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The Future of Design Process Research? Exploring Process Theory and Methodology

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Abstract: Design processes are at the heart of design research. Current design research at the micro- and macro-level has led to profound insights about designing. However, missing are design process research approaches that are able to theorize between (meso-level) and beyond levels of analysis. This fragmentation of process research and theory across levels hampers research synthesis and theory development. In this paper we illustrate the limitations of current design research methodologies to analyse and theorize process. Specifically, the issue lies in the challenge of analysing and theorizing the temporal embeddedness of data in the overall design process. We introduce a Process Theory agenda for future design process research focused on the meso-levels as the mediator of interactions between design processes across levels. As such, this paper contributes a novel characterisation of a critical challenge in design research, proposing process theory for addressing this.

Keywords: design process; research methodology; process theory; conceptual model

1. Introduction

Design process models, such as co-evolution (Dorst & Cross, 2001) or the double diamond (Design Council, 2015) have had a profound impact on both practice and scholarship in design. Thus, process research critically shapes the work of practicing designers as well as students, and forms a fundamental aspect of theory development in design research (Daalhuizen, 2014).

Despite the importance of design process research, there has been significant fragmentation in the literature across levels, particularly between micro-level design cognition and macro-level design management perspectives (Cash, Skec, & Storga, 2019). This has led to three major challenges in current design process research. First, lack of meso-level studies that connect across levels. Second, a corresponding lack of research method development at this level, particularly in contrast with developments at the micro- and macro-levels (Cash

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et al. 2019). Whereas protocol studies may be robust for analyzing aspects of shorter design sessions (around 90 minutes), and ethnographic and narrative approaches may be strong for analyzing a complete design process (several months), what is missing are approaches that can link the micro strength of protocol studies with the macro strength of ethnographic and narrative approaches. Third, the above challenges have led to a lack of theoretical sophistication at the meso- level. Even if data is collected about the design process, analysis and theorizing of such data tends to either adhere to a variance analysis leaving out the process elements, or lack the empirical grounding and reflexivity needed for a deeper process analysis. This would require analysing and theorizing the design process, by appreciating how actions and their consequences in design have an influence over time, highlighting issues like path-dependency or interactions across levels of analysis. These limitations of existing design methodologies hamper research synthesis and theory development, as well as negatively impacting our ability to deliver design theory that considers interactions across levels (Cash et al. 2019). Thus, there is a critical need to better understand the nature of these challenges in design research, and further, to identify potential lenses for developing integrative, meso-level perspectives on the design process. We argue that there are opportunities for more process analysis and better theorization from data.

Given this need we aim to develop a framework for better understanding the fragmentation of perspectives in design process research, and subsequently identify potential ways forward rooted in meso-level process theory (see e.g., Cash et al., 2019). Based on methodological review, 'for which we picked the dominant research methods for studying design processes to illustrate the point and show the research space. The review is not intended to be exhaustive, but rather a conceptual development approach well suited to situations where current theory is sparse (Handfield & Melnyk, 1998), we contribute a novel characterisation of process research in design, as well as proposing a new theoretical lens for addressing this. This both extends design theory in this area, and points to critical opportunities for improved design support across levels.

The structure of the article is as follows. We first develop a conceptual framework of different design process levels and delineate variance from process theory. Based on this framework, we then develop a typology that describes current approaches to the study of design processes as well as their strengths and weaknesses in light of our conceptual framework. Following this we develop a process theory based agenda for future design process research.

2. Conceptual Framework: prospects for bridging micro- and macro-level theorizing about the design process

In the following, we introduce a conceptual framework for understanding perspectives on study of design processes. For this we delineate micro- and macro-level processes and introduce the relevance of meso-level interactions between micro- and macro-level. Next,

we delve deeper into process analyses and theory as a distinctive form of theorizing. Our aim here is not an exhaustive review, but an illustration of the larger point of a lack of meso-level research and how this relates to the issue how to analyse and theorize process itself. Given the relevance of insights from psychology and organization studies for design, we mainly draw from there to illustrate our conceptual framework.

