A CONCEPTUAL MODEL FOR INTEGRATING DESIGN THINKING AND LEAN STARTUP METHODS INTO THE INNOVATION PROCESS

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ABSTRACT

Design thinking is a methodology that comes from the industrial design realm and is centred on culling better needs insight from users. Another popular methodology is based gaining insight on the potential of an opportunity through experimentation, testing, and iterating with users. This is commonly referred to as lean startup methods. However, from a research perspective, we still do not know the most effective way to implement these user focused design methods within the innovation process within organizations, and which aspects of the design process are the most impactful in developing new opportunities. In this research, we propose a high-level conceptual process model on how user focused design methods such as design thinking and lean startup methods can be integrated into the up-front innovation process within organizations. We review the conceptual model, associated activities, and process considerations. The article concludes with thoughts on future research.

Keywords: User centred design, Design process, New product development

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1 INTRODUCTION

There are things we know that improve innovation outcomes, such as focusing on the up-front of new product development (NPD) in terms of pre-development marketing, understanding user needs, developing concepts, etc. (Cooper, 2008). We also know that highly collaborative teams, having some process to guide development, and cost engineering early in the process can be helpful (Cooper and Sommer, 2016; Marion and Meyer, 2010). However, there is little research that shows how design thinking and lean startup methods can be integrated together in the innovation process. This research proposes a conceptual process that integrates these two methods together, with an emphasis on early interaction with users and stakeholders.

There are several design methodologies that have been developed and propagated over the past several decades. One is centred on culling needs of users to improve problem formulation. This is commonly referred to as design thinking. Design thinking is a methodology that comes from the industrial design realm. Popularized by design and engineering firms like IDEO (Brown, 2008), design thinking is a series of activities that put the user at the center, to gain empathy and a deep understanding of behaviour, values, and point-of-view, and to develop opportunities out of those insights (Liedtka, 2018). Over the past ten years, design thinking implementation at the corporate level has gained an enormous amount of traction, with IBM, Ford, SAP, and Intuit among those that have implemented design thinking methods in their organizations. Case results such as those at IBM have indicated improvements not just in new top-line revenue, but substantial reductions in cost (IBM, 2018).

Another methodology is focused on gaining insight into the potential of an opportunity through experimentation, testing, and iterating with users, typically centred further along in the product development process than design thinking. These approaches are commonly referred to as lean startup methods (Ries, 2011). Lean startup methods have been in the minds of new ventures and more recently established firms because of the potential to increase the amount of knowledge related to a particular idea or product through low cost, iterative testing, and ultimate reaction to the test case. This incremental development, test, learn, and recalibrate philosophy has its roots in the practical works of Silicon Valley entrepreneur Steve Blank (Blank, 2013). The book, The Lean Startup (Ries, 2011), popularized the methods and exposed this thinking to the corporate world. Firms from medical devices to energy companies are trying to integrate these methods into existing processes, such as agile development.

However, from a research perspective backed by qualitative and quantitative studies, we still do not know the most effective way to implement these user focused design methods within the innovation process of organizations, the overall effect on innovation, the impact on process improvements, or which aspects of the design process are the most impactful in developing new opportunities. In this research, we propose a high-level conceptual process model on how user focused design methods such as design thinking and lean startup methods can be integrated into the up-front innovation process within organizations. This framework is the result of conceptualization of the design process from literature and observation/participation with an early design process integration study at a large organization. We contribute to the current state of knowledge by proposing ways in which two established methods can be combined in a novel manner to improve the up-front phases of the innovation process.

In this article, design thinking and lean startup methods are briefly reviewed. Then, research methods are detailed, followed by a discussion of the proposed process. We conclude with potential directions and questions on future research areas of interest to both academics and practitioners.

