 2014). Further, major questions remain regarding how methods should be developed, validated, and studied (see e.g. Reich, 2010). Consequently, there is little explanatory, and no predictive, theory of methods and their performance (Andreasen, 2003; Daalhuizen et al., 2014). This is in stark contrast to other aspects of design, which have received significant theoretical and empirical attention (Cash, 2018; Christensen & Ball, 2019; Love, 2002) and for which rich and coherent bodies of knowledge have been established. For example, mature bodies of knowledge have emerged surrounding the design process and activity (Cash, 2018; Hay et al., 2017), the object of design e.g. the artefact (Bucciarelli, 2002), and the designer and design team (Badke-Schaub, Lauche, & Neumann, 2007; Nigel Cross, 2018; Kleinsmann & Valkenburg, 2008). Cash (2020) identified 133 theories mentioned during the last 15 years of design research, none of which focus on methods. These
challenges are reflected in substantial, critical debate on the value and impact of methods in practice (see e.g. Andreasen et al., 2015; Cantamessa, 2003; Daalhuizen et al., 2014; Dorst, 2008; Wallace, 2011), as well as how they can be integrated in future design education (Meyer & Norman, 2020). Thus, there is a need to develop a more robust explanation of the method phenomenon in design.

Currently, a design method can be broadly defined as ‘a formalised representation of a design activity, which functions as a mental tool to support designers in achieving a goal, in relation to the circumstances and resources available’ (Daalhuizen et al. 2019). This means that methods act as information carriers, conveying how to perform specific design practices, through the processing, interpretation, and subsequent change of behaviour by their users. Therefore, a method’s content, as found in numerous textbooks (e.g. Cross, 1994; Ulrich & Eppinger, 2015), represents an explicit embodiment of understanding about current or new imagined design practice (Roozenburg & Eekels, 1995). This is key to facilitating knowledge transfer, collaboration, communication, and education in design (Badke-Schaub, Daalhuizen, & Roozenburg, 2011; Cantamessa, 2003; Daalhuizen et al., 2009). However, the specific variables and relationships (i.e. the core theoretical concepts (Wacker, 2008) shaping the function and impact of method content remain undefined. Thus, there is a critical need to bring together knowledge on what actually constitutes the key elements of a method i.e. its essential content, and operationalise this in a model with predictive power.

In order to address this need, we propose and test a Method Content Theory, as a step towards a wider Theory of Design Methods. In doing so we distil key content variables, operationalise predictions linking these to performance measures, and empirically demonstrate the explanatory and predictive power of the resultant model. As such, we both build and test theory regarding design methods, following the theory-driven research cycle (Cash, 2018). This results in three major contributions. First, we, for the first time, formalise a Method Content Theory in design. Second, we operationalise this theory and demonstrate its predictive power with respect to key method performance measures. Third, we leverage these insights to provide concrete guidance for method development, testing, and implementation, as well as an agenda for future theory-driven research in this area.

1 Background

The role and impact of methods in design have received considerable attention in the literature. Most notably, methods have been characterised as means for describing, coordinating, and providing a common vocabulary for the social process of design work (Bucciarelli, 1995; Jensen & Andreasen, 2010; Stappers & Sanders, 2003), communicating and justifying design outcomes (Araujo, 2001), and guiding and/or teaching design (Andreasen, 2011; Bender & Blessing, 2004; Roozenburg & Eekels, 1995). Design methods range from general heuristics to algorithm-like templates (Daalhuizen, 2014). For example, Conjecture analysis (Darke, 1979) or satisficing (Simon, 1996) are heuristic in nature and when formalized as rules can serve to instruct
how to behave while doing design work (Daalhuizen et al., 2014; Daly et al., 2012). Whereas the former examples might be rather simplistic in nature most methods are more sophisticated and represent more complex design work. For example, the Morphological approach (Zwicky, 1967) prescribes a more systematic way of working. Design methods address all stages of the design process; from early exploration e.g. Contextmapping (Visser et al., 2005), to detailing and delivery e.g. visualization for presentation (Eissen & Steur, 2011). However, cutting across this diversity is the central interaction between the method user and the method content (Andreasen et al., 2015; Daalhuizen, 2014).

The general relationship between method and user has formed the basis for an array of proposed definitions of design methods (see e.g. Araujo, 2001), building on two foundational works. First, Christopher Jones (1992) defined methods as a means to externalize the thought processes of designers, with the aim to professionalize the field and support designers in dealing with increasingly complex problems. Jones thus emphasized the intimate connection between methods and their users, yet also expressed his dissatisfaction with the way methodology was developing in the field (Jones, 1977). Second, Roozenburg and Eekels (1995) defined a method as the diachronic structure of an activity that is to be consciously applied in order to achieve some change in the world (a goal) i.e. a method as a means to achieving a goal. Together, these works highlight how methods are much more than systematizations of the design process to be robotically followed by designers (Daalhuizen et al., 2014; Jensen & Andreasen, 2010; Jones, 1977); rather they reflect a symbiotic relationship between the method and user, directed towards achieving a goal. However, research on how this relationship fundamentally functions remains sparse (Daalhuizen, 2014; Dorst, 2008; Gericke et al., 2017). Specifically, there is no current model for describing the essential elements of a method, how these interact with a method user in context, and how variations in this interaction might impact performance.

1.1 Understanding method use

Current design methods literature can be synthesised to identify five key factors that elaborate the basic method phenomenon: the method content, the method user, the intended goal, the information artefact, and the use context. This builds on prior work by Dorst (2008) and others (Badke-Schaub, 1999; Daalhuizen et al., 2014; Gericke et al., 2016), who have emphasised the importance of linking methods to issues regarding the actor in design, the object of design, the information artefacts and the context of design. Dorst captured the importance of this situated conceptualisation of methods on a practical level when he wrote: “if I am a designer with the following capabilities, and I am confronted with a design task with these characteristics, and I am working in this situation, and I have progressed to this point in the design process, then what should I do now?” (1997, p. 21). Hence, the five factors are outlined below.

First, a method contains information about a way of working with some ordering in time (procedural knowledge) that serves as a means to (help) achieve a goal (Roozenburg & Eekels, 1995). Here, ordering
information can be as simple as a heuristic like ‘prototype, test, and iterate’ or as complex as multiple iterative stages with detailed steps and activities (e.g. Eppinger & Ulrich, 2015; VDI, 1987). Thus, a method is framed as containing content in the form of information that must be interpreted by a designer (Daalhuizen, 2014), and will result in an observable (change in their) way of working (Roozenburg & Eekels, 1995).

Second, method content is typically embodied in some form of information artefact i.e. the tools used to store, manipulate, and display information (Green & Blackwell, 1998). Further, during use, methods typically draw on and produce numerous other information artefacts, either related to the design itself as ‘design artefacts’ or the design process as ‘procedural artefacts’ (Perry & Sanderson, 1998). Such artefacts function as embodiments of the method content itself, as well as complex boundary objects and mediators of design work (Robertson, 1996). They both augment designers’ capabilities and shape their perception and understanding when using methods, as well as more generally when doing design (Dalsgaard, 2017). Thus, while these are a key aspect of overall method use, their nature and role in the embodiment of method content and facilitation of use can vary substantially.

Third, the designer interprets and responds to the method. This means that a methods’ content needs to be consciously processed and applied in order to have an effect (Daalhuizen, 2014a). This leads to the general conceptualisation of methods as ‘mental tools’ that interact with a designer’s beliefs, knowledge, and cognitive processes (Daalhuizen, 2014; Jones, 1992). This interaction with a designer’s beliefs and knowledge has been referred to as ‘mindset’ (Andreasen, 2003; Daalhuizen et al., 2014).

Fourth, methods are goal-oriented i.e. their purpose is to support designers in achieving design goals (Badke-Schaub et al., 2011; Dorst, 2008; Gericke et al., 2017). Such goals exist at higher or lower levels of resolution in the design process (Andreasen et al., 2015). For example, a goal that describes the overall aim of a design project is typically divided into multiple sub-goals, which must each be met in order to satisfy the overall goal. Further, goals vary in the extent to which they are formulated, expressed and adopted explicitly and concretely (Fricke, 1999). That is, goals can be rather implicit and imprecise or explicit and concrete and everything in between. Methods thus serve as means to help designers achieve their intended goals.

