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**Design Science for Organizational Change: How Design Theory Uncovers and Shapes
Generativity Logics in Organizations**

Pascal Le Masson, Agathe Gilain, Armand Hatchuel, Caroline Jobin, Maxime Thomas,
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Abstract

Design science research has developed strongly in the last decades with rich contributions to organization science and, more specifically, to organizational change. These contributions were not straightforward and cannot be obtained without strong epistemological and theoretical rigor. In the first part of this chapter, we show why it is critical to encompass a variety of design approaches and methods within a unified theoretical framework that underlines the logic and rationality – namely, the design theory—assumed in each type of design science research. In the second part, we use this framework to compare three families of design science research approaches and underline for each of them their methodological assumptions and the type of organizational changes they aim to achieve. We show that these streams account in different ways, and more or less explicitly, for design as a generative process that includes organizational change. We illustrate each of these approaches with specific research cases from the literature. Finally, we conclude with key insights for organizational change researchers and discuss how design science research could further contribute to the development of organizational change theory.

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Introduction

Design science research has strongly developed in the last decades with rich contributions to organization science and, more specifically, to organizational change. Design Science Research today raises great expectation for research on organizational change: intuitively, the reason is that organizational change being the result of a process of invention, learning, generation, collective creation, and design science being the science of generativity, invention, and creation, it is reasonable to rely on design science to conduct research on organizational change – and compared to other approaches of organizational change, design science research let the researcher hope to have better analytical and experimental control of design-based processes of organizational change. Yet, the contributions of design science research to organizational change were not straightforward and cannot be obtained without strong epistemological and theoretical rigor: the expectations raised by design science research also imply strong requirements in terms of research method and epistemology. Hence this chapter addresses the strengths and challenges of using design science as an approach to researching change.

In the first part of the chapter, we remind of the expectations raised by design science research, seen as a way to address the tension between rigor and relevance in management, and a way to access original phenomena on collective generativity in organization – we then show how these expectations actually imply critical requirements and how these requirements can be met by relying on design theory, that enables to model rationality in design science research on organizational change – we also show that when choosing a design theory framework for research on organizational change, a design science researcher actually chooses a specific analytical framework to take into account the generativity issues in organizational change research. In part two of this chapter, we illustrate this diversity of approaches by analyzing and comparing three families of design science research approaches: (1) empirical studies of how design practices impact organizations; (2) interventional research approaches where researchers design artifacts to develop knowledge on organizational change; and (3) collaborative research where researchers rely on design theory to experiment with design-based organizations. Each of these families relates in a specific way to design theory. We

underline for each of them their methodological assumptions, their strengths and challenges, and the type of organizational changes they aim to achieve. We show that these streams account in different ways, and more or less explicitly, for design as a generative process that includes organizational change. We illustrate each of these approaches with specific research cases from the literature. Finally, we conclude with some key insights for organizational change researchers and discuss how design science research could further contribute to the development of organizational change theory.

Part 1

Epistemological issues: The Critical Role of Design Theory to Model Rationality in Design Science Research on Organizational Change

Traditionally, design science research is defined as the research on design, seen as design action and design artifacts. More specifically design science research in organizations relates to the collective action of design and is deeply related to the issue of changes, evolutions, and inventions in organizations. Design science research has its roots in Simonian Science of the Artificial (Simon, 1969), underlining that it aims at studying not only “how things are, but also how they ought to be” – this (often used) quote from Simon being of course a clear positioning in favor of a constructivist approach against analytical, positivist ones – and also raising strong issues for research: it means that design science research will not only describe how an organization works but also describe, experiment and design how it could work differently to get different results – design science being finally a way to have a stronger, more rigorous understanding of what “construction” is (in constructivism). One such example would be examining not only how a company deals with competence management system but also designing and experimenting new, ‘better’ competence management systems (see Sein et al. 2011, detailed below in part 2). Hence, design science research is fundamentally grounded in the theory and practice of change and seems particularly suited to study change and contribute to the field of organizational development and change. Yet, such research promise has been quite hard to reach in practice because it had to meet strong methodological requirements, which actually correspond to critical epistemological issues.

In this first part, we describe this growing stream of research in design science. We analyze two main expectations that are at the root of design science research: (1) the expectation to combine relevance and rigor with access to unique, (2) the expectation to access to original forms of collective action; we underline how these expectations raise critical requirements for solid research. We then show that these requirements correspond to two main epistemological issues: the intervention issue and the theoretical framework issue, and we conclude this part by eliciting how design theory can play a strong role in addressing these issues.

A Growing Stream of Research in Design Science leading to Original Results

Today, there are very active academic communities using design science research to study organizations. One can refer to the success of the conferences of DESRIST (Design Science Research in Information Science and Technology), the development of journals, such as the recently launched Design Science Journal, the growing success of the Design Theory SIG (Special Interest Group) of the Design Society, and the development of design science research in specific management areas such as entrepreneurship, the management of information systems, and innovation management.

Over time, important developments in the fields of organization science and organizational change research were obtained thanks to a design science research approach. To name a few: Sarasvathy (2003) uncovered the effectuation logic of the entrepreneur based on an analytical framework of entrepreneurship as a science of the artificial; Hatchuel et al., 2006, based on advanced design theory (C-K design theory, C for Concept, K for Knowledge), showed the development of design-oriented organizations with multiple organizational developments; relying on the analysis of the design practice of Frank Gehry, Boland et al., 2008 proposed lessons for organization leaders; relying on Simonian Analysis of Modularity Effectiveness (that shows the impact of modularity in certain classes of actions), Yoo et al. (2010) characterized the new organizing logic of digital innovation; and by studying design thinking methods, Carlgren et al., 2016 have shown that these methods induce only limited changes in organizations.

Expectations from Design Science Research and Related Requirements

These research streams share two main expectations.

1 - A way to address the tension between rigor and relevance in management. Many authors working with the design perspective recalled the long-standing debates on the relevance of knowledge produced in the field of management and organization in the 80s, 90s, and 2000s (Berglund et al. 2018; Avenier 2010; Sein et al. 2011; Romme and Dimov 2021; Hatchuel 2005; van Aken 2005; Denyer et al. 2008). Romme and Endenburg regret that “over time, the status of design and intervention research in organization studies has changed from a core activity to a relatively minor project outside the mainstream (Baligh et al., 1996) [...] largely disconnected from the development toward a generic design science (Warfield, 1996)” (p. 288) and they expect that design science research can precisely reverse this trend and contribute to relevant organization studies.

It is widely expected that the design perspective will help combine rigor and relevance. For van Aken (2005), Design Science would be Mode 2 knowledge production producing field-tested and grounded technological rules for management science and organization rules. The intuition, explained by van der Borgh et al., (2020), is that design science research produces empirical material and addresses organizational issues in action and leads to design theory and principles that can be more general than the specific situation where they emerged. Knowledge produced must go beyond idiosyncratic solutions; thus, it is clearly different from consulting and acts as “boundary objects” between academic research and practitioners (van der Borgh et al., 2020, p.137).