2.1 From Micro-Level to Macro-Level Design Processes

Generally speaking, we can differentiate between the content process of design and five hierarchical levels that influence both content and each other. We build a conceptual framework to delineate these processes as micro-, meso- and macro-level (Cash et al. 2019). Critically, this multi-level conceptualisation allows for interactions between individual cognitive processes and organisational managerial processes (Leenders & Dolfsma, 2016), with emergent effects developing as smaller level phenomena propagate into larger level effects (Marks, Mathieu & Zaccaro, 2011; Wiley, 1988). For example, interaction across levels could be here at the individual level the staunch actions of a designer, who engaged in user testing and found the prototype not to be working as expected. At the meso-level these results lead the team to discuss the way user testing was done, convincing them that they need to redesign parts of the prototype. However, at the organizational level when management heard of this they decided that this costs too much time and money and to go ahead, seeing that the user test only involved ten users. Thus, these levels are differentiated for analysis, yet closely linked.

On the micro-level of the design process, we have the content of design, the individual designer, their activity (Kozlowski et al., 2016; Wiley, 1988) and the situation they are facing (Suchman, 2006). The content of design refers to the design itself as it changes over time. This process is often tightly interwoven with the individual level. For example at the individual level, we can study the design process that an individual goes through the role of uncertainty perception and how this leads to prototyping (Cash & Kreye, 2017; 2018).

At the meso-level, work in psychology (for a review see Hülsheger, Anderson & Salgado, 2009) or organization studies (Garud, Tuertscher & Van de Ven, 2013) has shown the importance of teams. To illustrate for example from a more organizational perspective, the meso-level plays an important role as organizations struggle with their core rigidities (Leonard-Barton, 1992), teams and projects allow an organization to develop and try new approaches, products or services. From an psychological perspective, here we go beyond the individual to look at the design process that a team goes through, especially interaction between individuals in a team (Kozlowski et al., 2016) and emergence in team processes (Kozlowski & Ilgen, 2006). Learning plays another vital role here, but this learning becomes more explicitly social process (Elkjær, 2004). Next to learning, we find here the team dynamics as well, with politics, identity or conflict making a pronounced entrance into the design process.

At the macro level the unit of analysis changes. Here the focus on the interactions between

teams/departments/functions (Kozlowski et al., 2016; Wiley, 1988), the interactions with the organization and wider social structures (Gorman, 2014; Salvato & Rerup, 2011). While not all of the organization might be involved in the design process, the design process is influenced by the organizational situation that surrounds it. Think here for example of the way decisions are being made that impact the design process, the way that culture and existing ways-of-working might clash with a design process, or how organizational capabilities can help and hinder a design process. Especially in the last decennia, the role of design beyond a single organization and design in systems have played a more important role. As design increasingly happens in between organizations and in systems, we see new dynamics occurring in the design process Cash, Škec & Štorga, 2019). In design research, such processes are studied under the umbrella of networked innovation, open innovation or innovation ecosystems.

2.2 Variance Theory versus Process Theory

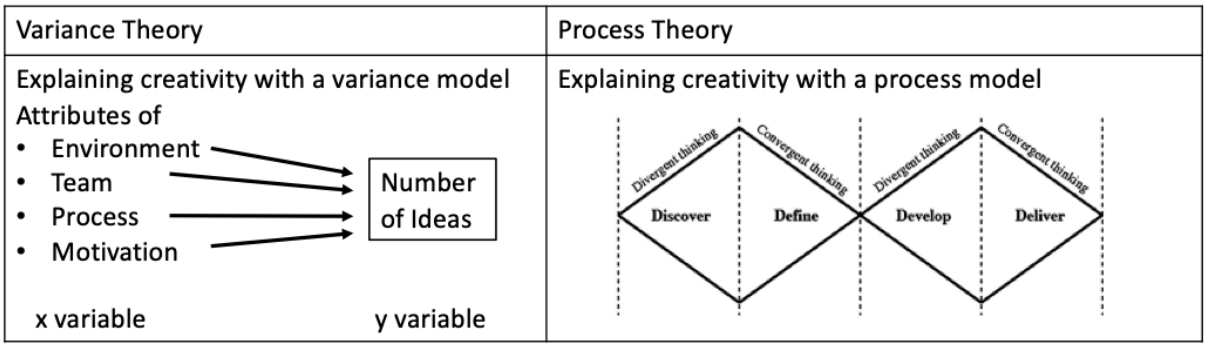

Figure 1 Comparison of Variance and Process After Mohr (1982), Langley (1999) and Design Council (2008/2015)