Fifth, method use in practice is influenced by a complex set of contextual factors (Cash et al., 2015), including positioning within the wider design process, the specific design task and artefact under consideration, and the social team and organisational environment (Badke-Schaub, 1999; van Kuijk et al., 2019). Further, outcomes are widely considered to be directly affected by the way in which a method is ‘staged’ i.e. how methods are chosen and used in relation to the emerging situation at a given moment in a design project is affected by contextual factors (Andreasen et al., 2015). Last, methods are related to, and must function in accordance with, the many low-level techniques and ‘mundane acts’ of design in order to support work in real-life contexts (Botero et al., 2020). Thus, these also form part of the context that affect method use.
In interaction, these factors form the basis for understanding the wider method phenomenon in design. That is, the performance of a method is dependent on the interaction between its content, information artefacts, user, context, and design goals. Important here, is that while use, outcomes, and goals, are influenced by, interpreted with respect to, and processed in context, method content and its embodiment are not i.e. these are typically developed in another context (e.g. in a university). It thus becomes clear why the impact of methods is not just a matter of systematic application of a formal protocol (Cantamessa, 1999; Roozenburg & Eekels, 1995), i.e. of only procedural information. Methods and their impact are fundamentally flexible, goal-oriented means that require reflexivity (Bender & Blessing, 2004; Fricke, 1999) and reflection-in-action (Adams et al., 2003; Schön, 2017) in order to account for evolving users, goals, and contexts. And thus, for a method to function, it must be understood in relation to all five factors. For example, how well a design outcome addresses a goal, and hence its perceived success is highly dependent on the context of use (Daalhuizen, 2014; Dorst, 2008). However, no current model captures all five factors, their interaction, or their impact on method performance, hence it is necessary to identify a starting-point for this research. Importantly, while users, goals, information artefacts, and context are changeable, method content is relatively stable, making it a persistent factor supporting many aspects of design work. This makes method content unique amongst the five factors, and thus provides a key first step in developing a wider understanding of method use. This overall framing is illustrated in Figure 1.

**Figure 1:** Method content and its relation to method use, context, design goals, information artefacts and design outcomes

### 1.2 Efficacy and Effectiveness in relation to method performance

While research specifically focused on method content is sparse, two perspectives can yield relevant insight. First, method content can be seen as a ‘theory’ with explanatory and predictive power (Hevner, 2007). Here, method content contains procedural information and/or knowledge about a specific, goal-directed way of working with expected outcomes (Daalhuizen et al., 2019; Roozenburg & Eekels, 1995). This directly maps to definitions of theory as organised knowledge about variables and their interrelationships with explanatory and predictive power in a specific domain (Wacker, 2008). Second, method content can be seen as a designed
artefact with distinct properties and use characteristics. Here, method content is explicitly designed with the aim to make specific information accessible, convincing, and usable for others (Araujo, 2001). This maps to discussions in user-centred design, which aims to develop artefacts that are usable and useful for the intended users (ISO 9241-210:2019). These two perspectives provide a basis for understanding how method content affects performance. Furthermore, they have been elaborated and used for similar purposes in other fields, such as prevention science (Flay et al., 2005; Gottfredson et al., 2015).

From the first perspective – method content as theory – ‘good’ theory clearly defines its core variables, their relationships, and domain of action, able to support falsifiable predictions of what would, should, or could happen in various instances (Wacker 2008). Here, method content should be clearly, and coherently defined and offer predictable effects on the designer and use in context. In methodological terms Gottfredson et al. (2015) define this as efficacy. Efficacy relates to how well a method supports the transfer of knowledge to the user and its effect on the designer’s behaviour i.e. the direct effect of the content on a designer, typically tested under controlled conditions.

From the second perspective – method content as a designed artefact – well-designed artefacts combine properties that make them understandable, useful, and desirable to their users (ISO 9241-210:2019). Here, method content should be usable and desirable. In methodological terms Gottfredson et al. (2015) defines this as effectiveness. Effectiveness relates to how well a method allows designers to achieve the desired effect in context, typically tested in real-life conditions.

Together efficacy and effectiveness provide a basis for generically understanding the relationship between method content and performance in practice.

2 Building a Method Content Theory

In this section we propose a Method Content Theory and describe its major elements: the core variables and internal relationships (Section 2.1) and the logic underpinning performance predictions (Section 2.2).

2.1 Method content variables and internal relationships

Five major variables form the core of our conceptualisation of method content: Method Goal, Method Procedure, Method Rationale, Method Framing, and Method Mindset. These variables directly correspond to the factors that elaborate the method phenomenon (Section 1.1 and Figure 1). That is, they link different elements of method content to the wider method phenomenon. Method Goal corresponds to how a method can contribute to achieving a design goal. Method Procedure corresponds to how a method’s prescribed procedure can contribute to reaching the design goal. Method Rationale provides justification for the Method Goal. Method Framing corresponds to the context(s) in which the method is to be used. Method Mindset corresponds to the beliefs and knowledge that a method users’ needs to possess to use the method.
‘Good’ methods have content for at least all five variables that are both internally clear and coherent, as well as linked to the factors external to the method content (i.e. excluding information artefacts), which shape method use as illustrated in Figure 1. That is, Method Goal ought to provide information about what design goals the method will help achieve. Method Procedure ought to provide information about how a specific way of working will help to achieve those design goals. Method Rationale ought to provide information about the relevance and justification of the method goal in a given context. Method Framing ought to provide information about how the method can be appropriately used in relation to specific circumstances of the context. And last, Method Mindset ought to provide information about the required or appropriate mindset that the method user must have or adopt for the method to be useable and efficacious. All of these variables reflect the explicit content provided by the method as detailed below.

2.1.1 Method Goal

Any method serves to help achieve one or more design goals. The content must therefore describe what goal the use of the method is to contribute to, its scope, and degree of flexibility. This refers to the specific goals that a method aims to help achieve and that are explicitly described as part of the method content, and not, for example the goals a designer might have in mind or that are described in the design brief. Here, a pre-existing variable can be adapted from the management domain: Goal Clarity (Lee et al., 1991). Translated to the current context, Method Goal is defined as: the described goals and the prioritization of those goals a method aims to help achieve through its use.

2.1.2 Method Procedure

Content provides guidance on how to reach the goal. This procedural knowledge can be extremely precise and prescriptive or more open-ended, but all methods contain some kind of structural knowledge about a specific way to reach a goal (Roozenburg & Eekels, 1995). Content often also contains substantive knowledge, e.g. specific theory or typologies, yet when this is the case, this knowledge is integrated in a proposed way of working (procedure) in order to reach the goal. Here, we draw on descriptions of what is required to understand a method’s procedure from Roozenburg and Eekels (1995) in order to propose the variable: Method Procedure. Roozenburg and Eekels characterized the procedural information contained in a method as representing the ‘structure’ of the design activity. Here, structure refers to the minimal set of actions that are necessary to perform a specific design activity as well as their logical and chronological ordering. In building on Roozenburg and Eekels (1995), Method Procedure is defined as: the structural activities described in the method and their relative chronological and logical ordering.

2.1.3 Method Framing

Content provides information that frames the method’s use in relation to appropriate context(s) of use and its relevant factors (Badke-Schaub & Frankenberger, 1999). For example, organizational context has shown
to have significant influence on the use of user-centred design methods (van Kuijk et al., 2019). A method user must be able to understand in what type of situation(s) the method can be used and is expected to be effective. This includes knowledge about when and where in the design process in can be used, the domain(s) it can be used in, the kinds of problems/challenges that might occur as well as who and what are needed to use the method in a meaningful way. Here, we draw together prior descriptions of contextual framing in design (Andreasen et al., 2015; Badke-Schaub, 1999; Badke-Schaub et al., 2011; Dorst, 2008; Gericke et al., 2017) in order to propose the variable: Method Framing. Method Framing is defined as: the context of use described in the method and its implications and prerequisites for method use.