2 THE INNOVATION PROCESS

The NPD or innovation process has been studied extensively since the late 1960s. From the first studies of the Boston Consulting Group, through Project SAPPHO in the 1970s, through the various works of Robert Cooper starting in the 1980s (Kleinschmidt and Cooper, 1987; Cooper, 2008; Cooper and Sommer, 2016), nearly all aspects of the innovation process have been investigated, from teams to process controls. We know that the rate of product and service failure rates hover around 40%

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(Markham and Lee, 2013), so given the number of research and development (R&D) funds spent on developing new products and services, improving innovation outcomes is still an area that needs active academic and practitioner investigation. This research is of particular importance because those failure rates have not changed since the initial studies in the 1960s. However, over the last thirty years, research has shown what does work to improve innovation performance for those organizations that seek to implement specific processes and methods. A focus on the front-end of development — explicitly getting customer insight and early marketing work; iterative learning during development; a way to manage the process; and a properly executed launch (Cooper and Kleinschmidt, 1987; Cooper, 2017) — has been shown to improve innovation outcomes.

We segment the innovation process into three total phases, namely Discovery, Development, and Commercialization (Ulrich and Eppinger, 2015). While some NPD and innovation literature has more stages, the process can be distilled into three overall segments that contain fundamentally different activities and tasks. During the Discovery phase, ideas are generated, markets are scoped, initial business cases are developed, and ideas are developed into concepts. These are activities that Cooper (2005) terms 'doing your homework' to vet thoroughly the opportunity and concept, with a constant eye on the customer and market. During the Development phase, detailed design and engineering begin. Further market planning is completed, and prototypes for components and systems are completed. During Commercialization, final testing, design tweaks, and manufacturing set-up are completed for the product launch. Often, this process is reflected as a funnel, with more ideas being investigated during Discovery, then culled as the process matures, with less attractive designs being halted.

It is during the Discovery phase that both design thinking and lean startup methods are most naturally focused (Luchs, 2016; Lockwood, 2009). Both are designed to develop and gain user feedback on early idea generation, although some have argued the fundamentals of the processes are different (Fixson and Rao, 2014). However, each has its unique attributes and approach that we describe in more detail in the next sub-sections. Overall, both of these methods are designed to improve the quality of opportunities and ideas entering the innovation funnel, while simultaneously trying to improve and validate the overall concepts. The intention is that higher quality, vetted opportunities and ideas will improve the overall success of innovation efforts.

2.1 Design Thinking

Design thinking has drawn substantial attention from academics over the last 15 years as it has become increasingly embraced by practitioners. Micheli et al. (2019) found a nearly exponential increase in academic publication on design thinking since 2005. At its core, design thinking is human or user-centred. While there may be differences in implementation between IDEO, Stanford's d-School, and IBM, there are commonalities in approaches (Seidel and Fixson, 2013). One is the use of ethnography and field research to gain an understanding of people's actual behaviours. Ethnography is the study of people in their natural setting as a way of gaining empathy for and a rich understanding of their behaviour and point-of-view, which can help identify interesting insights into what they may need or benefit from (Micheli et al., 2018). Another common attribute of design thinking is a variety of systematic approaches to building on information from ethnographic investigation. These can include developing and framing users' traits through the use of personas, mind mapping the opportunity space, and structured brainstorming to create and sort ideas. The last common thread among different design thinking processes is experimentation, which may take the form of visualization and presentations, low-cost field experiments, and other ways to gain feedback on the opportunity, ideas and concepts (Gans et al., 2019). IDEO terms these phases inspiration, ideation, and implementation (Brown, 2008).

In her 2018 article, Jeanne Liedtka synthesizes the results of studying over 50 projects and suggests that design thinking can be as transformative to organizations as TQM was in the 1980s (Liedtka, 2018). She notes aspects from employee buy-in to sensemaking to experimentation as characteristics that make it so powerful. Company examples like the dramatic improvements in project time-to-market promoted by IBM, Ford's use of design thinking for the future of mobility, and the many projects noted by design firms like Continuum and Frog abound. However, recent research has questioned the overall ability of design thinking to deliver truly innovative ideas (Iskander, 2018).

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Design thinking research has generally focused internally on development teams themselves, but given the potential of design thinking, how can users and stakeholders best be integrated into the overall NPD or innovation process within an organization? In research on the internal implementation of design thinking, these questions have not been adequately addressed. We formally synthesize this into the following research proposition:

Research Proposition 1: How might design thinking be best integrated into the overall innovation process of an organization?