This intuition raises clear *requirements*:

Requirement 1: The design problem should be new and original (in comparison with the literature); otherwise, the solution is just an instantiation of already available results (van Aken et al., 2016; van Aken and Berends, 2018).

Requirement 2: Being part of the research process and research object, the design process has to be as controlled as any knowledge production step in scientific research. Hatchuel (2005) went as far as explaining that the relevance gap in management is related to the actionability of the knowledge produced by research; hence, a strong link between the epistemology of management and the research method so that a controlled “design” process in research would be a warranty of rigor and relevance of the knowledge produced.

Requirement 3: Design research results still have to be expressed in “generic” terms. For example, Denyer et al. (2008) detail how knowledge produced in Design Science Research combines rigor and relevance by leading to propositions that follow the CIMO logic, i.e., always clarifying for any research proposition its **C**ontext, the **I**ntervention type it relates to, the generative **M**echanism that led to this proposition, and its intended **O**utcome. Romme and Dimov (2021) proposed to extend this CIMO logic to CAMO logic, replacing Intervention with Agency.

Hence, the expectation of bridging relevance and rigor with design science research also raises strong requirements. These requirements don't seem out of reach, but one can already notice that they are related to two strong epistemological issues: on the one hand, the epistemology of intervention and the issue of the validity of knowledge produced in action research; on the other hand the epistemology of design, and the issue of the model of rationality for an activity such as design that is inherently related to emergence, the unknown, creativity, invention, discovery ... i.e., the many notions that were long considered out of the realm of deductive rationality. This second epistemological issue will be even more acute after studying the second expectation associated to design science—a way to access the original phenomena.

2 - A way to access original phenomena on collective generativity in organization. Linked to the relevance-rigor ambition, the researchers in this stream of work also expect to access original knowledge in management science. The intuition is clear: in the design perspective, researchers can follow the design of new practices, new processes, new structures, new values, and new competencies to face contemporary challenges, including sustainable development goals and transitions. Hence, they are on the spot to report the emergence of new forms of collective action and, more precisely, “generative action,” i.e., new capacities to collectively invent, discover, and develop solutions. “Follow the design” appears as a strategy for design science researchers to be able to produce new original results for the management science community.

This strategy appeared fruitful in past decades since it enabled researchers to analyze the emergence of new forms of organizing for innovation in companies (e.g., design-oriented organizations (Hatchuel et al., 2006), design-driven laboratories (Dell’Era & Verganti, 2009), and

intermediaries as architects of the unknown (Agogu  et al., 2013). Today, this strategy might become even more interesting since more and more actors in an organization are now in charge of organizing design (design at the plant level (Harl  et al., in press), and design in public policy (Pluchinotta et al., 2019), hence leading in the coming years to the emergence of unique, until now unseen, forms of collective action. These scholars who focus on collective design action to be able to identify, as early as possible, the emergence of new forms of collective action face critical requirements.

Requirement 4: Being able to observe the phenomena. This research strategy requires *a capacity to observe* design activities, and this is far from self-evident. Design consists in creating objects, services, and knowledge; hence design activity takes place *before* the artifacts are here. Thus, this is a very abstract activity (compared with production, where the objects and processes can more easily be observed). Of course, there are artifacts in design (drawings, computations, proofs-of-concept, prototypes, etc.), but they are often preceded by important design work. They mirror only one part of the activity, and despite AI-based data treatment, they often remain extremely difficult to analyze. Moreover, in companies and organizations, design is often very strategic, and hence confidential, so that researchers cannot easily access design action in these places.

Requirement 5: Being able to analyze, characterize, position, and criticize the phenomena. Researchers, particularly if they are in an action research perspective, are also expected to *put observations in perspective, to be able to formulate alternate hypotheses, to keep a critical distance, and to even support the experimentation of alternate forms of action*. But these actions require a reference for action—what does it mean to “improve” the quality design action? What can actually be the “quality” of a design process? This requires a reformulation of the underlying theory of design action to be able to characterize its outcomes. One example is given in Elmquist and Le Masson (2009), where the value of a project is discussed in an organization, and design theory enables to clarify the variety of forms of performance that can be expected from a project (this example is described in more depth below in this chapter).

Requirement 6: Being able to control the interaction in a design process. Studying a design process, a researcher can either remain in a pure “observation” position (and the only requirement is

the one mentioned above, i.e., how to rigorously observe design without disturbing it), or a researcher can be in an “experimentation” position being able to design a solution, and then to submit this artifact to the target organization to evaluate the impact (and the requirement becomes: why this solution, how to evaluate the reaction of the organization, etc.). This latter solution implicitly considers that the organization is not designing or was not able to design the solution proposed by the researcher. A third solution is to *co-design* with the organization and make it able to design its own solution. In this latter case, the control of the interaction between the “design” researcher and the “design” organization is more complex and requires a theory of the interaction in a design situation.

Fortunately, in recent decades, it has become easier to meet these requirements. On the one hand, advances in design theory provided new capacity for empirical investigations. Based on contemporary design theories, such as C-K theory (Hatchuel & Weil, 2009; Hatchuel et al., 2018), it became easier to observe, analyze, and criticize design processes, easier to propose new testable research hypotheses, and also easier to elaborate new complex experiments where researchers and practitioners co-design new organizations in a controlled way. On the other hand, design action has been more and more digitalized, which enabled new data treatments. In addition, design has also developed in public spaces (e.g., fablab, open innovation, crowdsourcing, etc.) where confidentiality was less an issue. This contributed to access to new design observations. Hence, contemporary advances in design theory and digitalization contributed to render possible the smart strategy of researchers who focused on collective design action to be able to identify, as early as possible, the emergence of new forms of collective action.

Epistemological Issues

It is now clear that design science research has great expectations, but these expectations are also related to strong requirements. These requirements correspond to two main epistemological issues: an interventional issue and a theoretical framework issue.

1-Interventional Issue: Which Scientific Control of Action Research in a Design Situation?

Design science researchers are led to intervene and contribute to collective design processes that involve strong relations with organizational changes. This kind of research can be scientifically

fruitful (Hatchuel and David, 2007; Shani et al., 2007; David & Hatchuel, 2007), but it is also recognized as highly demanding—interventional researches need a rigorous observation and understanding of the rich and complex interactions between the researcher and the organizational context. The control of such analysis is a critical issue for research validity (Coghlan, 2022). It has been claimed that design science is not action research. “Action research is focused on problem-solving through social and organizational change. Design science is focused on problem-solving by creating and positioning an artifact in a natural setting. (Baskerville, 2008, p. 442). Although this distinction appears grounded, it relates to the means of the research (social action versus artifact design) and not to the scientific control of the research process, be it via social action or via artifact design. In both cases, research is expected to have an impact on collective action and hence lead to organizational change, as the process of organizational change is carefully followed and controlled. Thus, design science research must address the epistemological issues related to intervention, just as action research does.