2.1.4 Method Rationale

Content provides information that explains why a method’s goal is relevant and meaningful in its specific domain and context of use. This is relevant information if we expect the method user to be able to use and adapt it to a given context and circumstances. The importance of flexible use of methods has been shown by for example (Bender & Blessing, 2004). As with Method Goal, a pre-existing variable can be adapted from the management domain: Goal Rationale (Lee et al., 1991). In this light, Method Rationale is defined as: the performance-goal relationship and motivations underlying the goals of the method.

2.1.5 Method Mindset

Finally, content provides guidance on what mindset is appropriate when using a method. Mindset consists of at least specific beliefs, perspective on design, values, experiences with idiosyncratic enactment of design and design methods, focus, and specific need for methodological support (Andreasen, 2003; Andreasen et al., 2015; Daalhuizen et al., 2014). The mindset that designers develop has direct implications for their use of specific methods, and vice versa, methods also require a certain mindset to be used appropriately. Therefore, method content needs to provide information that allows designers to reflect on whether it corresponds to their mindset and/or how to adapt their mindset to fit the method. Here, we draw together prior descriptions of mindset (Andreasen, 2003; Daalhuizen et al., 2014) in order to propose the variable: Method Mindset. Method Mindset is defined as: the set of described values, principles, underlying beliefs, and logic that inform a method and its use.

2.1.6 Relationships between variables

Beyond the general interaction between all variables as part of a ‘whole’ content description, there are three major internal relationships. First, Method Goal and Method Procedure are closely related such that when a designer uses the method the process leads to achieving the intended outcome in a reliable manner. This relationship determines the goal-orientedness of a method and deals with the internal logic of the method. Further, both of these variables deal with the internal logical consistency of the method. Specifically, method content contains purposeful knowledge that is considered prescriptive (Badke-Schaub, Daalhuizen, &
Roozenburg, 2011; Dorst, 1997; Finger & Dixon, 1989; Roozenburg & Eekels, 1995), and can serve diverse purposes. This means that in order to logically understand method content it must articulate both the intended goal that it helps to achieve and the associated procedure to be followed.

Second, **Method Framing** and **Method Rationale** are closely related such that the staging of a method is appropriate to its use context. Both of these variables deal with the contextual positioning of the method with respect to the wider design process and organisational context. For example, they both provide important ques for designers when faced with ambiguous information regarding procedure or goal. Therefore, clarity in these variables can allow a designer to infer goals or ways forward in the face of incomplete or conflicting procedural information. This relationship determines the appropriateness of a method and deals with the contextual positioning of the method. Specifically, design practices happen in context, and method content is thus interpreted, adapted, and used with respect to this context. This can be simply captured by relating to the questions *when, where, and how should a method be used?* (**Method Framing**) and *why should a method be used in this context?* (**Method Rationale**). Dorst (2008) alluded to the importance of this in his criticism of the overemphasis of design process over questions of context, method users, design research, etc.

Third, **Method Mindset** directly relates to how the method is interpreted by the method user (Andreasen, 2003) which is an important first step that shapes how a method is used. As such, it broadly connects the two parings above by providing a basis for understanding the internal logic of the method content: **Method Goal** and **Method Procedure**, with respect to its implied context: **Method Framing** and **Method Rationale**. This relationship determines to what extent the method user is able to understand the way the method will help to achieve its goal and how it will do so in a given context of use and deals with the user’s interpretation of the method. Additionally, **Method Mindset** provides information about underlying values and beliefs that can help a user to understand perceived deficiencies or conflicts between these two pairs.

In sum Method Content Theory encapsulates five major variables, with three distinctive internal relationships informing their interaction. This understanding of the theory’s internal logic is illustrated in Figure 2.
Finally, in order for the proposed Method Content Theory to be meaningful it is necessary to understand what falsifiable predictions it offers. This requires a logic for connecting the variables and relationships outlined in Figure 2 to wider design performance and raises the following questions: what basic properties of methods are relevant to method performance, and how do these map onto the conceptualisations of ‘good’ theory and ‘good’ artefact? Drawing on the discussion in Section 1.2 it is possible to identify four key properties of ‘good’ method content, two associated with efficacy and two with effectiveness. Focusing on the internal structure and logic of the content, based on the features of ‘good’ theory (Wacker, 1998; Wacker, 2008) and efficacy (Flay et al., 2005), we propose the properties: Defined and Predictable. Focusing on the use of the content in practice, based on the features of ‘good’ method artefacts (Araujo, 2001) and method effectiveness (Daalhuizen, 2014), we propose the properties: Usable and Desirable. These are summarised in Figure 3, and provide the core theoretical constructs bridging abstract conceptualizations of method content and more concrete and specific measures of performance.
Synthesising these properties (Figure 3) with the proposed variables and relationships (Figure 2), it is possible to develop concrete predictions for what should, could, and would happen when any one of these elements is manipulated. Specifically, performance will be negatively impacted by i) incomplete description of the content variables, ii) conflict between the closely related content variables, iii) conflict between the internal logic and implied context.

3 Testing Method Content Theory predictions

In order to initially evaluate the predictive power of the proposed Method Content Theory we operationalise and test the predictions outlined in Section 2.2, using a quantitative theory-testing approach.

3.1 Performance measures and hypotheses

To test the predictive power of the proposed theory we draw on established performance measures related to method outcomes. This helps connect the proposed theory to prior works in the design domain as well as providing already validated scales, increasing robustness and validity. Further, we limit this discussion to a focus on measures related to the properties Defined and Predictable (Figure 3) because these relate directly to the content of a method itself. Logically, these efficacy properties need to be considered before effectiveness, similar to, for example, practices in prevention science (Gottfredson et al., 2015), clinical psychology (Clarke, 1995), or even product design where basic functionality is evaluated separately from market success (Buijs, 2003). If method content is to be defined and predictable, it needs to contain high quality information, it needs to contain information that unambiguously informs the designer how to behave,
and needs to contain coherent information so that means and goal are aligned. Therefore, we operationalised performance with respect to the perceived completeness of the key variables: **Knowledge Quality** (Chiu et al., 2006; DeLone & McLean, 2003; McKinney, Yoon, & Zahedi, 2002), their perceived ambiguity: **Role Ambiguity** (Rizzo, House, & Litzman, 1970), and their logical coherence: **Goal-means Conflict** (Lee et al., 1991). These dependent variables have each been previously validated and are defined as:

**Knowledge Quality**: measures the quality of shared knowledge content, through six content attributes: relevance, ease of understanding, accuracy, completeness, reliability, and timeliness (Chiu et al., 2006).

**Role Ambiguity**: measures both the predictability of outcomes in response to one's behaviour as well as the presence and clarity of requirements that guide behaviour and help determine its appropriateness (Rizzo et al., 1970).

**Goal-means Conflict**: measures the conflict that arises from lack of clarity, ambiguity and misalignment in relation to goal and procedure (Lee et al., 1991).

Based on the predictions in Section 2.2. and these dependent variables it is possible to formulate three main hypotheses.

**Hypothesis 1** follows the first main prediction: performance outcomes will be negatively impacted by incomplete description of the content variables. This comprises 13 sub-hypotheses (H1a-m) testing the direct relationship between each content variable/dependent variable combination except **Method Mindset** and **Knowledge Quality** or **Role Ambiguity**, as these dependent variables are independent of mindset considerations. See below:

- **H1a**: Completeness in the description of Method Goal increases Knowledge Quality.
- **H1b**: Completeness in the description of Method Goal decreases Role Ambiguity.
- **H1c**: Completeness in the description of Method Goal decreases Goal-Means conflict.
- **H1d**: Completeness in the description of Method Procedure increases Knowledge Quality.
- **H1e**: Completeness in the description of Method Procedure decreases Role Ambiguity.
- **H1f**: Completeness in the description of Method Procedure decreases Goal-Means Conflict.
- **H1g**: Completeness in the description of Method Rationale increases Knowledge Quality.
- **H1h**: Completeness in the description of Method Rationale decreases Role Ambiguity.
- **H1i**: Completeness in the description of Method Rationale decreases Goal-Means Conflict.
- **H1j**: Completeness in the description of Method Framing increases Knowledge Quality.
- **H1k**: Completeness in the description of Method Framing decreases Role Ambiguity.
H1I: Completeness in the description of Method Framing decreases Goal-Means Conflict.