2.2 Lean Startup Methods

Lean startup methods, popularized by the work of Eric Ries (2011) and Steve Blank (2013), espouse the concept of a more scientific approach to the development of startups. The lean startup method is centred on the idea of experimentation and validation (Blank and Dorf, 2020) through the use of a minimally viable product or MVP. The MVP is used to gather data from users and customers, evaluated, and changes to the concept or business model are then introduced. This data-informed change is the concept of 'pivoting' or changing direction based on this iterative feedback loop. Recent research has indicated that this informed, hypothesis-driven approach to startup development can help entrepreneurs pursue more promising ventures (Felin et al., 2019).

In organizations, having teams develop concepts and test them more extensively can be useful, particularly during the Discovery phase and part of what Cooper (2006) describes as the up-front 'homework.' The MVP is a crucial attribute and is where design thinking and lean startup methods overlap. Many design thinking processes discuss this prototype phase as low or zero cost. The ExperiencePoint and IDEO design thinker innovation simulations ask teams explicitly to develop a prototype for feedback that can be constructed, tested and deployed in less than an hour and for less than $100. On the plus side, this can push teams to distil their concepts to their most basic elements. The lean startup also has ties to agile processes, where customer feedback on core features is essential.

However, there are questions to be answered by research to give a complete story of how best to implement lean startup methods, particularly in engineering organizations. In the startup realm, recent research suggests that a more well-defined plan of action is needed, rather than a series of low-cost experiments and pivots (Felin et al., 2019). That may indeed be the case in zero-stage ventures, where decisions can mean a binary outcome of making it to first revenue or ceasing existence. In established organizations, the situation is different, and low-cost experiments can help inform decisions and directions on very immature projects. However, what type of low-cost experiments would be the most useful needs more examination. What are the most impactful MVPs for the development of an opportunity within organizations? And what level of complexity and cost best inform the innovation process? Taken together, these questions on lean startup integration within NPD bring us to our second research proposition:

Research Proposition 2: For established organizations, how might lean startup methods such as MVPs best be integrated into the development process?

2.3 Integrating Design Thinking and Lean Startup Methods in Organizations

Fundamentally, design thinking and lean startup methods hold enormous promise to be integrated into the innovation process together. One could argue that they are best integrated into the first phase of the innovation process to allow new ideas time and validation to mature. Traditionally, stage-gate, by its nature, is designed to stop unproven or underwhelming projects from moving further into the process. While this is beneficial from a project control and management perspective, it can eliminate those more innovative projects that do not conform to the firms' preferred plans, business models, and existing markets. Design thinking and lean startup methods operate to improve idea quality and then gain insight into the quality of that idea before committing to expensive design and engineering. These methods include multiple steps such as ethnography, structured brainstorming, and building prototypes that organizations will need to perform, manage, and integrate into existing processes. This brings us to our last research proposition. Stated formally:

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Research Proposition 3: How might design thinking and lean startup methods be integrated together in an organization's more established innovation processes?

3 RESEARCH METHODS

This research represents an investigation into design thinking and lean startup methods and how they can integrate into the design innovation process with a focus on engagement with users and stakeholders. To accomplish this task, this study uses a mix of digital ethnography, business historiography, and ethnographic, embedded participant observation of an organization's project. A multi-method approach allows this research to triangulate observations and viewpoints (Given, 2008; Collier & Elman, 2008; Creswell, 2003). Following the recommendations of Yin (1994), we studied in-depth one organization as it developed a design innovation process. Weekly process design meetings were observed for a period of three months. In addition, three prototyping workshops on the design process were held with a total of 23 participants. Coding was performed in real-time with the research team. Studying one organization allows for the development of a deep understanding of how an organization operates (Tripsas, 2009). We approached this research at the project-level, which is a preferred method for studying innovation and the associated activities and tasks that support it (Bunduchi, 2017; Barczak, et al., 2008; Devaraj and Kohli, 2003).

4 RESULTS AND DISCUSSION

In scoping how design thinking and lean startup methods could be integrated into an organization's opportunity development efforts, we propose the following high-level conceptual process, as a framework fitting the developing innovation process we observed. An innovation process that integrates design thinking, lean startup methods, and agile development can be conceptualized with two fundamental phases as shown in Figure 1.