Generally speaking, the majority of research approaches follow a variance analysis. Scholars investigate the co-variance between dependent and independent variables (e.g. effect of X on Y). Underlying such research is a perspective on reality, where reality is made up of "things" studied as "entities". Such a perspective highlights outcomes, products, and continuity. Variance analysis is strong at testing theoretical propositions and through that well suited for theory testing. Variance analysis relies on statistical generalization to go from specific data to general implications for the phenomenon under study (Langley, 1999). For example, much of the work on shared understanding or creative constraints has been variance-based.

Instead, a growing movement of scholars in a wide range of scientific fields like strategy (Langley, 2016), innovation (Garud et al. 2013), or learning (Gheradi, 2006), have started investigating phenomena from a process perspective (e.g. analysing design process over time). Process analysis excels at developing theory while being relevant to practice through staying close to practice (Langley & Tsoukas, 2016). A key challenge though in process research is developing research methods that allow for appropriate analysis and theorizing

of processes (Langley, 1999). Trying to analyse and theorize a process, but applying variance methods is inappropriate, as process research requires different modes of thinking, analysing and theorizing (De Cock & Sharp, 2007; Helin et al. 2014).

Regarding methods, while quantitative process research is possible, process research tends to rely on qualitative methods for data collection over time and use theoretical generalization. Process theorizing puts process central to investigate how issues emerge, change and disappear over time (Langley & Tsoukas, 2010; 2016). The hallmark of process theorizing is starting with "how" questions, rather than "what" or "why" (Langley et al. 2013). By taking time and timing serious, process theorizing takes into account relationships, path dependency and focuses research on how things change (Langley & Tsoukas, 2010; 2016). To illustrate, think of how the initial framing and reframing during a design project by individuals can help the reframing process of a design team, but such reframing might be more difficult when facing the political realities of pitching a design at a top management team. To be able to understand this process, requires analysing the process in a way that is analyses the temporal order and theorizes how certain actions led to certain consequences. Rather than seeing things as static entities, process research focuses on the dynamic, the ephemeral, and the novel (e.g., Leenders, Contractor, & DeChurch, 2016; Navarro, Roe & Artiles, 2015).

Theory and methodology are importantly intertwined. Regarding theory, there are several existing theories in design that follow this process analysis, reflecting the importance of the design process to design research. The double diamond (reference) has played an important role in design practice, especially in design education. An example of a process theory is co-evolution, where a process perspective on problem and solution co-evolution points out how both problem and solution not only change throughout the process but also that the changes often relate to each other, as new insights about the problem can point out new possibilities for solutions.

Building such process theory requires research methodologies that allow for process analyses and theorizing. An example would be Linkography (Goldschmidt, 1995), which is explicitly interested in the design process. Two aspects are important for process methodology. First, to be truly process though, data needs to be collected throughout the design process and the temporal embeddedness of data needs to remain central in analysing the data. Throughout the theorizing process, the temporal order of events is central and theorizing focuses on how events at different times in the process affect later parts of the process. This means that even if data was collected of the process, this process element of the data can get lost if analysis and theorizing of the data do not take into account the process nature of the data. Therefore, a process perspective is arguably well suited to study the dynamic, ephemeral and novel aspects of the design process. In the following, we discuss existing approaches to study design processes and highlight the limitations regarding micro- versus macro-level and their interactions as well as variance versus process analysis and theorizing.

Thus, we are again able to distinguish research perspectives between variance and process

analysis. Bringing this together with the levels described in Section X we are able to critically evaluate current work in design research on these two dimensions: variance vs. process & micro- vs. macro-level.