H1m: Completeness in the description of Method Mindset decreases Goal-Means Conflict.

**Hypothesis 2** follows the second main prediction: performance outcomes will be negatively impacted by conflict between the closely related content variables (Method Goal/Method Procedure; Method Framing/Method Rationale). Here, the Method Goal/Method Procedure pair link to Goal-means Conflict (H2c) and should not impact Knowledge Quality and Role Ambiguity, and the Method Framing/Method Rationale pair link to Knowledge Quality and Role Ambiguity (H2a, b) and should not impact Goal-means Conflict. Hence Hypothesis 2 has three sub-hypotheses. See below:

- H2a: Conflict between Method Framing and Method Rationale decreases Knowledge Quality.
- H2b: Conflict between Method Framing and Method Rationale increases Role Ambiguity.
- H2c: Conflict between Method Goal and Method Procedure increases Goal-Means Conflict.

**Hypothesis 3** follows the third main prediction: performance outcomes will be negatively impacted by conflict between the internal logic and implied context. Specifically, the wider design goal is often implied by the Method Framing/Method Rationale pair, which could conflict with the internal goal logic of the Method Goal/Method Procedure pair. Therefore, interaction between these pairs should link to Goal-means Conflict. This will also put a priority on Method Mindset in helping to resolve any conflict in this relationship. Hence, Hypothesis 3 has two sub-hypotheses dealing with i) the inter-pair alignment and ii) the role of Method Mindset when this alignment relationship is introduced (H3a and b), see below. These hypotheses test both the importance of the variables, as well as of the proposed relationships between them. The dependent variables and hypotheses are summarised in Figure 4.

- H3a: Alignment between Method Framing/Method Rationale and Method Goal/Method Procedure decreases Goal-Means Conflict.
- H3b: Alignment between Method Framing/Method Rationale and Goal/Method Procedure increases the significance of Method Mindset.
3.2 Sample and organisation

We base our testing on a questionnaire dataset collected from 305 masters level design students. A student sample was used for three main reasons. First, the hypotheses are abstract and should hold true across levels of expertise. Second, students support increased internal validity due to their relative homogeneity and ability to follow complex study designs (Bello et al., 2009), which are essential for testing novel theoretical propositions, as in this case. Third, students provide sufficient numbers to evaluate correlation type hypotheses following best practice guidelines for statistical validity and sample size (Collins et al., 2007).

3.3 Measurement instruments

All variables were evaluated using 7-point Likert-type instruments. In order to maximise robustness these instruments were adapted from previous validation studies wherever possible. Thus, we directly adopted instruments for Method Goal and Method Rationale from Lee et al. (1991), and further slightly adapted these to address Method Procedure. Method Procedure was evaluated for each step in a method and was thus normalised across steps for analysis purposes. Similarly, Knowledge Quality was directly adapted from Chiu et al. (2006), and has also been validated in the design context by Cash et al. (2017). Role Ambiguity and Goal-means Conflict were adapted from the widely used scales proposed by Rizzo et al. (1970). For the design specific Method Framing, and Method Mindset new instruments were developed. Here, we drew on prior design theory regarding the knowledge required to use design methods (see Section 2.1). Each of the items used can be found in Appendix A.
Once all instruments were defined we carried out a number of refinements and checks in order to ensure their validity. First, pre-study, all adaptations of wording to the design context were iterated with both students and experts to ensure clarity and consistency in interpretation. Second, post-study, all instruments were checked for consistency using Cronbach alpha (Cortina, 1993), which proved robust across all variables as detailed in Appendix A. Third, post-study, we carried out confirmatory factor analysis, which again proved robust. Specifically, all variables loaded to one primary factor as detailed in Appendix A. Based on this, the mean was calculated for each instrument following standard practice. Finally, a pairwise correlation analysis was used as an initial evaluation of multi-collinearity. This revealed relatively high correlation between some variables, as detailed in Appendix A. However, based on the overall outcome of these checks, as well as the grounding in prior work, we concluded that the instruments used in this study are both theoretically and empirically robust.

3.4 Assessment task and data collection

Participants were given the individual task to assess three methods. Each participant evaluated the content of a subset of three methods drawn from a total set of 58 methods, all from the Delft Design Guide (Van Boeijen, et al., 2014)\(^1\). Participants were each assigned a pair of methods randomly to ensure complete coverage. They were allowed to freely pick one method in addition, to increase participation and motivation. All participants brought or were provided with a copy of the Delft Design Guide. The exercise was part of the course curriculum, yet participants could choose to opt-out for use of the data for research purposes.

For the task, the set of 58 methods were paired with each other to produce 58 pairs. Each method in the set appeared once as first option of a pair, and once as second option to control for order effects. Pairing happened randomly yet between methods that were dissimilar, by only pairing methods that belonged to different phases of the design process as structured in the Delft Design Guide, see Appendix B. The common source in the Delft Design Guide was used to control for possible confounds stemming from method embodiment or method complexity.

Data was collected from participants using an in-class, electronic survey. Participants were first introduced to the assessment task and provided with the required background information about methods and their use in a 45-minute lecture. Participants were then asked to respond to all survey questions for each of the methods in the order indicated, with the self-selected method last. This resulted in a total of 805 complete evaluations of single methods, divided across 305 students.

3.5 Analytical method

\(^1\) The Delft Design Guide is a textbook on design methods containing most of the methods taught in the design curriculum at the faculty of Industrial Design Engineering, Delft University of Technology.
As we used Likert-type instruments, prior to testing the data was evaluated for normality (using a Shapiro-Wilk W test), multi-collinearity (using Variance Inflation Factor (VIF)), and heteroskedasticity (using a Breusch-Pagan/Cook-Weisberg test). In each case VIF and heteroskedasticity were found to be acceptable, but normality was rejected based on the Shapiro-Wilk W test. Therefore, we used a robust step-wise OLS regression, controlling for experience with the method, design work experience, educational focus, method ordering (i.e. first, second, third, of the three methods evaluated), and method number (i.e. placement in Appendix B). Robust regression is an approach to dealing with a data set where there are outliers or influential observations; as is the case here. Finally, in order to account for the pair-wise correlation outcomes (Section 3.3) we examined the effects on each dependent variable separately. Further, we checked all main outcomes (Table 2) using versions where each correlated independent variable was evaluated individually. This follows best practice, provided the robust VIF outcomes noted above, and confirmed all significant results from the main regression analysis. Based on this approach and the confirmatory checks described above we conclude that the reported results are robust. Table 1 provides descriptive statistics for all variables.

Table 1: Descriptive statistics, n = 805

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Method Framing</td>
<td>2.58</td>
<td>1.00</td>
</tr>
<tr>
<td>2 Method Mindset</td>
<td>2.40</td>
<td>0.94</td>
</tr>
<tr>
<td>3 Method Goal</td>
<td>2.59</td>
<td>1.03</td>
</tr>
<tr>
<td>4 Method Rationale</td>
<td>2.85</td>
<td>1.09</td>
</tr>
<tr>
<td>5 Method Procedure</td>
<td>2.49</td>
<td>1.01</td>
</tr>
<tr>
<td>6 Knowledge Quality</td>
<td>2.62</td>
<td>1.00</td>
</tr>
<tr>
<td>7 Role Ambiguity</td>
<td>2.90</td>
<td>1.10</td>
</tr>
<tr>
<td>8 Goal-means Conflict</td>
<td>4.86</td>
<td>1.24</td>
</tr>
</tbody>
</table>

4 Results

In this section we first evaluate hypothesis testing and second offer initial steps towards connecting these findings to real world practice, by evaluating qualitative experiences of method use.