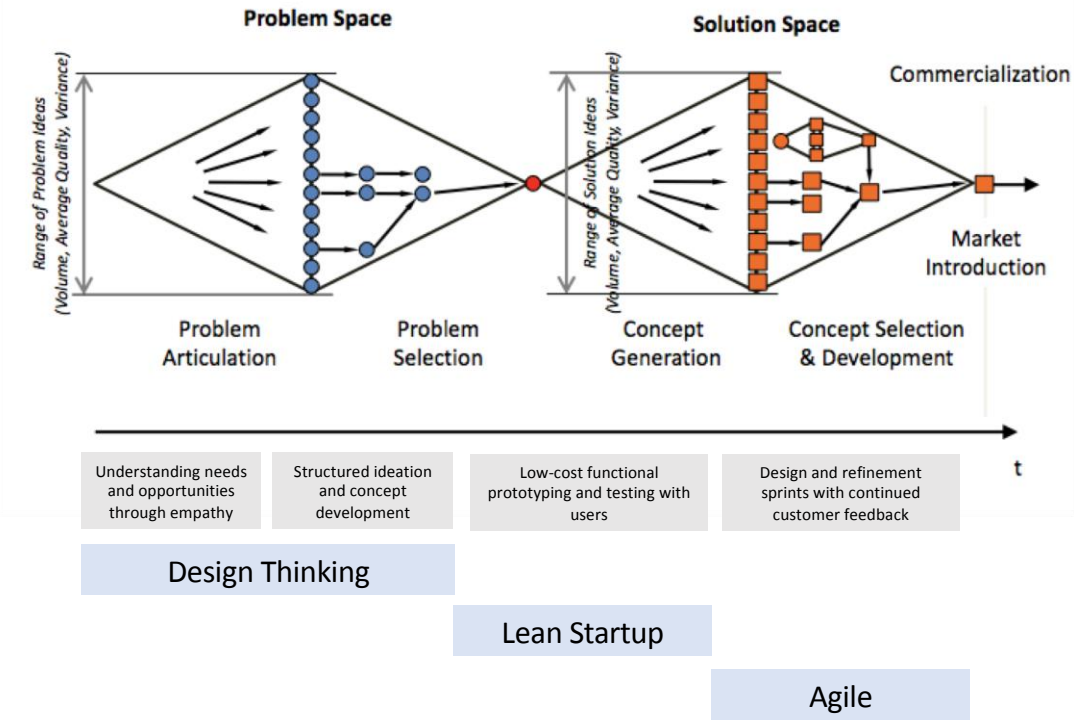

Figure 1. Innovation process noting the problem space and the solution space (Marion and Fixson, 2018).

On the left side of the diagram is the Problem Space, which involves identifying promising opportunities, articulating them, and then selecting the most promising candidates. This part of the process, often referred to as the 'fuzzy front-end,' encompasses investigation into user needs, the market, and business and technology strategy (Cooper, 2005). On the right side of the diagram is the Solution Space, which involves developing concepts, selecting or combining them into a single

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project, and designing and engineering the project to bring it towards commercialization (Marion and Fixson, 2018). Within these two spaces, fit the overall frameworks and activities of innovation. Moving down a level of detail are the activities that comprise both design thinking and lean startup methods that align with and inform problem articulation, problem selection, concept generation, and concept development. For this conceptual research, we investigate: understanding user needs (problem articulation); approaches to structured ideation (problem selection); low-cost prototyping (concept generation); and design and refinement sprints (concept development).

4.1 Problem Articulation, User Needs and Selection

In this design process model, the purpose of the problem articulation activities is, as just noted, to bring an appropriate breadth and depth of contextual knowledge into the early problem formulation stages of this innovation process. It is true that this sort of knowledge-gathering takes place, to some degree, as part of design thinking or lean startup processes. But, for organizations, our research leads us to hypothesize that background knowledge gathering is often insufficient, if just interleaved with other activities like rapid ideation, prototyping, testing, and such — especially for more complex projects.