Actually, many design science researchers claim to rely on action research principles. (See multiple references in design science, action research, and intervention research, e.g., Susman & Evered, 1978; Radaelli et al., 2014; Hatchuel & David, 2007; Sein et al., 2011). The Sein et al. (2011) paper on Action Design Research proposes a design research method that is derived from action research principles but dedicated to design science research. The authors illustrate Action Design Research method by reinterpreting research conducted with an action research method with a design action, for example, designing a new competence management system at Volvo (Lindgren et al., 2004). According to Sein et al., 2011, Action Design Research identifies four stages: (1) problem formulation (based on principle 1 “practice-inspired research” and principle 2 “theory-ingrained artifact”); (2) building, intervention, and evaluation (based on principle 3 “reciprocal shaping,” principle 4 “mutually influential roles” and principle 5 “authentic and concurrent evaluation”); (3) reflection and learning (based on principle 6 “guided emergence”); and (4) formalization of learning (based on principle 7 “generalized outcomes”) (p. 41). Building on action research helps to address several requirements, more specifically, requirement 1 (assure the problem is new and original),

requirement 3 (generalized results), requirement 5 (analytical and critical capacity), and requirement 6 (controlled interaction with the design organization).

2- Theoretical Framework Issue: Which Theory of the Design Action Rationality?

As mentioned above, research on design also has to account for the design process itself: how to observe it, to control it, to criticize it, to improve it, to “value” it, and to learn from it. Design science research has to rigorously account for what Simon called the exploration of what “ought to be” (instead of what is) (Simon, 1969). More generally, it has to account for the generativity logic and expandable rationality at the heart of design (Hatchuel et al., 2018). Hence, any design science research must rely (implicitly or explicitly) on assumptions on how such generativity and expandability can be described and modeled. This is what we call the “design theory” mobilized by the researchers, *understood as a theory of the design action rationality* (Le Masson et al., 2013).

The difficulty has long been recognized—discovery, emergence, unknown, generativity, invention, imagination, and ideation were long considered as beyond the realm of classical epistemology. Some authors even allude to a specific “designerly way of knowing” (Cross 1982, 2001) that would be inherently separated from science. Several authors mentioned that design reasoning could be linked to Peirce’s “abduction,” but it has also been shown that Peirce’s abduction was, for Peirce, more a research program than a research result; and this research program fell short of accounting for emergence and hypothesis construction, and at best explained the inference to the best explanation (Douven, 2021a, b; Koskela et al., 2018; Kroll et al., in press), which remains far from the issues of generativity. Yet, several streams of research have also developed models of design rationality, showing that at least certain forms of design could be compatible with a rationality model and hence with a scientific approach.

Many papers in design science research assume that design action can be modeled as problem-solving (Hevner et al., 2004)). Other authors consider formal design logic, such as Hatchuel and Weil’s (2009) C-K theory. In each case, the assumed design theory has strong implications for the research itself. Such theory (from the Greek θεωρεῖν (theorein), i.e., to look at, to observe, to contemplate) acts as a spectacle, an unavoidable filter that conditions research methods, observables,

measurements, and analytical frameworks. The assumed design theory will also determine specific types of hypotheses and results. Last but not least, it will strongly impact and eventually generate a research bias on the type of organizational changes that will be explored and observed during a particular design science research. If we follow the requirements listed above, it appears that design theory will play a critical role in requirement 2 (a controlled design process), requirement 4 (capacity to observe design activity), requirement 5 (critique and improvement of the design process and organization) and requirement 6 (controlled interaction with practitioners-designers).

Analytical Framework for Research in Design Science and Organizational Change: The Role of Design Theory

As a consequence, design science research on organizational change will have to address the two epistemological issues mentioned above, with a specific position toward action research and a (tacit or explicit) design theory. These epistemological choices will consequently enable us to meet the six requirements to fulfill the expectations of design science research, particularly in terms of results on organizational change. In the second part of this chapter, we will describe in more depth three main streams of research in design science, each of these streams being characterized by its choices on the above issues, and hence illustrating how these choices finally induce certain types of results for organizational change. One of the greatest sources of differentiation between the three streams comes from the choice of the design theory that will underline the research. Hence, before digging deeper into these three streams, it is important to underline some of the differences in the approaches of design theory.

Many papers in design science build on the Simonian approach of design. A Simonian approach is based on problem-solving, with an (occasionally multicriteria) objective function and several constraints and rules that can be applied to reach the objective of solving the problem. It is largely inspired by the works done by Simon on the General Problem Solver program and variations around branch and bound algorithms (Simon, 1969; Simon, 1979). The issue consists in characterizing the way to search for a solution in a knowledge-based, occasionally highly combinatorial, highly

complex problem space¹. With a Simonian approach, design is assimilated into a search in a knowledge-based system. As a consequence, in the literature that builds on Simonian design theory, the authors use the term “design theory” to characterize how specific *pieces of knowledge* used in a specific design can actually have a broader validity beyond the artefactual single use (Gregor et al., 2007)), i.e., how they form relevant, generic design rules (van Aken, 2005). In the table below, we give some examples of how a Simonian approach to design rationality can contribute to meeting the requirements for design science research (See Table 1 below.)

In the last decades, several authors have underlined that a Simonian approach is too limited to account for the generative logic of design (Schön, 1990; von Foerster, 1991; Hatchuel, 2002; Dorst, 2006). These authors showed that a Simonian model didn't endogenize the “discovery” of new rules and new knowledge during (and because of) the design process. This is the “unfinished program” of Herbert Simon (Hatchuel, 2002). Research on design theory (Yoshikawa, 1981; Tomiyama & Yoshikawa, 1986; Braha & Reich, 2003; Shai & Reich, 2004; Hatchuel & Weil, 2009) precisely progressed by extending this Simonian type of a knowledge-based approach by combining it with models of invention, discoveries, imagination, and partially unknown propositions. This stream of work uses the notion of design theory to characterize the whole design rationality. One example is C-K theory (Hatchuel & Weil, 2009) (C for concept, K for knowledge)—a design theory that a) *includes* the knowledge of design rules (in K-space), b) also accounts for *the structuration of the unknown before it becomes known*, hence the “problems” to be solved, but also chimera, imagination, creativity, etc., (in the C-space), and c) also accounts for the interaction between the known and the unknown, i.e., *how knowledge enables the formulation of new chimera and original paths in the unknown* and, vice-versa, *how these chimera and original paths in the unknown lead to create new knowledge*.

¹ Simon is particularly famous for having noticed the fact that in such problem solving situation, actors (and organizations) show a bounded rationality (to simplify: they tend to reuse well-known routines instead of finding the optimal solution) ; Simon also showed how complex problems can be solved by identifying critical design rules, in particular rules that modularize the problem – which also relates to clear organizational issues: whether or not an organization rely on modular design knowledge will determine its design performance (Baldwin and Clark 2000).