4.1 Evaluating Method Content Theory predictions: Hypothesis testing

Table 2 presents the results of our seven regression analyses. We generally support the proposed hypotheses illustrated in Figure 4. 1-3 support the predicted direct effects (Hypothesis 1) i.e. increasing the clarity of the content variables has a positive effect on performance. 4-6 support the interaction effects (Hypothesis 2) i.e. increasing coherence between Method Framing/Method Rationale, and Method Goal/Method Procedure has a positive effect on performance. Finally, 7 supports the effect of the alignment relationship between these pairs (Hypothesis 3) i.e. increasing coherence between Method Framing/Method Rationale // Method Goal/Method Procedure, has a positive effect on performance, and increases the significance of Method Mindset. Important to note here is that due to the extensive debate about correction and over-correction
for multiple-hypothesis testing (Armstrong, 2014), we report the full nominal p-values in Table 2 without applying any corrections. While this study does not meet the criteria set out by Armstrong (2014) for requiring Bonferroni correction, for transparency we have also checked its application at the level of each individual regression analysis. The results remain largely the same, with the following becoming non-significant: Method Framing in 1 and 6, Method Goal in 2, Alignment in 7. However, Bonferroni corrections are typically very conservative and should be taken with caution (Armstrong, 2014).

4.2 Closing the loop: Method Content Theory predictions in practice

To close the loop back to designers’ actual experience of using methods, we present illustrative quotes sourced from the sample students’ statements on their prior experiences when reflecting on one positive and one negative past experience with a method. In doing so, we illustrate that issues related to method content are often directly linked to students’ actual experiences. First, many students associated negative experiences with a lack of clarity in the link between the Method Procedure, Method Goal, and Method Rationale; as illustrated by the example quote: “A lot of things had to be defined. Axis, areas etc. We were never sure about if what we were doing was right and therefore kept going back. We had tons of brainstorms that lead to nothing, which is un-motivating” (Student A). This lack of clarity can cause doubt about the design work itself and can hamper users in determining if what is being done is actually good, which can be demotivating. This type of experience was common, and is illustrated by the following: “The goal of each step of the method was not clear to us. It felt like the method was confusing us and keeping us farther away from the true problem instead of helping us solve this problem” (Student B).

Second, numerous statements highlighted negative experiences linked to misalignment between the designer’s mindset and experience and the Method Mindset, due to lack of clear description. See for example: “There was just a lack of synergy between me, my groupmates, and the actual method. I do think that that had to do something with the ambiguity of the method, which is something that we as young designers were a bit scared about” (Student C). Here, a clear description of Method Mindset would have allowed the inexperienced students to determine that perhaps this method was not suitable for them (yet) or at least not without first gaining a better understanding of the underlying values and principles.

Finally, many positive experiences were associated with clarity in method content, and its positive impact on performance and motivation. See for example: “the goal and reasoning behind every step was clear so I was motivated to continue using it. This was probably partly because the method was presented well. In practice, the method forced you to think critically about a multitude of factors by making your formulate and sort them in a specific way” (Student D); and “Even though it seems hard to approach a design challenge from a different angle like [the method] does, the steps (...) are so clear to follow, that you are automatically ‘pushed’ to look
into different directions” (Student E). Together these statements underline the importance of clear, coherent, and complete method content for design performance.
Table 2: Results of the regression analyses

<table>
<thead>
<tr>
<th>N = 805</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variables</td>
<td>Knowledge Quality</td>
<td>Role Ambiguity</td>
<td>Goal-means Conflict</td>
<td>Knowledge Quality</td>
<td>Role Ambiguity</td>
<td>Goal-means Conflict</td>
<td>Goal-means Conflict</td>
</tr>
<tr>
<td>R-squared</td>
<td>.562</td>
<td>.556</td>
<td>.126</td>
<td>.573</td>
<td>.590</td>
<td>.139</td>
<td>.134</td>
</tr>
<tr>
<td>Method Framing</td>
<td>.083*</td>
<td>.0164***</td>
<td>.163***</td>
<td>.339***</td>
<td>.658***</td>
<td>.294*</td>
<td>-.110</td>
</tr>
<tr>
<td>p-value</td>
<td>.089</td>
<td>.004</td>
<td>.013</td>
<td>.001</td>
<td>.000</td>
<td>.074</td>
<td>.414</td>
</tr>
<tr>
<td>(Standard error)</td>
<td>(.05)</td>
<td>(.06)</td>
<td>(.07)</td>
<td>(.10)</td>
<td>(.11)</td>
<td>(.16)</td>
<td>(.14)</td>
</tr>
<tr>
<td>Method Mindset</td>
<td>.050</td>
<td>-.029</td>
<td>-.243***</td>
<td>.078</td>
<td>.026</td>
<td>-.250***</td>
<td>-.237***</td>
</tr>
<tr>
<td>Method Goal</td>
<td>.041</td>
<td>.671</td>
<td>.005</td>
<td>.178</td>
<td>.667</td>
<td>.003</td>
<td>.007</td>
</tr>
<tr>
<td>(Standard error)</td>
<td>(.06)</td>
<td>(.07)</td>
<td>(.09)</td>
<td>(.06)</td>
<td>(.06)</td>
<td>(.09)</td>
<td>(.09)</td>
</tr>
<tr>
<td>Method Purpose</td>
<td>.010</td>
<td>.088</td>
<td>.000</td>
<td>.294</td>
<td>.919</td>
<td>.000</td>
<td>.689</td>
</tr>
<tr>
<td>(Standard error)</td>
<td>(.04)</td>
<td>(.06)</td>
<td>(.06)</td>
<td>(.10)</td>
<td>(.11)</td>
<td>(.13)</td>
<td>(.14)</td>
</tr>
<tr>
<td>Method Procedure</td>
<td>.0457***</td>
<td>.530***</td>
<td>-.256***</td>
<td>.398***</td>
<td>.427***</td>
<td>-.627***</td>
<td>.029</td>
</tr>
<tr>
<td>Method Framing / Method Purpose</td>
<td>.019</td>
<td>.148***</td>
<td>.124**</td>
<td>.297***</td>
<td>.558***</td>
<td>.241*</td>
<td>-.146</td>
</tr>
<tr>
<td>(Standard error)</td>
<td>(.04)</td>
<td>(.05)</td>
<td>(.05)</td>
<td>(.09)</td>
<td>(.09)</td>
<td>(.14)</td>
<td>(.13)</td>
</tr>
<tr>
<td>Method Goal / Method Procedure</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.841</td>
</tr>
<tr>
<td>(Standard error)</td>
<td>(.04)</td>
<td>(.04)</td>
<td>(.06)</td>
<td>(.09)</td>
<td>(.11)</td>
<td>(.14)</td>
<td>(.14)</td>
</tr>
<tr>
<td>Alignment between Method Framing/Method Purpose and Method Goal/Method Procedure</td>
<td>-.078**</td>
<td>-.151***</td>
<td>-.042</td>
<td>.014</td>
<td>.000</td>
<td>.355</td>
<td>.037</td>
</tr>
<tr>
<td>(Standard error)</td>
<td>(.03)</td>
<td>(.03)</td>
<td>(.03)</td>
<td>(.05)</td>
<td>(.05)</td>
<td>(.05)</td>
<td>(.05)</td>
</tr>
<tr>
<td>Control variables</td>
<td>Method experience</td>
<td>.001</td>
<td>-.005</td>
<td>-.018</td>
<td>.004</td>
<td>.003</td>
<td>-.021</td>
</tr>
<tr>
<td>(Standard error)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.02)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.02)</td>
<td>(.02)</td>
</tr>
<tr>
<td>Work experience</td>
<td>.004**</td>
<td>-.001</td>
<td>-.001</td>
<td>.004**</td>
<td>-.001</td>
<td>-.001</td>
<td>-.001</td>
</tr>
<tr>
<td>(Standard error)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
</tr>
<tr>
<td>Education</td>
<td>-.018</td>
<td>-.062</td>
<td>-.095</td>
<td>-.015</td>
<td>-.056</td>
<td>-.099</td>
<td>-.095</td>
</tr>
<tr>
<td>Method</td>
<td>(.04)</td>
<td>(.04)</td>
<td>(.07)</td>
<td>(.04)</td>
<td>(.04)</td>
<td>(.10)</td>
<td>(.07)</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Method order</td>
<td>.033</td>
<td>-.034</td>
<td>-.041</td>
<td>.078</td>
<td>.051</td>
<td>-.081</td>
<td>-.043</td>
</tr>
<tr>
<td></td>
<td>(.08)</td>
<td>(.09)</td>
<td>(.14)</td>
<td>(.08)</td>
<td>(.09)</td>
<td>(.14)</td>
<td>(.14)</td>
</tr>
<tr>
<td>Method number</td>
<td>-.001</td>
<td>-.001</td>
<td>.002</td>
<td>-.001</td>
<td>-.002</td>
<td>.002</td>
<td>.002</td>
</tr>
<tr>
<td></td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
</tr>
<tr>
<td>Constant</td>
<td>.414</td>
<td>.840**</td>
<td>6.301***</td>
<td>-.270</td>
<td>-.516</td>
<td>7.060***</td>
<td>7.881***</td>
</tr>
<tr>
<td></td>
<td>(.33)</td>
<td>(.37)</td>
<td>(.56)</td>
<td>(.40)</td>
<td>(.43)</td>
<td>(.67)</td>
<td>(.93)</td>
</tr>
</tbody>
</table>