3. Current approaches and their limitations to study design processes: levels, analysis and theorizing

There are three major approaches to the study of design research that we will discuss in this section in reference to our proposed conceptual dimensions: protocol studies, ethnographic approaches and narrative approaches. We chose these three approaches as they are prominent approaches to study design processes, but as we will argue, the way these methods are currently applied are problematic regarding dealing with levels, analysing and theorizing of the design process itself.

3.1 Protocol studies

Building on the work of Ericson and Simon (1993) protocol studies have had a profound impact on design studies. Protocol studies investigate design processes in terms of verbal exchanges, cognition, and behaviour (Hay et al. 2017), primarily of individuals but also teams. This typically covers processes enacted in a matter of seconds, and with study durations in the range of minutes to hours. As such, protocol-studies are concerned with micro-level processes in design. In terms of analysis, protocol studies typically rely on detailed statistical analysis, drawing on variance analysis. This has resulted in, for example, work on design cognition highlighting conjecture-based problem formulation, problem solution co- evolution, analogical reasoning, mental simulation, fixated solution generation Ball & Christensen, 2019) and the role of uncertainty perception in the design process (Cash & Kreye, 2018).

Strengths:

- Due to the variance analysis underlying such protocol studies though, protocol studies are better suited for testing theory, rather than constructing new theory
- Protocol studies excel at analysing the micro aspects of design sessions

Weaknesses:

- Methodologically protocol studies are challenging to scale-up to include more participants or longer time-frames (Hay et al. 2017)
- Theoretically it is difficult to relate insights from the micro level of protocol studies to the macro level of longer design processes

3.2 Narrative approaches

Next to protocol studies, a different approach is narrative methods. Here, design scholars capture a narrative of the design process as it develops over time, highlighting the moments

that were impactful for the overall narrative of the design process. Data analysis often done qualitatively and inductively. Where protocol studies excel at finely grained micro-level analysis of individual sessions, narrative approaches are better suited to study the macro-level of longer design processes, e.g. 6 months Going from descriptive narratives to good theory, requires a deeper sensitivity to the underlying processes at work (see e.g., Pentland, 1999; Langley & Tsoukas, 2016; Pentland & Feldman, 2007).

Strengths:

- Developing rich theoretical insights, by connecting the dots across a longer lasting design process
- Narrative research is close to the experience of designers, meaning such theorizing can be more relatable and meaningful (Weick, 1999)

Weaknesses:

- Lack a detailed account of how the narrative is grounded in the empirical data, especially considering the plurality of narratives that different people would tell
- While the content is there, it is not clear how the content process and the narrative have influenced each other

3.3 Ethnographic approaches

Lastly, we have ethnographic approaches. Originally stemming from anthropology to study cultures and drawing on fieldwork of finely grained analysis from observations, interviews and fieldnotes, ethnographic approaches in design have led to a better understanding of the social and practice elements of design. Ethnographic approaches can be used at different levels. For example at the micro level ethnographic methods can be used to study design practices and the situatedness of these practices. At the macro level, ethnographic methods can also be used to better understand design processes. See e.g., Lok & De Rond (2013) for an example of process ethnographic approach. Data analysis happens inductively, but not necessarily analysing the process explicitly.

Strengths:

- Develop rich theoretical insights that are useful for theory construction
- Strong situatedness of design and descriptions of actions of designers

Weaknesses:

- Ethnographic approaches as currently applied within design studies leave time largely out of the analysis
- Ethnographic approaches were invented to capture collective culture. When applied to design, ethnographic approaches can lose the role of the individual

3.4 Positioning Current Approaches on the two dimensions

Bringing these insights together we are able to position each approach with respect to our dimensions in order to highlight a number of key challenges for design process research. We argue that protocol studies excel at analysing micro-level processes using variance analysis, that lack analysis and theorizing across time. While current ways of applying ethnographic and narrative approaches excel at studying macro-level processes. Here we argue that ethnographic approaches are more inclined to employ atemporal analysis akin to variance analysis, while narrative approaches are inherently temporal, but the necessary analysis and theorizing of the process itself is missing. Studying "process" requires an analyses of the temporal embeddedness of that data. Or the other way around, just collectinf data during the design process and depicting a theory as a process, does not mean that the data was analyzed and theorized regarding its temporal embeddedness in the design process. Therefore, we argue that all three approaches as currently employed in design studies have serious limitations regarding the prospects of furthering our understanding of the design process. Figure Y positions current approaches in respect to our typology.