These works have contributed to elaborate a design theory comparable in its structure, foundations, and impact to decision theory, optimization, or game theory. Contemporary design theory has led to critical results and opened new possibilities for studying the generativity of design processes. For instance it enabled :

- to characterize the variety of design reasoning (strong C exploration vs. strong K exploration, for instance; or depth-first vs. breadth first in C-space...) (Hatchuel & Weil, 2009),
- to measure the variety and originality of C-exploration (whereas a problem solving approach tend to measure the distance to an optimal solution),
- to measure fixation in design processes (biases in the generation process, ie a generation process that only results in a restricted set of solutions compared to the set of imaginable solutions – these biases are very different from biases in a decision process or a Simonian problem solving process, which again compare one result to the optimal one) (Duncker 1945)
- to experiment with defixation
- to criticize specific design processes and experiment less biased ones.

Relying on these advanced design theory formulations opens new ways to address design science research requirements, possibly taking into better account the generativity of the design action. To give some examples (See also Table 1 below) (more detailed cases in the second part):

- *Control specific facets of the design process (requirement 2)*. C-K design theory suggests paying attention to “independent knowledge” (e.g., through organizational processes) since C-K design theory predicts that access to new independent knowledge can strongly impact the generative capacity (Le Masson et al., 2016).
- *Observe new aspects of collective design action actions (requirement 4)*. Design theory suggests recording not only a solution but also the variety of “solution paths” that were explored since this variety is both a signature of the generative capacity of an organization and

also forms a rich ground for re-exploration and continuous development inside a given innovation field (Elmqvist & Le Masson, 2009).

- *Identify specific quality criteria of design action to enable enriched criticism and to improve collective design action (requirement 5).* Design theory suggests characterizing how a collective design process enables to overcome organization fixation to help generate solutions out of the “easily accessible” ones (Agogu  et al., 2014; Jansson & Smith, 1991).
- *Enables complex but controlled design interactions between designer-researchers and designer-practitioners (requirement 6).* Based on C-K theory, designer-researchers were able to conduct research following complex yet controlled co-design processes (Elmqvist & Segrestin, 2009; Vourch et al., in press; Della Rossa et al., 2022; Pluchinotta et al., 2019) to lead to original results in organizational change.

These examples illustrate how a design theory framework that takes into account the generativity logic of design leads to specific research methods that enable the control of the factors of the generativity process (requirement 2), that observe the generativity phenomena (requirement 4), that criticize generativity quality and propose ways to improve it (requirement 5), and that elaborate more complex ways to study collective generativity mechanisms that comprise several designers including researcher-designers and practitioners-designers (requirement 6).

Table 1

How the Choice of Design Theory Framework Impacts on Design Science Research

	Simonian design theory framework	Contemporary design theory framework
Requirement 2: factors that might influence the design process	Example: to solve the identified problem → rely on top-level expertise (quality of the state of the art) and explore all combinations (computation power)	Example: to explore a design concept → discover/create new independent knowledge, be able to formulate/explore ‘crazy concepts’
Requirement 4: observe collective design action	Example : characterize a solution (eg material artifact) and evaluate its fit with the target	Example: characterize new ‘solution paths’, newly created knowledge

Requirement 5: analyze, evaluate, criticize design action	Example: analyze the quality of the fit between problem and solution (and learn from this)	Example: evaluate defixations (individual or organizational); or: compare generativity of design strategies (breadth vs depth...)
Requirement 6: control complex interaction in design action	Example: clear separation between 'users' (contribute to set the problem) and designers (frame the problem, propose solutions)	Example: multi-actors design processes, with complex (but controlled) provision of knowledge and ideas by participants (e.g. KCP process)

Hence, when choosing a design theory, a design science researcher actually chooses a specific analytical framework to observe the generativity issues, and hence, chooses one of the very contrasting ways to meet the requirements for design research methods, leading then to different results for research on organizational change and the logic of generativity in organizational change. To illustrate this point, in part 2, we analyze three main research streams in design science research.

Part 2

Comparing Design Science Approaches: The Deep Correspondence between Design Theory, Design Science Research Methods and Results for Organizational Change

Several design science research approaches have unfolded in the last decades, yet they all share the same logic. They are all (1) addressing a specific organizational issue, (2) based on specific research methods for organizational investigations, (3) framed (implicitly or explicitly) by a specific theory of design rationality (also called design theory), and (4) supported by research results validation. In this section, we apply this framework (organizational issue, method, design theory framework, and results) to analyze three design science research streams in the literature. This calls for three remarks. First, we only focus on design science research that relates to organizational change (there are many other works that deal with design science research but without direct links to organizational change). Second, with these three streams of work, we illustrate the variety of approaches without any claim of exhaustiveness. Third, we selected papers based on empirical research over theoretical papers.

The analysis of these three streams shows the deep correspondence between design theory, design science research methods, and results for organizational change.

Stream 1: Observe New, Original Design Processes and Organizations without Specific Model of Design Rationality

The first stream of design science research focuses on the empirical study of design practices and their impact on organizations (Carlgren et al., 2016; Dell’Era & Verganti, 2009)). The authors don’t put a particular emphasis on design theory. In this stream, “design” is mainly envisaged by some features (e.g., in design there is a prototype or there is problem framing hence the study focuss on prototype or problem framing) or particular outputs (e.g., in design there is the generation of new meanings, hence the study focuses on meaning) *without a specific generativity model, ie without specific design theory*. The authors try to uncover the organizational forms that lead to these (design specific) features and outputs, e.g., types of routines, types of resources, and the effects of these features and outputs on the organization. The authors contribute to organizational change by characterizing the organizational impact associated with the emergence of the new design-specific routines: either they characterize the new routines that *support* these new “design organizations” or they describe the effect of the new “design organization” on the rest of the organization. In particular, they describe the occasional increased performance of the organization.

In the table below, we detail two different examples (Carlgren et al. 2016, Dell’era & Verganti 2009). In Carlgren et al. (2016), the authors aim at “increasing our empirical understanding of how design thinking is practiced in organizations” (p. 53), i.e., they characterize, in the language of organizational concepts, a method that has recently emerged in organization studies and is self-defined as “design thinking.” Remarkably, they explain that they *avoid relying on any design theory* and analyze this self-defined “design thinking” *in a general language of organizational concepts*—the analytical framework is based on the analysis of similar organizational concepts in other action contexts, namely the analysis of TQM (Dean & Bowen, 1994) who distinguish different levels of analysis of organizational concepts (principles-mindsets, practices, techniques) in full coherence with the notion of organizational routines (Feldman & Pentland, 2003). Studying six companies that utilize

design thinking, the authors uncover five themes that characterize how design thinking is practiced in organizations—user focus, problem framing, visualization, experimentation, and diversity—and they describe each team in terms of principles/mindsets, practices, and techniques. Table 5 (in Carlgren et al. 2016) shows that there is a variety of practices that combine these themes at different levels. In discussion, they show that these five themes are also present in existing works on design and design theory. The paper makes a clear contribution to the analysis of new organizational concepts (new design-based principles/mindsets, techniques, practices). However, probably because of the lack of a design theory reference for characterizing the generativity rationality, the paper leaves open for further research the issues of the generativity performance of design thinking themes: is there good/bad visualization, good/bad problem framing, good/bad diversity, are there biases? Consequently, it also leaves open the question of improvement and learning of the design thinking concept.