* p<.1, ** p<.05, *** p<.01
Discussion

Methods are an important part of design research and a crucial means of impacting education and practice. However, there is a critical need to bring together knowledge on what actually constitutes the key elements of a method, and operationalise this in a model with predictive power. In response to this we have proposed and initially tested Method Content Theory (Figure 2). This provides a basis for suggesting a future research agenda, as well as a number of implications for design theory, method development, education, and practice. However, before discussing implications, limitations should be considered.

5.1 Limitations

There are two main limitations of this work. First, this paper focused on method content as an important part of the overall method phenomenon. Due to content’s static nature and independence from implementation (Section 1.1) it forms a logical starting point for a more comprehensive effort to build a wider Theory of Design Methods going forward. However, future work is needed to expand the scope of conceptualisation to include the other aspects of methods in design, such as use (Andreasen et al., 2015; Daalhuizen, 2014), contextual dependencies (Badke-Schaub & Frankenberger, 1999; Dorst, 2008), method development and validation (Daalhuizen et al., 2019; Frey & Dym, 2006; Vermaas, 2016), and interactions between method choice and contingencies that emerge in any given project (Lee et al., 2018; van Kuijk et al., 2019). Such work could draw on examples of similar developments in prevention science and psychology as well as discussions regarding systematic approaches to method development and validation (Frey & Dym, 2006; Vermaas, 2016).

Second, the quantitative approach used in this paper provides robust support for the initial validation of the proposed theory by evaluating effects across multiple different methods with different foci i.e. showing the generality of Method Content Theory across method types. However, future work is needed in order to more extensively test the predictions offered. In particular, experimental approaches could explore other performance measures and relational links, while richer studies of practice could reveal additional relationships or variables informing the interaction between method content and method use in context (Lloyd, 2019). We also note that the methods used in this study are relatively straightforward methods intended to help with concrete design tasks. Validation on more complex, high-level methods is needed. Further, qualitative and quantitative evaluation of implications in practice would support the refinement and expansion of the proposed work towards the inclusion of effectiveness measures (Figure 3).

5.2 A future research agenda

The work presented in this paper takes a first step towards synthesizing and concretizing a fragmented and largely tacit discussion around methods (Albers et al., 2011; Andreasen, 2011; Araujo, Benedetto-Neto, Campello, Segre, & Wright, 1996; Badke-Schaub et al., 2011; Cross, 1993; Jones, 1977). This aligns with Gericke et al.’s (2017) and Dorst’s (2008) calls for clarification of methods in design, as well as elements of
their work i.e. formalising understanding of e.g. procedure, core idea, and scope. Our work extends and integrates prior discussions on design methods, including the link with mindset (e.g. Andreasen, 2003), method choice and flexible use (Bender & Blessing, 2004; Gericke et al., 2016; Lee et al., 2018), and methodological context-dependency (van Kuijk et al., 2019). More generally, by describing method content as a carrier of information that requires processing, interpretation, and (often) adaptation by method users (Figure 2), we point to the intimate relationship between method content, method user, and context of use (Figure 1). As such, it explains why the designer has a pivotal role in relation to design methodology (Badke-Schaub et al., 2011; Badke-Schaub & Frankenberger, 1999); as a mediator between method content, goals, context, and task. This provides a foundation for further testing and refinement of the variables and relationships linked to method content, as well as complementing qualitative studies of the wider method phenomena in practice (Lloyd, 2019). Thus, the proposed Method Content Theory provides an important formalisation and synthesis of design method research.

This answers a call for more structured and coherent conceptualization of methods and the information they present (Daalhuizen, 2014; Gericke et al., 2017) and explains why and how different content elements are required. This also highlights the interaction between content and the wider method phenomena (Dorst, 2008; Lloyd, 2019). Based on these interactions it is possible to build on the proposed Method Content Theory to define aspects of a future research agenda in the study of design methods and their use; outlined in Table 3. The proposed theory and agenda identified in Table 3 form the basis for implications for design theory, method development, education and practice, as described in the subsequent sections.
Table 3: An agenda for future design methods research

<table>
<thead>
<tr>
<th>Major research gaps</th>
<th>Suggested research questions</th>
</tr>
</thead>
</table>
| **Properties of method content**: Within the proposed theory (Figure 2) it is unknown how the variables and relationships vary in expression across different types of methods and tools; and how their manipulation might impact the functioning of method content and its relationship with performance. | • How does the expression of content variables and relationships vary across (classes of) design methods?  
• How does the expression of variables and relationships vary across methods generally?  
• How does manipulating specific variables or relationships e.g. introducing ambiguity or conflict between variables, effect the expression of the other variables and relationships?  
• How does manipulating specific variables or relationships effect design performance outcomes? |
| **Method embodiment**: Method content requires embodiment in order to be recorded and communicated. However, little is known about the specific effects of different approaches to embodiment e.g. method cards, textbooks, videos etc. (Araujo, 2001; Gericke et al., 2016) or how these affect performance independently from method content. | • How does the specific embodiment approach affect the perception, processing, and implementation of method content?  
• How does the specific embodiment approach affect the relationship between method content and design performance outcomes? |
| **Method content and the designer**: Method content must be processed and realised by a designer (Figure 1). However, little is known about how content might interact with designers experience, professional identity, or other cognitive and affective characteristics (Cross, 2004; Daalhuizen et al., 2014; Kunrath et al., 2020; Lawson & Dorst, 2013). | • How do designers’ professional identity, mindset, and experience affect the perception, processing, and implementation of method content?  
• How does method content and use influence perceptions and development of professional identity, mindset, learning, and experience?  
• How does method content and use influence perceptions of performance and personal wellbeing?  
• How do different styles of learning and reflection on methods influence designer’s development? |
| **Method content and use in context**: Method content is translated into practice via use in context (Figure 1). However, questions remain regarding how content interacts with the more dynamic aspects of context, as well as how the properties associated with efficacy and effectiveness interact (Figure 3). | • How does use in context affect the perception, processing, and impact of method content?  
• How do method content and use in context interact with the longitudinal development of an organisation?  
• How do method content and use in context relate to design performance outcomes i.e. how do efficacy and effectiveness interact? |
| **Method content, method development, and validation**: Current guidance on method development and validation is fragmented (Dalsgaard, 2017; Vermaas, 2016), and lacking in widely accepted measures of method performance, or standards or evidence required for performance claims. | • How should method content and wider methods be developed systematically without excluding core design elements of intuition, creativity, reflection?  
• How can method content and wider method performance measures be operationalised for effective development and validation i.e. using proxies for longer-term performance via short term, testable, performance indicators such as learning effects, internalisation or other scales?  
• How should method content and wider method performance claims be supported in order to ensure appropriate rigour, transparency, and credibility for academia and industry? |