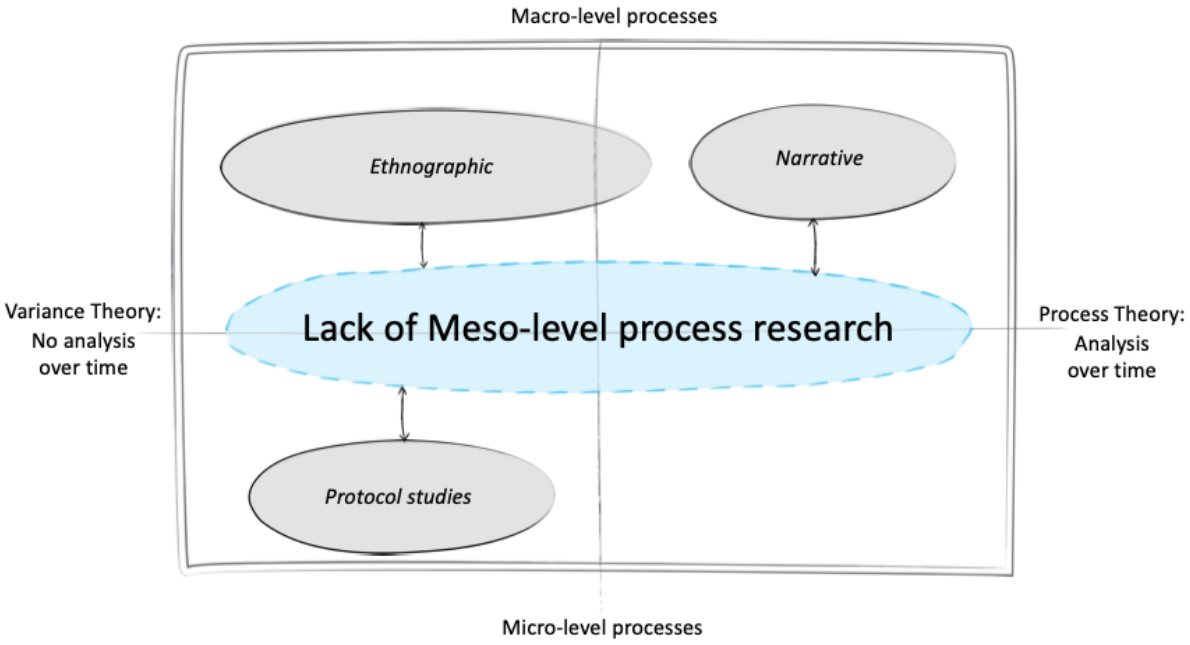

Figure 2 Overview of typology and methodologies

We conclude that there are four major research challenges for furthering our understanding of the whole design process. First, we need to develop research methodologies for design studies that take time, timing and temporality more serious, by empirically grounding research in time. Second, a consequence of the first challenge is that we need a more sophisticated theorization of path-dependency and emergence throughout the design process. Third, we need a better understanding of interactions across levels in the design process (Cash et al., 2019). Fourth, we need to develop or adapt research methods to

capture the design process in ways that are meaningful to practitioners and theorists alike (e.g., Wegener & Lorino, *in press)*.

3.5 Limitations

Before we continue with the future research agenda, we need to address the limitations of our current paper, some of which can be addressed by future research. The most important limitation is that the paper is not intended as an exhaustive review of the literature. Given the word constraints of a conference paper, such an exhaustive review was not possible. This would have required a more systemic reviewing approach, which would be a next step. Both on the issues of process theory and process methodology a more in-depth analysis is required to work out the differences between current research methods and their applications in design and what is required in methodological innovation and theorizing. By developing an illustration of a new perspective on research and design processes, we want to highlight the issues, rather than a building an exhaustive argument on what process theories and how to apply it to design research.