In Dell’Era (2009), the authors aim “to investigate the organizational characteristics of design-driven laboratories and to identify the peculiarities that allow them to adopt different innovation strategies (p. 16).” They study specific, new organizational forms that they call design-driven laboratories (DDL), formal organizational units that manage research and development and that significantly contribute to the generation of new meanings. The analytical framework is twofold: (1) descriptors of the laboratory organization derived from a well-known description of R&D organization: internal organization, internal communication, external organization/coordination of the DDL with external partners (Clark & Wheelwright, 1993); and (2) descriptors of the innovation strategy that contrasts functional innovation versus meaning innovation, the second one being considered as a specificity of design-driven innovation (Verganti, 2003). Based on nine DDLs, the authors uncover the existence of a specific model for DDLs that (1) organizationally rely on external resources but also conduct internal research and have a development process (clearly separated from research), and (2) strategically combine meaning innovation and technological innovation. The authors also identify three types of DDL (called “technological,” “linguistic,” and “hybrid”) characterized by (1) specific organizational features (in terms of internal organization, communication, and external coordination) and (2) a specific balance of technological/functional innovation that accompanies

meaning innovation (“technological DDL” also makes technological innovation, whereas “linguistic DDL” makes mainly meaning innovation). This paper makes a clear contribution to the analyses of design-driven organizations. Design theory is used to characterize “meaning creation” as specific to a design-driven organization. Yet, probably because of the lack of a model of generativity rationality, the paper doesn’t discuss the generativity process itself: what are the types of knowledge that lead to original, unique meaning creation? Are there biases in meaning creation? Or how is the organization capable of overcoming certain biases in the generativity process? Consequently, it also leaves open the question of improvement and learning in DDLs.

These two examples illustrate a stream of work that *manages to describe original, unique design-driven organizational features such as “design thinking” or design-driven labs by relying mainly on “classical”² organizational descriptors*. The analytical framework makes only limited reference to design theory and models of generativity, i.e., only to discuss the coherence of results with known features (see Carlgren et al., 2016) or to characterize a specific organizational performance (such as meaning creation in Dell’Era et al., 2009).

From a research method perspective, the great advantages of this approach are: (1) it avoids complex methodological issues (no need to observe new variables, even more, this type of research doesn’t require interventional research), and 2) it uses a well-known organizational language and yet manages to describe an original, unique, new organizational form. The limits are related to the absence of a model of generativity—without such a model, the papers leave open the issue of possible limits of the generativity capacity of the organization (biases, fixations, etc.) and its possible improvement by organizational change (via experimentations, learning, etc.)

Table 2

Two Examples of Papers That Observe New, Original Design Processes and Organizations – Without a Specific Model of Design Rationality

² Classical: in the sense: not specific to design action.

	Organizational issues	Method	Design Theory framework	Results	Comments
Carlgren et al. 2016	Analyze ‘design thinking’ in organization as a novel design-oriented routine, with variety of implementation, taking soft factor into account (empathy, comfortable with ambiguity, enjoyment from pb solving)	Interview study (36) in 6 companies, based on a routine-based framework (principles/mindset, practices, techniques) used by on Total Quality Management (TQM)	No framework linked to design theory – analytical framework related to organizational concepts (Feldman & Pentland: routine in principle vs in practice)	Five themes characterizing the Design thinking concept (user focus, problem framing, visualization, experimentation, diversity) – variety of practices combining these five themes.	<i>Analyze organizational facets of a design-based practice . No evaluation of ‘generativity’ of this practices: good/bad visualization, good/bad diversity? Biases? Static framework makes more difficult to analyze orga learning and change</i>
Dell’Era Verganti 2009	Analyze new design-driven labs: show that they are different from known organizational forms that do one of the two innovations (technology devt vs meaning creation) and characterize organizational features (internal actors, external actors, communication)	Case study on 9 design-driven labs; analytical framework = lab organisation (Clark & Fujimoto 1993) and innovation strategy characterized by 2 dimensions (function-technology vs meaning) (Verganti 2003)	The 2 dimensions of innovation strategy come from « design as brokering languages »	DDL is a new organization that combines meaning creation and technology devt, as opposed to ‘socio-cultural innovation’ and ‘technology innovation’	<i>Analyze design-driven organizations. No evaluation of the generativity process (factors, biases?). leaves open the question of improvement and learning in DDLs</i>

Stream 2: Organizational Change Experimentation by Designing Artefacts

In the second stream of design science, researchers design artifacts both to change organizations and to develop scientific knowledge on organizational change processes. This stream, particularly well documented in the information systems and the entrepreneurship literature (e.g., Yoo

et al., 2010; Eaton et al., 2015; Berglund & Mansoori, in press), is rooted in a Simonian theory of design, which considers design activities as problem-solving (Hevner et al. 2004; Gregor and Hevner 2013). In the table below, we detail four papers that follow this approach (Romme & Endenburg, 2006; Andriessen, 2007; Sein et al., 2011; van der Borgh et al., 2020).

Table 3

Four Examples of Papers That Experiment with Organizational Change by Designing Artifacts

	Organizational issues	Method	Design Theory framework	Results	Comments
Romme & Endenburg 2006	Redesign consultative system of 'works council' to provide genuine consultation between management and workers	Science-based organization design, in 5 steps: organization science state for the art, 2- identify construction principles, 3- design rules for 4- organization design, 5- implementation and testing	No explicit design theory – but clear design process in a redesign mode to face complex organizational problems related to current organizational design and processes.	New design rules for the implementation of 'circular consultancy' (avoid too strong or too poor CEO involvement; create a 'general circle' to discuss performance problems)	<i>Describe strong (re)design with the organization; No design theory framework to evaluate the redesign process</i>
Andriessen 2007	Reporting on intellectual capital in organization, the implementation reveals the organizational conditions for the solution adaptation	Design based research using action research (6 cases): 3 initial steps (designing, theorizing, agenda setting), 5 implementation steps (diagnosing, action planning, action taking, evaluating, learning); 2 last steps (reflecting,	Not detailed, described as problem solving: solution concept for one generic problem then, adaptation to specific context)	Indications and contraindications for intellectual capital method (types of problems, of contexts, related generative mechanisms)	<i>Clear result on organization and organizational change; No design theory framework for the design of the IC tool and the analysis of the design activity in the organization</i>

developing K)					
Sein et al. 2011	Develop IT software for competence management system (CMS), addressing 3 issues (user isolation, ignore emerging competences, rigid reporting style)	Action design research – the case study is a reinterpretation of a published action research (Lindgren et al. 2004): 1- problem formulation, 2- building-intrvention-evaluation, 3- reflection and learning, 4- formalization of learning	No explicit design theory, problem solving approach with diagnostic with the organization, then solution designed by the researchers, then test and learn with the organization	A CMS with transparency (but should be more user-controlled), with real-time competence tracking (but should have more feedback loops), with integration of indiv interest to develop new competences (but should incorporate orga perspective)	<i>Several interactions with the organization, clear learning on CMS – the capacity of the organization to design its own solution is not studied (nor its improvement)</i>
Van der Borgh et al 2020	Find solution to sales lead black hole (why, in B2B, so few marketing leads are transformed into sales)	Design science: 1-identify focal field problem, 2- exploratory diagnostic (cause and consequences), 3- identify and test bottlenecks in the lead assignment process, 4- develop ‘artefact’ ie experiment to evolve some parameters of the model, 5- testing, learning	No explicit design theory but rigorous problem solving approach (diagnostic, model, find an optimum inside the model)	Act on marketing lead by 1- emphasizing when there are new customers, 2-reminding there no ‘sure hit’, 3- prioritizing speed over optimal assignment, 4- making sure marketing people provide quick feedback	<i>Interesting result on sales organization. Limited control of the ‘quality’ of the final design (alternatives? improvement trajectory?). The design capacity of the organization is not studied</i>