Within Problem Articulation, a broad spectrum of technology and market trends should be analysed. More complex systems will have to take a large number of external factors into consideration and will tend to take longer to design and bring to market than is typical of design thinking or lean startup efforts. In gathering preparatory knowledge, it will be helpful to cast a wider net over the marketplace, and more and longer-term trends will need to be understood. Activities similar to these do typically take place as part of a firm's ongoing technology and marketing strategy development (Schilling & Shankar, 2019). But they may not be as sharply-focused to explore specific problems, or as directly connected to a specific design effort, as would be needed for identifying promising opportunities. Their lack of connection to specific design efforts is suggested in common descriptions of the design process, where they are often just labelled as undifferentiated "experience" or "exploration," as inputs. (Cross, 2008 - chapter 3; Lewrick et al., 2018). Thus, they are given as up-front preparatory steps, an explicit part of this conceptual process, rather than as assumed background.

Gaining deep insight into behaviour and non-obvious user needs is a central tenet in design thinking. This can be accomplished through field research, observation, interviews, and other qualitative methods. As already noted, ethnographic approaches are commonly employed. In this conceptual framework, we propose that each of these methods be used at the discretion of the design team. Industry examples include the development of the Insulet Omnipod via EPAM Continuum (EPAM Continuum, 2021). This complex project was driven by a deep understanding of a specific user group: active children with Type 1 diabetes.

For large organizations, and/or for complex projects, a greater variety of people, firms, and other stakeholders are likely to be important. These may be grouped and described not just as personas, but as archetypical firms and organizations, other market participants, and may also include, if appropriate, more general segments of society. As with personas, these are characterized, with an emphasis on their interests, needs, and functions, and on aspects of their economic or business drivers and constraints. This emphasis aligns with the first two areas in the Desirability, Viability, Feasibility viewpoints often taken in design thinking work. And, in a similar way, these help to balance concerns about technical feasibility that can often dominate early decision making in more complex projects.

4.2 Concept Generation, Selection and Development

4.2.1 Structured ideation and concept development

Ideation is designed to create multiple options which express the opportunity (Liedtka, 2015). These may take the form of raw ideas expressed as text or simple visual graphics. Common to this step are approaches such as small brainstorming teams working with sticky notes or virtual teams using networked collaborative software packages, including visual collaboration, project wikis, discussion fora, and the like. Different design techniques for ideation exist and can be useful in different contexts (Daly et al., 2016). While individual techniques vary, most are group-oriented. These may include brainwriting, design heuristics, and other analysis techniques.

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4.2.2 Low-cost functional prototyping and testing with users

As demonstrated by design thinking and lean startup processes, the value here of eliciting reliable feedback from users and stakeholders cannot be overstated. This may result from feedback on sacrificial concepts and associated prototypes. This phase is designed to have the user pre-experience something new or novel (Atance and O'Neil, 2001; Liedtka, 2015). At the core of lean startup methods (Ries, 2011) is the concept of a purely functional minimally viable product, or MVP. For more complex projects, prototypes may be a more abstract representation of the sacrificial concept, such as a storyboard or journey map. One option is to implement a strategy of maximizing the use of the latest digital tools and prototyping solutions. This may include digital renderings and other simulation techniques.

In this phase, these prototypes can be presented to users for feedback. Any feedback can then quickly inform changes to opportunity and sacrificial concepts. This can include feedback on overall scope, technical feasibility, etc. This open cycle of feedback and development iteration is an example of agile development. While not as formal as SCRUM (see scrum.org) methods for software development, this back and forth between potential customers and the design team is at the heart of agile methods. It is expected that once implemented, specific design sprints will be a feature of this phase of the process — again, supported by in-person or online collaborative software packages. Project communication and collaboration by team members should be intense (Marion and Fixson, 2020).

In terms of research proposition 1 (RP1), design thinking may be integrated directly into the very beginning phases of an organization's development process. This can include a broad field investigation with an extensive cadre of users that can help inform the process and early stages of problem articulation — a kind of mapping of the relevant territory. The development team can establish a close bond with potential users and partners through such activities as uncovering user needs, and listening to the particular requirements of specific applications. Once these relationships are formed, the interchange of information on project needs may extend further, become regular, and break down the traditional pre-contractual barriers between parties.

In terms of RP2, design thinking may have a substantial influence on the first phase of the innovation process. Design thinking is naturally tailored for this up-front stage. For lean startup processes, the focus on iteration and learning cycles is a match for the next phases of concept development, which includes concept generation, testing, and interfacing with users. The iterative approach with potential users can then mature as the project progresses. This includes continued refinement of the opportunity, with constant testing and feedback. Fundamentally, this transition from design thinking to lean startup to more agile methods of final development and execution can be integrated seamlessly.