4. Towards a future research agenda for studying the design processes

Given the challenges and position outlined in Section 3 it is possible to identify process theory as a potentially important perspective for design research, allowing design scholars a more comprehensive understanding of the whole design process and creating theory that captures the design process. Discussions of the role of the design process and its relation with methods has a long history in design studies (see e.g. Jonas et al. 2010). We see an opportunity similar to the work of Karl Weick (e.g., 1977; 1979; 1995; 2004) for organization studies, whose work took organization studies from focusing on the outcome "organization" to highlighting the processes of organiz*ing*. This seemingly simple change has led to profound repercussions in how organizations were understood, leading to work highlighting the process in strategy (Mintzberg, 2007), innovation (Van den Ven, 1992: Van den Ven & Poole, 1995; 2000) decision making (March, 1994) or organizational change (Pettigrew, 1985; 1990). In order to generate such process theory though, required methodological development. Existing research approaches needed to be adapted for studying the process of how the phenomenon unfolds over time. For example regarding innovation the work of Van den Ven (1992) and Van den Ven & Poole (1995; 2000) was an important stepping stone, as their work was initiated by the conceptual questions on what process is and how to design research in line with a perspective of what organizational processes are (Van den Ven, 1992). This was followed by a theoretical discussion of processes of change in organizations (Van den Ven & Poole, 1995). Their work culminated in an extensive research program of what the management of innovation entails, comparing processes across different contexts (van den Ven & Poole, 2000).

Here we need to contrast our future research agenda from other research that seems similar,

but has other goals. To illustrate, we employ a recent paper combining ethnographic with narrative approaches (Celikoglu, Krippendorff & Ogut, 2019). While interesting in itself, this study shows that although data is collected during the design process, in the analysis the design process itself is not analyzed, but contingency analysis and qualitative content analysis. Both analysis approaches turn qualitative process data into quantities that are analysed according to a variance logic.

We think that the field of design is also ripe for a similar development to organization studies, where instead we take the notion of "design process" more seriously and adapt existing methods to capture, analyse and theorize the process more extensively. Theorizing process in design, would mean going from a focus on the outcome of design–"the" design–to focusing more on the design*ing* and how the designing and the design interacted over time. Process theorizing is therefore interested in how a design changes through the design process, in the flow of design, in the agency of the designer and prioritizes the design process over only focusing on the outcome (Langley & Tsoukas, 2010). Regarding analysed the design process, it would mean that the temporal embeddedness of data, what comes before and what comes after, has to become central to the analysis process. This leads to a number of changes for theorizing. First, process theory is focused on the events in a design process (e.g., Leenders, Contractor, & DeChurch, 2016) rather than the change of variables. Second, process theory strives to understand the final causes of how a design came to be, rather than understanding efficient causes as variance theorizing does (Mohr, 1982). Last, process theorizing takes timing seriously, meaning that the order of time in which events happened becomes crucial for understanding the design outcome (Langley & Tsoukas, 2010). This switch we call for is nicely summarized by Garud, Jain & Tuertscher (2008): "This suggests a change in the meaning of the word 'design' itself — from one that separates the process of design from its outcome, to one that considers design as both the medium and outcome of action." (p. 351). Taking this together with our review of current approaches it is possible to identify four major themes for future design process research. For each we first describe these four themes and provide two exemplary research questions.

4.1 Exploring development of more process research methodologies fit for design studies

Similar to the methodological developments needed in other fields for process research to fulfil its potential (e.g. Langley, 1999), design researchers also need their own methodological development to further process research through process analysis and process thinking (De Cock & Sharp, 2007). Taking time and timing seriously is a considerable methodological and intellectual challenge (Langley & Tsoukas, 2016), which requires exemplars for design scholars to emulate and adapt in their own inquiries into the design process. Examples from Organization studies for narratives are Tsoukas & Hatch (2001), Pentland & Feldman (2007) or Pentland (1999). Examples for ethnographic approaches are Lok & De Rond (2013), Deken et al. (2016) or Cohendet & Simon (2016). Exemplary research questions here could be:

- How can design scholars adapt ethnographic approaches to incorporate process elements more?
- How can design scholars ground narrative approaches more explicitly in empirical data?