This stream of work is deeply linked to research in the management of information systems, where researchers considered, in the early 2000s, that research was often too abstract and not enough grounded. This stream developed highly codified research methods that rely on the design (by the research team) of original solutions that are tested in organizations (Hevner et al., 2004; Baskerville, 2008) and lead to generic results for organization science. In this stream of work, the method is

discussed in many papers e.g. Peffers et al., 2007; Gregor & Hevner, 2013) and books (Dresch et al., 2015) with clear steps and analytical frameworks. The canonical method unfolds as follows.

Step 1. Each paper clarifies an organizational issue that is not necessarily related to the design activity itself (and most often is not): organizing work councils, reporting intellectual capital, competence management systems, and sales lead black holes. At this step, the research team makes sure that the issue is new in the literature and corresponds to the need of the target organization(s). This diagnostic phase must be very cautious (as described, for instance, in van der Borgh et al., 2020). Researchers focus on “real problems” instead of “perception problems” (i.e., when a manager has an inaccurate perception of the management process and its performance) or “norm problems” (i.e., unrealistic targets) (van Aken & Berends, 2018). By focusing on these different problems, researchers avoid “irrelevant academic research” (van der Borgh et al., 2020, p. 136) and avoid providing practitioners with incorrect recommendations and guidelines. The researchers model the problem by avoiding “dependent variables that do not directly capture the issue” and independent variables that “lack of pragmatic validity” (van der Borgh et al., 2020).

Step 2. The research team develops a solution to the problem for the target organization(s).

Step 3: The solution is implemented, tested, and evaluated.

Step 4: The research team learns about the organization and the general validity of the proposed solution. The research team learns the “technological rules in management and organization” (van Aken, 2005) and results appear as propositions that are validated for certain Context, Intervention/Agency, Mechanism, and Outcome (Denyer et al., 2008; Romme & Dimov, 2021).

In line with a problem-solving approach, the organization sets the initial problem and evaluates (validates) the satisficing artifacts that solve it. It might seem that there is a limited capacity for the researcher to question the problem and the implicit performance criteria of the organization; hence an organizational change is confined to the designed artifacts. Yet, over time, this stream of work leads to more applied action research principles (see Sein et al., 2011 seminal paper on “action design research”) precisely to take better account of the issue of the interaction with the target

organization both at the problem formulation stage and at the evaluation stage, clarifying the loops that result from this process.

These works rely, explicitly or sometimes implicitly, on Simonian problem solving, used as a design theory analytical framework. This methodological choice is adapted to organizational situations where (a) there is a clear problem to be solved once and for all (or at least for a relatively long time) – even with creativity (Pries-Heje et al., 2019) and (b) the process of the design of the solution can be “externalized” to the research team, i. e., the design process is “isolated” from the target organization, since the organization doesn’t design itself. This methodological choice also implies that:

- Researchers tend to propose one solution, considered as the fittest, i.e., the one that a priori fits best with the target organization. Some authors might propose several solution – they discuss loops, or cycles of trial and learning in their research process. Regardless, this leads the authors to not consider multiple solution paths, to neglect paths with ‘crazy’ ideas, apparently unfeasible, unmarketable one, to give few account of utopia, and imaginary solutions. This standpoint is particularly relevant in the case of organizations that will only implement *one* solution without redesign, learning, or improvements. Conversely, considering the memory of multiple solution paths, including the craziest one, can be relevant in the case of a repeated game, parallel exploration, i.e., in design situations that require strong generativity, such as cybersecurity or improvement of refugee reception (Amard et al., 2022) or in entrepreneurship (Seckler et al., in press) particularly deep tech entrepreneurship (Agogué et al., 2015)).
- Researchers tend to neglect the design capacities of the target organization and, consequently, the capacity of the target organization to change its own design capacities. This clear separation between the researcher-designer and the target organization-user allows the research to only focus on the learning associated with each *final* solution. The interactions between the research team and the organization *during* the phase of the design of the solution can be neglected (see, for instance, the very interesting detailed analyses of the interaction in Sein et al., where interactions are strong during problem setting and solution evaluation, but seem absent during the phase of solution design (Sein et al., 2011)).

In a nutshell, this stream of work provides great results for organizational change (see, for instance, (Romme & Dimov, 2021)) as long as (1) the design issue doesn't require too strong generativity and (2) the organization itself is not a generative organization.

Stream 3: Uncover a Specific Form of Organizational Change: Generativity Process and Generativity Building in Organizations

The third stream of design science research focuses more specifically on the generativity logic in organizations. In this research stream, researchers develop a variety of advanced design theories (for synthesis, see Hatchuel et al., 2011; Le Masson et al., 2013) and mobilize them in order to account for, observe, and participate in a specific class of organizational changes: *generative processes and generativity building* in organizations. It comprises works that rely on a Simonian approach yet looks for complementary alternative approaches of design rationality to account for generativity logics beyond problem-solving (Schön, 1990; Hatchuel, 2002; Dorst, 2006).

Advanced findings have been obtained at the level of leadership (Ezzat, 2017), innovation processes (BenMahmoud-Jouini & Midler, 2020), company strategy (Hooge & Dalmaso, 2015), cross-industry partnerships (Gillier et al., 2010), ecosystems of organizations (Agogué et al., 2013; Agogué et al., 2017)) and public policy (Pluchinotta et al., 2019). The organization changes associated with these studies are characterized by the *simultaneous generation of new artifacts and of new design capabilities in the organization*. In Table 4 below, eight papers illustrate this stream of work, each of them is characterized by the organizational issue it addresses, its research method, the design theory it uses as an analytical framework, and its main results.

1. This stream of work, first, is characterized by specific organizational issues. In each paper, the research questions are all related to generativity in an organization and how organizational change could improve this generativity. Hence, in contrast with previous design science research streams, the design issue at hand requires stronger generativity and the organizational change issue consists in *increasing the generativity capacity of the organization itself*.