5.2.1 Implications for design theory

Method Content Theory has a number of implications for wider design theory. First, by disambiguating method content and method use (Figures 1 and 3), we offer a potential explanation for differing accounts of method utility and uptake in practice (Andreasen et al., 2015; Badke-Schaub et al., 2011; Cantamessa, 1999). For example, Cantamessa (1999) linked the concepts of organizational routines and design capabilities to the discussion of methods, and concluded that method makers need to explicitly integrate information about the context of use, in order to make methods usable. Similarly, Schønheyder and Nordby (2018) described how – in the case of a Norwegian Design Company – methods are adapted to the situation, designer’s skills, and situational demands. Thus, method content provides a persistent feature of otherwise changeable design work. This extends discussions of design methods by formalising conceptualisations of a major stable element in design work i.e. method content; matching similar theoretical efforts to formalise understanding of design processes or designer experience (Cash, 2020). Method Content Theory conceptualizes a distinct element of the broader method phenomenon, by clarifying the variables and relationships involved in this phenomenon. In doing so, it furthers work by Daalhuizen et al. (2019) on the development of methods in organizational contexts, by adding a robust and more fine-grained conceptualization of method content to their framework. Similarly, it links to work by Gericke et al. (2020) on the transfer of methods by offering an operationalized model of method content variables and relationships. Second, the definition of method content, and its core variables and relationships (Figure 2), offers a foundation for resolving a number of previously conflicting results. For example, by identifying the role of Method Mindset it is possible to explain the significant individual differences found in the use and experience of methods by student designers with different outlooks on design (Andreasen, 2003; Daalhuizen et al., 2014). If Method Mindset is not clearly described, designers cannot easily correct for missing information or misalignment amongst the other content variables. Hence, Method Content Theory offers a number of core concepts and relationships, which form a foundation for theorising about method functioning and performance. Further, it concretely connects discussions of design methods to design processes in practice (Daalhuizen et al., 2009; Gericke et al., 2016), and designer experience and professional identity (Kunrath et al., 2020; Lawson & Dorst, 2013). Finally, Method Content Theory for the first time brings explicit predictions to discussions of method development. Specifically, we define a framework for understanding ‘good’ method content (Figure 3) and three major predictions associated with this (Section 2.2); mirroring similar developments in other method-based fields, such as software engineering (Kitchenham et al., 2002; Kitchenham, Linkman, & Law, 1997) and prevention science (Gottfredson et al., 2015). This is unprecedented in design research and constitutes an important step forward for design methodology as a field of study.

5.2.2 Implications for method development in design
Method Content Theory provides a set of content variables, and associated scales (Appendix A), which can guide initial method development and validation. This, for the first time, provides concrete and operational structure around which method content can be developed. Central to this guidance are the four properties of ‘good’ content and the associated predictions (see Figure 3). Method developers should use these as a reference for constructing method content, similar to the support proposed by Wacker (2008) for developing theory. Importantly, the distinction between method efficacy and method effectiveness (Figure 3) clarifies many of the debates surrounding method validation (Olewnik & Lewis, 2005; Vermaas, 2016), and points to distinct validation goals and accompanying choice of study design and research methods etc. However, it is also important to consider the many other factors affecting overall method success (Figure 1). For example, the design of the method beyond its content (method as a designed artefact), the appropriateness of the context in which the method is used, and the characteristics and idiosyncrasies of the method users. Thus, Method Content Theory offers complementary insights to other guidance on method development by Daalhuizen et al. (2019) and Gericke et al. (2017), as well as on method validation by e.g. Olewnik and Lewis (2005) and Vermaas (2016).

5.2.3 Implications for design education and practice

In the context of design education, Method Content Theory has two main implications. First, it distinguishes method content variables, reducing the ambiguity around prior descriptions of methods, and facilitating more focused teaching and reflection associated with each variable and relationship. For example, a teacher is able to more easily highlight the structural interaction between Method Goal and Method Procedure, or the important role played by Method Mindset in guiding decision making in the face of conflicting information. Second, when teaching specific methods, teachers can more concretely assess where there might be content weaknesses or gaps – which might impact a student’s understanding and enactment of a method – and can subsequently more easily compensate for these by providing extra information or clarification in class.

Similarly, the proposed theory has implications for practitioners. First, following the method development and educational contexts, Method Content Theory provides an important support for practitioners in communicating and learning about methods, systematically reflecting on failures in method efficacy or effectiveness, and understanding method development or modification to their specific practices. The predictive power of Method Content Theory thus provides an important basis for understand the potential effects of changing any specific part of a method’s content with respect to the other major variables and relationships. Second, by supporting a more structured method development approach practitioners are better able to evaluate the suitability of a (new) method and determine how to adapt and/or apply it. Thus, Method Content Theory provides a structured means for communicating, reflecting on, evaluating, and modifying/developing methods in both the educational and practical contexts.
6 Conclusions

In this study, we aimed to develop a more robust explanation of the method phenomenon in design by proposing and testing a *Method Content Theory*, as a step towards a wider theory of design methods. Critical to this contribution is a conceptualisation of i) how methods function in context (Figure 1); ii) the main elements of method content i.e. *Method Framing, Method Rationale, Method Goal, Method Procedure*, and *Method Mindset*, and their major inter-relationships (Figure 2); and iii) predictors of method performance i.e. what makes ‘good’ content (Figure 3). Based on this conceptualisation we provide initial quantitative validation for the proposed theory and demonstrated strong predictive power with respect to a number of methodological performance indicators. Following this, we build on the proposed Method Content Theory to define aspects of a future research agenda, outlining core research gaps and research questions (Table 3). Thus, this research provides major implications for research, education and practice, as well as actionable insights for design methodology, method development and validation.
References


Buijs, J. (2003). Modelling product innovation processes, from linear logic to circular chaos. Creativity and...


32
### Appendix A: Detail of Likert instruments, Cronbach alpha and factor analysis

<table>
<thead>
<tr>
<th>Variable and Cronbach alpha</th>
<th>Factor loading</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>1 Method Framing (α = .87)</strong></td>
<td></td>
</tr>
<tr>
<td>I understand when the method should be used in a design process</td>
<td>.68</td>
</tr>
<tr>
<td>I know in what situations the method can and cannot be used</td>
<td>.68</td>
</tr>
<tr>
<td>I understand who should be involved to use this method successfully</td>
<td>.69</td>
</tr>
<tr>
<td>I know what competences are needed to use this method successfully</td>
<td>.79</td>
</tr>
<tr>
<td>I know what materials and other input are needed to use this method successfully</td>
<td>.77</td>
</tr>
<tr>
<td>The method offers the knowledge I need to use it successfully</td>
<td>.67</td>
</tr>
<tr>
<td><strong>2 Method Mindset (α = .88)</strong></td>
<td></td>
</tr>
<tr>
<td>I know how to use this method</td>
<td>.72</td>
</tr>
<tr>
<td>I understand what is needed to use this method</td>
<td>.77</td>
</tr>
<tr>
<td>I know exactly what the focus of this method is</td>
<td>.74</td>
</tr>
<tr>
<td>I know what values the method is based upon (e.g. empathy with the user)</td>
<td>.71</td>
</tr>
<tr>
<td>I understand the basic premise of the method (e.g. users have valuable knowledge/good ideas come from free association)</td>
<td>.73</td>
</tr>
<tr>
<td>I understand the underlying logic of the method (i.e. why the method works)</td>
<td>.75</td>
</tr>
<tr>
<td><strong>3 Method Goal (α = .85)</strong></td>
<td></td>
</tr>
<tr>
<td>I understand exactly what I am supposed to do in this method</td>
<td>.72</td>
</tr>
<tr>
<td>I have specific, clear goals to aim for in this method</td>
<td>.79</td>
</tr>
<tr>
<td>If I have more than one goal to accomplish, I know their priority</td>
<td>.71</td>
</tr>
<tr>
<td>The method helps me to attain the goals</td>
<td>.76</td>
</tr>
<tr>
<td><strong>4 Method Rationale (α = .82)</strong></td>
<td></td>
</tr>
<tr>
<td>I understand how to determine when the method has worked well (i.e. when it has been successful)</td>
<td>.74</td>
</tr>
<tr>
<td>I understand what the end conditions of the method are (i.e. when the method is finished)</td>
<td>.67</td>
</tr>
<tr>
<td>The method explains the reasons for the goal</td>
<td>.68</td>
</tr>
<tr>
<td>The method helps me reflect on how well it is working in relation to the goal</td>
<td>.75</td>
</tr>
<tr>
<td><strong>5 Method Procedure (α = .94)</strong></td>
<td></td>
</tr>
<tr>
<td>I understand exactly what I am supposed to practically do in this step</td>
<td>.83</td>
</tr>
<tr>
<td>I understand exactly how to approach this step (e.g. converge or diverge / involve stakeholders)</td>
<td>.84</td>
</tr>
<tr>
<td>I understand exactly how to complete this step</td>
<td>.89</td>
</tr>
<tr>
<td>I am confident in my understanding of this step</td>
<td>.91</td>
</tr>
<tr>
<td>I am confident that I can perform the step</td>
<td>.87</td>
</tr>
<tr>
<td><strong>6 Knowledge Quality (α = .86)</strong></td>
<td></td>
</tr>
<tr>
<td>I think the information provided by the method was easy to understand</td>
<td>.69</td>
</tr>
<tr>
<td>I think the information provided by the method was complete</td>
<td>.69</td>
</tr>
<tr>
<td>I think the information provided by the method was reliable</td>
<td>.80</td>
</tr>
<tr>
<td>I think the information provided by the method was accurate</td>
<td>.82</td>
</tr>
<tr>
<td>I think the information provided by the method was relevant to the goal</td>
<td>.73</td>
</tr>
<tr>
<td><strong>7 Role Ambiguity (α = .85)</strong></td>
<td></td>
</tr>
<tr>
<td>I understand how to adapt this method to suit my needs</td>
<td>.63</td>
</tr>
<tr>
<td>I think the goals and steps are clearly planned</td>
<td>.69</td>
</tr>
<tr>
<td>I understand how to divide my time properly when using this method</td>
<td>.76</td>
</tr>
<tr>
<td>I know what my responsibilities are in using this method</td>
<td>.78</td>
</tr>
<tr>
<td>I know exactly what is expected of me in this method</td>
<td>.78</td>
</tr>
<tr>
<td><strong>8 Goal-means Conflict (α = .91)</strong></td>
<td></td>
</tr>
<tr>
<td>The method asks me to do things that should be done differently</td>
<td>.74</td>
</tr>
<tr>
<td>There is incompatibilities between the steps the method prescribes and the method's goals and values</td>
<td>.81</td>
</tr>
<tr>
<td>I have to bend a step and/or value in order to complete the method</td>
<td>.76</td>
</tr>
<tr>
<td>The method gives incompatible instructions in two or more steps</td>
<td>.74</td>
</tr>
<tr>
<td>The method asks me to work on unnecessary things</td>
<td>.76</td>
</tr>
</tbody>
</table>
The steps in this method do not help me achieve the goal.