In terms of RP3, we hypothesize that a sequential adoption and integration of these methods may prove successful. In a sequential adoption of these methods, a key to informing the project can be the development of close relationships with potential users, as just noted. This can allow more impactful insights on the application, future product plans, and gaps in competitive solutions. Design thinking by its nature is human-centered; the human relationships formed by this type of approach can build strong and forgiving bonds as a project progresses through a sometimes-messy development effort.

There are several theoretical and practical implications for integrating design thinking and lean startup methods into the design innovation process. One is that most organizations rely on a form of stage-gate (Cooper, 2019). Increasingly, methods like design thinking, lean startup, and agile are being integrated and embedded into traditional forms of innovation management. Cooper and Sommer (2018) found that agile methods and design thinking naturally pair well because of the iterative nature of concept development. These can be used sequentially at different stages in the process. However, many firms still separate design thinking initiatives from the traditional front-end of the design innovation process (Carlgren et al., 2016), rather than integrating fully into the overall process. Often, these can be in centralized innovation departments or labs whose mission is to innovate, but not commercialize. This can lead to problems with downstream attempts at selling promising projects, as the hand-off from central labs to individual business units can be challenging. The conceptual process

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described in this research shows how closely design thinking, lean startup, and agile can be blended into one process, with a specific focus on integrating users from beginning to end. Incorporating these methods may help foster better external relationships, which have been shown to improve innovation efforts (Knudsen, 2007).

This conceptual research illustrates that the process of concept development, prototype development, and interaction with users can be tightly integrated and fluid during the innovation process if design thinking and lean startup methods are linked together. Less formal and more frequent interaction with users can normalize the relationship sooner and break down some of the barriers that inhibit communication during development. Leading industry complex engineering examples that use this type of design thinking-based co-development methodology include Philips Healthcare, who use a process termed Cocreate (Philips Cocreate, 2020). Their process involves customers and users that Philips can 'innovate with, rather than develop for.' Philips has been a leader in design thinking application for over 30 years.

5 CONCLUDING THOUGHTS AND FUTURE RESEARCH

This article notes some of the potential of two methods that are designed to develop and vet new ideas for organizations. These two methods, design thinking and lean startup, are increasingly accessible to firms looking to improve their innovation process. In this research, we look at where these two methods might fit into an organization's overall development process. We examine a conceptual process, highlighting the idea that alignment with users across several segments of the process may be a strategy to accelerate opportunity development. The ability to identify opportunities, prototype and test them, and get early feedback on market potential can be an advantage to firms. Design thinking and lean startup methods may be paired to create an effective way to implement these strategies into the innovation process. The strengths of each of the methods in terms of customer needs, ideation, and development integrate well with a focus on user interaction.

Even with current research and the exponential growth in academic publications, there are still questions of best practices regarding implementation. One is a question with the organization itself. While firms like IBM have begun to have design thinking propagate throughout the organization, what is the best approach? Is it preferred to have implementation be similar to Six Sigma, with design thinking 'black belts' leading the charge? Or are specialized 'S.W.A.T.' teams within the organization to be used as a way to kick-start implementation? Lastly, what about implementing these methods within organizations developing complex systems engineering projects? There is little research that shows how well classic design thinking and design process methods for NPD can be applied to Large-scale Complex Engineered Systems (LaCES) which are usually developed in large organizations using expansive teams. LaCES include aerospace (e.g., aircraft, space systems), large maritime (e.g., submarines, aircraft carriers), nuclear (e.g., power plants), and major civil infrastructure systems (e.g., water supply systems, electric power grids, offshore oilrigs, and air and ground transportation systems). These systems require hundreds to thousands of engineers and scientists working over many years and in many locations to design and complete them. The current research is limited to theoretical comparisons of systems thinking and design thinking (Buchanan 2019) and the articulation of what makes a designer a good systems thinker (Dym et al., 2005; Frank, 2012; Greene and Papalambros, 2016). Our future research, using both qualitative and quantitative methods, will seek to shed light on this topic for integration of design innovation methods in the development of complex systems.

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