2. Second, in this stream of work, researchers use a design theory analytical framework that is at the required level of generativity. In Sarasvathy et al. (2008), the authors introduce a new model of environment design, namely effectuation (Wiltbank et al., 2006) to be able to account for the performance of Starbucks. Many papers explain that they rely on advanced design theories such as C-K design theory to be at the required level of analysis for the generativity phenomena. They observed generativity to overcome fixation (Ezzat et al., 2017), the generativity of several new policy alternatives (Pluchinotta et al., 2019), generativity in technology entrepreneurship (Agogu e et al., 2015), generativity of innovative R&D projects (Elmqvist & Le Masson, 2009), generativity in cross-industry exploratory partnerships (Gillier et al., 2010), generativity of prototyping (BenMahmoud-Jouini & Midler, 2020), and generativity of new generic technologies (Hooge et al., 2016). Note that the authors use a design theory as a canonical framework that is often adapted to specific contexts.
3. Third, depending on the research question, the researchers adopt a specific method. This stream of work shows a large variety of methods of which one can find a sample in Table 4: (Sarasvathy et al., 2008) conducted thought experiments and simulations; Ezzat et al. 2017) and (Agogu e et al., 2015) conducted laboratory experiments; BenMahmoud-Jouini and Midler 2020) and (Hooge et al., 2016) conducted observations; and Pluchinotta et al. 2019), (Elmqvist & Le Masson, 2009) and (Gillier et al., 2010) followed intervention research methods. Yet whatever the method chosen, it will always rely heavily on the chosen design theory framework: e.g. in case of an analytical approach, the design theory framework will structure an analytical framework, in case of an experimental paper, the design theory framework will structure the construction of hypotheses, the construction of the experiments, the construction of the observations variables and instruments; and in case of intervention research, the design theory framework will structure the elaboration of the action model (in particular the rationality of the agents in the model) and, hence, the hypotheses in terms of organizational change.

4. Fourth, the research results consist of enriched models of organizational generativity, often in a dual logic to (a) uncover biases and limits in the generativity of the existing organization and organizational processes, and (b) model, experiment, and evaluate new organizations with increased generativity. At this step, the results correspond (explicitly or implicitly) to the CIMO/CAMO framework (Context, Intervention/Agency, Mechanism, and Outcome) in the specific perspective of generativity (generativity of context, of agency, of design mechanism, of outcomes).

Generally speaking, this stream of research depends on the generativity of the design theory it uses. Therefore a regular effort in this research stream is to improve design theory itself and to account for the variety of forms of generativity design theory. This stream of work also depends on the design issues an organization faces and which the organization leans toward in increasing its generativity capacity.

Table 4

Examples of Papers That Uncover a Specific Form of Organizational Change: Generativity Process and Generativity Building in Organizations

	Organizational issues	Method	Design Theory framework	Results	Comments
Sarasvathy et al. 2008	Study design organizations that design their environment; show entrepreneurial expertise, based on one case study and simulation.	« construct alternative (imagined) histories of Starbucks », inspired from ‘thought experiment and mathematical simulation techniques’ (p. 341), each scenario based on a specific logic, ‘logical options opened to organizational designers’ (p. 340): planning /	Literature review on strategic management and organisational design identifies three ‘design’ approaches (planning, adaptive, visionary) to design environment, depending on control and predictability	Starbucks organization can be interpreted as a mix of four stories – it proves that a model of 4 logics explains better than a model of 3, hence validates the necessity to complete models of ’envt design by effectual	<i>Of course it doesn’t prove that there is no model that would better explain Starbuck! Eg explain interactions between the four logics? Also: What are the contingency criteria and validity domain?</i>

		adaptive / visionary / effectual	of the environment - and Wiltbank et al. 2006 add effectual, inspired by Simon:	logic (Starbuck is an anomaly for model of 3 and is explained by a model of 4).	
Elmqvist et al. 2008	Evaluation of R&D projects in context of intensive innovation (new framework, beyond independent projects)	Collaborative research, describing empirical practices in use and carry out a revision of the existing theoretical management models	C-K theory as interpretative framework: follow cognitive processes, providing information for evaluation (but doesn't prescribe it)	New evaluation criteria: new goal, new measures (financial sustainability, structured set of ideas, competences), new related actions and learning	<i>Design theory enables observation, development and experimentation of organizational methods</i>
Gillier et al. 2010	Overcome issues of cross- industry exploratory partnerships with matching and building	Experiment a DT- based method to organize 'matching' and 'building' with cross-industry exploratory partnership (french AEC)	C-K theory led to develop a method (opera) to map the innovation field of each partner and the intersections	Method acts as a boundary object (flexible enough to adapt, robust enough to maintain common identity); reveal generic concepts	<i>Close to action research (diagnostic, experiment, learning)</i>
Agogu�e et al. 2015	Understand early stage technology entrepreneurship (avoiding hindsight bias)	Experiment- 13 teams of young tech entrepreneurs develop technology/product concepts and explore market opportunities for a new technology platform	C-K theory: account for the two logics (causation and effectuation) + can be used as a method for entrepreneurs enabling also behaviour observation	How technology entrepreneur deviates from technological path by combining causation and effectuation. Elicit hindsight bias towards causality	<i>Results from lab experiments can not be easily translated into organizations</i>
Hooge et al. 2016	How to organize for the design of generic tech	Analysis of the organization for generic tech design	C-K as analytical framework	Identify specific performance criteria and competences	<i>Analysis of original orga (not experimental)</i>

Ezzat et al. 2017	Leadership for defixating in idea generation processes	Experimental method: hypothesis formulation, experiment with 60 ideators	C-K theory helps formulate hypotheses (which feedback can be defixating, which is not) and also measure fixation	Feedback can postively (resp. negatively) influence idea generation	<i>Generativity performance is measured, the model is predictive– yet in a lab context.</i>
Pluchinotta et al. 2019	‘lack of methodology for the generation of policy alternatives’ Policy alternatives generation can be managed through new design process (méthod and organization)	Pilot case study (Puglia water management), follows (implicitly) action resarch: diagnostic of initial decision situation (and its limits for stakeholders); experiment with the organisation; study of impact and learning	C-K theory: helps diagnose design fixation, helps propose a new design process (method & orga) to overcome fixation	A method that works in one situation + more generic lesson: a generative mechanism aimed at modifying stakholders’ value structure with the consequential expansion of the set of policy alternatives’	<i>Action research is not mentioned but the paper meets the requirements. Design theory enables the development of new organization and methods</i>
Jouini et al 2020	Analyse organizational role of prototypes	Analysis and comparison of prototypes (6 cases)	C-K as analytical framework	Proto archetypes: stimulators, demonstrators, validators	<i>Analytical paper (not experimental)</i>

Comparing the Three Streams—Design Theory as a Critical Means to Account for Generativity in Organizations and Organizational Change

The systematic review of these three research streams in design science research contributes to clarifying the landscape of design science research in relation to organizational change. First, design science research, as the study of design (action or artifact) in organizations, is based on different theories of design rationality. Second, these theories mainly differ in their ability to account for

generativity in organizations. Third, this ability is critical for the research methods used and for the contributions they can make to organization change.