The steps in this method are not enough to reach the goal.

The method’s steps and goals serve to limit rather than raise my performance.

Detail of pairwise correlation

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Method Framing</td>
<td>-.</td>
<td>-.</td>
<td>-.</td>
<td>-.</td>
<td>-.</td>
<td>-.</td>
<td>-.</td>
<td>-.</td>
</tr>
<tr>
<td>2 Method Mindset</td>
<td>.794</td>
<td>.797</td>
<td>.797</td>
<td>.797</td>
<td>.797</td>
<td>.797</td>
<td>.797</td>
<td>.797</td>
</tr>
<tr>
<td>3 Method Goal</td>
<td>.655</td>
<td>.702</td>
<td>.724</td>
<td>.724</td>
<td>.724</td>
<td>.724</td>
<td>.724</td>
<td>.724</td>
</tr>
<tr>
<td>4 Method Rationale</td>
<td>.646</td>
<td>.641</td>
<td>.627</td>
<td>.557</td>
<td>.557</td>
<td>.557</td>
<td>.557</td>
<td>.557</td>
</tr>
<tr>
<td>5 Method Procedure</td>
<td>.609</td>
<td>.612</td>
<td>.628</td>
<td>.564</td>
<td>.703</td>
<td>.703</td>
<td>.703</td>
<td>.703</td>
</tr>
<tr>
<td>6 Knowledge Quality</td>
<td>.612</td>
<td>.585</td>
<td>.596</td>
<td>.569</td>
<td>.704</td>
<td>.757</td>
<td>.757</td>
<td>.757</td>
</tr>
<tr>
<td>7 Role Ambiguity</td>
<td>-.207</td>
<td>-.267</td>
<td>-.27</td>
<td>-.176</td>
<td>-.296</td>
<td>-.382</td>
<td>-.284</td>
<td>-</td>
</tr>
<tr>
<td>8 Goal-means Conflict</td>
<td>-.</td>
<td>-.</td>
<td>-.</td>
<td>-.</td>
<td>-.</td>
<td>-.</td>
<td>-.</td>
<td>-.</td>
</tr>
</tbody>
</table>

Appendix B: Detail of method pairing

1. Analogies and Metaphors          Cultural Probes
2. Ansoff Growth Matrix            Brainwriting and Brain Drawing
3. Collage                         Harris Profile
4. Cost Price Estimation           Contextmapping
5. Business Model Canvas           Technical Documentation
6. Interviews                      C-Box
7. Datum Method                    Focus Group
8. Customer Journey                EcoDesign Checklist
9. Emotion Measurement Instrument (PreMo) Marketing Mix or 4Ps
10. EVR Decision Matrix            How-Tos
11. EcoDesign Strategy Wheel       Fish Trap Model
12. Fast Track Life Cycle Analysis (LCA) Questionnaires
13. Value Curve                    Interaction Prototyping & Evaluation
14. WWWWWWH                       Miles & Snow Business Strategies
15. Function Analysis              Personas
16. SWOT Analysis                  SCAMPER
17. Human Power                    Mind Map
18. VRIO Analysis                  Perceptual Map
19. Role-Playing                   Porter Competitive Strategies
20. Itemised Response & PMI        Written Scenario
21. List of Requirements           Product Usability Evaluation
22. Product Concept Evaluation     Search Areas
23. Morphological Chart            Three Dimensional Models
24. Weighted Objectives            Porter Five Forces
25. Problem Definition             Storyboard
26. Process Tree                   User Observations
27. Synectics                      Video Visualisations
28. Strategy Wheel                 Brainstorm
29. vALUe                          Trend Analysis
30. Cultural Probes                Analogies and Metaphors
31. Brainwriting and Brain Drawing Ansoff Growth Matrix
32. Harris Profile                 Collage
33. Contextmapping                 Cost Price Estimation
34. Technical Documentation        Business Model Canvas
35. C-Box                          Interviews
36. Focus Group                    Datum Method
37. EcoDesign Checklist            Customer Journey
38. Marketing Mix or 4Ps           Emotion Measurement Instrument (PreMo)
39. How-Tos                        EVR Decision Matrix
40. Fish Trap Model                EcoDesign Strategy Wheel
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>41.</td>
<td>Questionnaires</td>
</tr>
<tr>
<td>42.</td>
<td>Interaction Prototyping &amp; Evaluation</td>
</tr>
<tr>
<td>43.</td>
<td>Miles &amp; Snow Business Strategies</td>
</tr>
<tr>
<td>44.</td>
<td>Personas</td>
</tr>
<tr>
<td>45.</td>
<td>SCAMPER</td>
</tr>
<tr>
<td>46.</td>
<td>Mind Map</td>
</tr>
<tr>
<td>47.</td>
<td>Perceptual Map</td>
</tr>
<tr>
<td>48.</td>
<td>Porter Competitive Strategies</td>
</tr>
<tr>
<td>49.</td>
<td>Written Scenario</td>
</tr>
<tr>
<td>50.</td>
<td>Product Usability Evaluation</td>
</tr>
<tr>
<td>51.</td>
<td>Search Areas</td>
</tr>
<tr>
<td>52.</td>
<td>Three Dimensional Models</td>
</tr>
<tr>
<td>53.</td>
<td>Porter Five Forces</td>
</tr>
<tr>
<td>54.</td>
<td>Storyboard</td>
</tr>
<tr>
<td>55.</td>
<td>User Observations</td>
</tr>
<tr>
<td>56.</td>
<td>Video Visualisations</td>
</tr>
<tr>
<td>57.</td>
<td>Brainstorm</td>
</tr>
<tr>
<td>58.</td>
<td>Trend Analysis</td>
</tr>
</tbody>
</table>

36