Such research would require an explicit focus on research methodological work, thus not applying existing research methodologies from design, but rather learning from other process research approaches and exploring how to apply these to study design processes.

4.2 Exploring Path Dependency and Emergence in Design Processes

While there is a number of aspects that are problematic about not considering time as an element of the design process, the biggest issue is a lack of understanding path dependency. With this we mean an understanding how earlier events in a design process influence later events. A variance approach of statistical analysis essentially leaves out the timing of such events, merging the whole process into a couple of variables. Exemplary questions here could be:

- How do design reviews influence overall design processes?
- How do specific earlier design actions influence later design actions?

Here, the focus of analysing and theorizing would be on how the process during the design reviews might have influenced the overall design process. What considerations were raised in a design review and how were these addressed in the subsequent design process?

4.3 Exploring interactions across levels

Related to path dependency is the issue of a lack of analysis of how different elements of the design process influence each other over time. Think here especially of how the interaction in the team influences the individual designer, how the individual/team is influenced and vice versa influences the organization, how the content/artefact and the design process interact or how the situation influences and is influenced by the design process. All of these processes and their interaction require sophisticated methods to both capture data across time and analyse the timeliness of such data. A key challenge here is the inherent complexity of such interactions, but especially narrative approaches seem to be particularly suited to deal with such complexity (Tsoukas & Hatch, 2001). Exemplary research questions here could be:

- How do actions of individual designers influence the overall design process?
- How does learning of individual designers influence organizational learning regarding design?

Here, we would need research approaches that unpack the complex relationships between individuals, teams and organizations.

4.4 From retrospective accounts of design to prospective accounts of design processes

A limitation of current design research is the retrospective nature of much research (Weick, 1995). Even when data is collected in real-time, analysis approaches tend to employ retrospective hindsight to reinterpret the process that was studied. This means that the outcomes of such research tend to not align with the lived experience of the designers and other stakeholders that have been part of the process (Fachin & Langley, 2018). Instead, it is interesting to explore research that captures the ongoing sensemaking of participants engaged in the design process. Such accounts would help design scholars and practitioners better understand the uncertainties and ambiguities of the design process as experienced by practitioners (e.g., Wegener & Lorino, in press). We are inspired here amongst others by the words of William James:

> "What really exists is not things made but things in the making. (…) put yourself in the making" (James, 1909)

By putting ourselves as design researchers in the making/designing and finding ways to keep research close to the experience of making/designing, we believe that exciting new avenues for design research open up.

Exemplary research questions here could be:

- How can design scholars relate design practices used in specific situations to design processes?
- How can design scholars capture the prospective nature of designing?

Such research questions would require design researchers to become part of the process, to understand the emergent nature of the design process, to understand how designers navigate the uncertainty and ambiguity of the design process from the perspective of designers themselves.

5. Conclusion

In our paper, we set out to review how design scholars study the design process. Existing research methods in this area have delivered important insights into design work. We introduced a typology of design research approaches that sets out the dominant research approaches to study the design process across micro- meso-, and macro-level and variance theory versus process theory. Reviewing existing approaches through this typology led us to four main challenges for future theory design process theory development: temporality, path-dependency & emergence, interactions across levels, and capturing the lived experience of designers. We suggest a way forward through process theory and methodology in complement to existing protocol, narrative, and ethnographic approaches. We also identified opportunities to learn from other fields use of process narrative approaches (e.g. Pentland & Feldman, 2007) and ethnographic approaches (e.g., Deken et al., 2016; Cohendet & Simon, 2016). We hope with this framework for future design process research to highlight

key directions in this area and encourage other design researchers to take up the challenge of taking time, timing and process more serious.

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