We have characterized several streams of research in design science. They are contrasted but also contingent and complementary (see the comparison in Table 5 below). Depending on the research issue, the researcher can choose one or another, with specific consequences in terms of research topic, research investigations and methods, generating scholarly contributions, bringing about change. We briefly summarize these main features below, to guide the researcher to a choice that better fits her/his ambitions and circumstances.

In terms of research perspective and research topic: describing a new design-driven method or organization will lead to Stream 1. Changing an organization by providing a newly designed solution to an organizational problem corresponds to Stream 2. Focusing on generativity building in organization corresponds more to Stream 3. A research following stream 1 will contribute to organizational change by shedding light on unique, original organizations that might be imitated, reproduced, used as model for other implementations. A research following stream 2 will contribute to organizational change by bringing changes to the organization through newly designed artefacts, by analyzing the real-life experiment impact and by enabling to validate new organizational principles. A research following stream 3 favors an approach of organizational change that focused on building/increasing generativity capacities of the organization, hence endogenizing the generativity building capacity inside the organization.

Each choice has clear methodological consequences and each stream puts emphasis on specific aspects: a research in stream 1 requires a capacity to identify original and unique design-oriented organizations, the capacity to investigate these organizations and finally it requires that the analytical framework will take care of embedding of the organizational description into the well-established organizational descriptors; a research in stream 2 requires to find an organization that accept to experiment newly designed solution, it then requires that the research team is able to design a relevant solution and, methodologically speaking, it requires to carefully follow the methodological steps of action design research; a research in stream 3 will rigorously clarify its underlying design

theory, then rely on this theoretical framework to build the relevant empirical approach that can be more or less interventional (see the set of examples analyzed before) and, depending on the choice of the empirical approach, research in stream 3 might require to identify an organization that is interesting for the research analytical approach, or ready/willing to experiment organizational change oriented towards increased generativity capacities. This confirms the introduction: all three research stream are extremely demanding – yet each of them can lead to great results in research on organization change (as shown by the sample of papers that illustrate the thee streams).

Each stream can unfold in specific research directions, echoing contemporary societal challenges (to keep relevance-rigor balance). Stream 1 helps to study newly emerging design-driven organizations, which may be associated with contemporary design issues of “transitions” or “grand challenges” (Zolfagharian et al., 2019). Stream 2 focuses on the study of design issues requiring more generativity with organizations that are expected to solve several design issues without having specific generative capacities. Stream 3 focuses on the study of new organizational forms of generativity associated with “grand challenges” where, paradoxically, it is expected that the creation will contribute to preservation, i.e., preserve resources, preserve biodiversity, preserve society, preserve democracy, preserve mobility, etc. hence generativity that is creative preservation and not creative destruction (Carvajal Pérez et al., 2020; Hatchuel et al., 2019). These new forms of generativity might also require the development of new generative capacities in organizations that were not used to being design experts: for example, new design-oriented teams and processes were recently experimented/studied in organizations that were usually not considered as design-oriented, such as design organization at plant level (Harlé et al. 2022: how to increase the generativity capacity of a plant that was rather supposed to follow the routines and only marginally adapt them), design organization in public administration (Pluchinotta et al. 2019: how public administration can not only choose and control rules for collective action in industry but can also organize complex design process to enable all actors, including the administration itself, to invent new rules for collective action), and design organization in expert corporations and professions, for example, surgery (how a profession can not only choose and control best practices but can also organize to build new generativity

capacity, at the interface with other, powerful, design organizations – such a companies developong healthcare solutions to these same professional expert). Hence it appears that all three approaches are particularly relevant to research contemporary transformations of collective action and, conversely, design science research on these contemporary transformation will also lead to interesting advances for organizational change.

Table 5

Comparison of Three Streams of Research in Design Science

	Organization al issues	Method	Design Theory framework	Results	Potential developments
Stream 1: observe new, original design processes and organizations – without specific model of design rationality	Characterize design-driven methods/orga nizations	Observation	Design theory used to infer specific performance indicator (meaning creation)	Describe unique design-driven methods/organiz ations	<i>New design- driven organizations? (associated to 'transitions', 'grand challenges'...)</i>
Stream 2: experiment organizational change by designing artefacts	Organizationa l change (without reference to organization generativity capacities)	Codified approach, with strong link to action research (solution artefacts designed by researchers)	Simonian, problem solving approach	Organizational/m anagerial rules induced and tested by (researcher made) artefacts	<i>Towards design issues requiring more generativity (SDG...) with organization that would increase their generativity capacities</i>
Stream 3: uncover a specific form of organizational change: generativity process and generativity building in organizations	Focus on generativity building in organizations	Variety of methods (observation, laboratory experiment, simulation, intervention research...)	Design theory at the level of generativity of the phenomena under study.	Organizational/m anagerial rules for generativity building in organization.	<i>New forms of generativity (eg. generativity under preservation), in organizations that are "generativity newcomers".</i>

Conclusion

Design Science for Organizational Change: How Design Theory Uncovers and Shapes

Generativity Logics in Organizations

In this chapter, we showed that design science research, defined as the research on design (action and artifacts) in organizations, is deeply related to critical expectations on organizational change, namely the capacity to combine rigor and relevance and be able to address the critical issue of generativity in an organization – but these expectations are hard to meet because of the critical requirements and epistemological issues they raise. Meeting these requirements and addressing these epistemological issues is related to the choice of a design theory as an analytical framework for the generativity phenomena under study. We showed three specific research streams in design science research that are adapted to specific forms of generativity and hence provide differentiated methodological guidelines to address specific design and organizational issues – each of these streams relates differently to design theory and intervention methods. Each of these streams proposes a coherent research logic (organizational issues that can be addressed, associated methods, design theory analytical framework, type of results) and can lead to unique results on organizational change and specifically on generativity logic in organizational change.

Hence design science research appears as a demanding but unique research method to study organizational change. How does it interfere with other organizational change methods? Interestingly many streams of work in design science research depend on rigorous intervention research methods and epistemology – described, for instance, in Coghlan's chapter on action research in this book. This facet of design science research is not specific and actually builds on well-established research methods. Design science research is more unique in its way of putting emphasis on design and the logic of generativity in an organization – in this perspective, design science research brings a specific, original contribution to the research community of organizational change: specific research techniques associated with generativity observation, analysis, and experimentation. These techniques are largely associated with progress in design theory and the capacity of design theory to account for new forms

of generativity: design theory uncovers and shapes generativity logics in organizations that, conversely, can challenge design theory.

Undisputedly, such an active feedback loop between design theory and generativity in collective action leads to relevant results for practitioners. But it also leads to fundamental scientific results: favoring this active feedback loop between design theory and generativity in collective action, design science research can be one of the contributors to fundamental scientific advances on generativity processes, a contemporary scientific challenge at the heart of scientific disciplines as diverse as computer science, life science, mathematics, or physics. Studying with full rigor generativity in organized collective action, design science research appears as a relevant method to strengthen management science as one of the contemporary basic sciences.

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