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Design-Centered Entrepreneurship: A Four Stage Iterative Process for Opportunity Development

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We advance a design-based approach to developing opportunities—Design-Centered Entrepreneurship—based on the principles and practices of design. In doing so, we extrapolate a conceptual model for how design can be applied to opportunity development in order to maximize viability while also managing risk. We detail how ideation, prototyping, market engagement, and business modeling can promote aspects of opportunity development. Perhaps most importantly, we highlight the value of working towards a 'proof of concept' and how concept feasibility, desirability, and viability advance a milestone approach to entrepreneurship research. We detail key learning mechanisms that promote effectively converting ideas into form and offer propositions to advance future design-centered entrepreneurship scholarship.

Keywords: Design-centered entrepreneurship; opportunity development

Nous mettons en avant une approche conceptuelle de développement d'opportunités commerciales – Entrepreneuriat centré sur la Conception – qui est basée sur les principes et les pratiques de la conception. Ce faisant, nous extrapolons un modèle conceptuel montrant comment la conception peut être appliquée au développement d'opportunités afin de maximiser la viabilité tout en gérant les risques. Nous décrivons en détail comment la conceptualisation, le prototypage, la participation au marché et la modélisation économique peuvent valoriser les caractéristiques du développement d'opportunités. Mais peut-être est-il plus important de signaler que nous soulignons la valeur de la mise en œuvre d'une « démonstration de faisabilité » et comment la faisabilité, la désirabilité et la viabilité d'un concept font progresser une approche par étapes de la recherche sur l'entrepreneuriat. Nous décrivons les mécanismes clés d'apprentissage qui favorisent la conversion effective d'idées en réalités et offrent des propositions pour faire progresser les connaissances sur l'entrepreneuriat centré sur le concept.

Mots-clés : Entrepreneuriat centré sur le Concept; développement d'opportunités

Introduction

How can individuals with limited knowledge of relevant domains (for example, industry technologies, market processes, or customers) turn an idea into a viable new product? After all, many nascent entrepreneurs lack the resources, contacts, and experiences that allow seasoned entrepreneurs to quickly roll out products and services. The design approach offers a prescription for addressing this issue. Design is the process through which ideas are manifested. An important concept in design is the idea of the 'outsider's

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perspective.' Design theory emphasizes that a lack of knowledge can, under the right direction, provide this outsider's perspective which can benefit the new market entrant. In fact, an outsider's perspective can be advantageous as it reduces the local search bias and provides a basis for the systematic application of design techniques that aid in the development of novel products (Helfat 1994; Von Hippel 1994; March 1991; Martin and Mitchell 1998). Indeed, some research has shown that highly knowledgeable and experienced industry professionals are often conditioned by past success and mental models that ultimately constrain their creativity (Baron and Ward 2004; Baumol 2002; Hayward, Shepherd, and Griffin 2006; Ward 2004). NASA's JPL (Jet Propulsion Laboratory) Studio relies on its designers' outsider perspective on the science and engineering in order to make non obvious connections and discoveries (Balint and Freeman 2017). The concept of the outsider's perspective is widely recognized outside of academic literature as well, as evidenced by the popularity of idioms such as 'a fresh set of eyes' and 'too close to the problem.' If it is true that an outsider's perspective and design techniques work together to aid in the development of novel products and it is also true that industry professionals, embedded in their mental models, are creatively constrained, then it follows that individuals (outsiders) who are not so constrained, and who apply design techniques to their businesses, may create more novel goods and services. Considering the surge of entrepreneurship in high schools and universities around the world (Kuratko 2005; O'Connor 2013) and the promise of entrepreneurship to economic growth (Baumol 2010), society may benefit from a large number of nascent entrepreneurs who have outsider perspectives.

We contribute to the entrepreneurship literature by putting forward an approach we call 'design-centered entrepreneurship' that applies the principles and methodologies utilized in the design fields to opportunity development. Design is a process that shapes and converts ideas into form, whether that is a plan of action, an experience, or a physical thing (Simon 1996). In this paper, we review key aspects of the design process, explicating design methods and techniques across an iterative opportunity development process, and detailing how ideation, prototyping, market engagement, and business modeling can promote aspects of opportunity development. Deconstructing opportunity development into four stages, we are able to focus on sequential and accumulative milestones vital to the process—including concept feasibility, desirability, and viability. We introduce an applied conceptual model of design-centered entrepreneurship with propositions focused on how specific design techniques will promote opportunity development milestones. Perhaps most importantly, this design-centered approach emphasizes 'proof of concept,' which has not received adequate attention in the entrepreneurship literature, and our paper offers prescriptive guidance to those interested in enabling individuals with limited knowledge to create viable new products.

The paper unfolds along the following lines. In the next section, we present a theoretical argument for why the integration of the design approach is beneficial to understanding opportunity development. A conceptual model of design-centered entrepreneurship is advanced with propositions linking specific design techniques to sequential opportunity development milestones. The paper concludes with implications for research and practice.

Opportunity development and the nature of design

The term 'opportunity development' represents both a dynamic and iterative view of how opportunities reach venture form and reflects the gradual 'polishing' of what was initially

an unpolished idea (Dimov 2007a, 2007b). A variety of terms have been used to describe entrepreneurial opportunity including opportunity recognition (Baron 2006), opportunity discovery (Shane 2000), and opportunity identification (Shepherd and DeTienne 2005). Some have theorized that opportunities are objective — that is, they exist in the world separate from the entrepreneur waiting to be discovered (Kirzner 1973). However, there is growing support for the idea that opportunities are not separate from entrepreneurs; rather, it is the entrepreneur who develops opportunities (Sarason, Dean, and Dillard 2006).

To shed light on 'how' individuals, or teams, can effectively progress the opportunity development process, we borrow from the cross-disciplinary perspective of design (Eekels 2000). Principles of design have been extensively utilized in engineering, architecture, urban planning, and industrial design, among other areas of applied science. Regardless of their perspective, scholars and practitioners uniformly agree that design is a process that shapes ideas into form.

Design and the learning imperative

We define '*design*' as the learning process that shapes and converts ideas into form, whether that is a plan of action, an experience, or a physical thing (Simon 1996). At the heart of the design process is the shaping of a concept through 'learning.' Expert designers often begin the search for viable solutions as novices, but through the iterative process learn the language, issues, critical success factors, and constraints inherent in the domains of interest (Emerson, Fretz, and Shaw 2011). As a result, they gain knowledge of and credibility within the problem space. All mistakes and failures are to be seen as opportunities to learn and adapt. While the importance of learning in the process is vital, the design approach provides specific learning mechanisms and other principles important for converting ideas into form. For example:

- Learning from qualitative research—Designers expend significant time and energy to comprehend the nature and dynamics of a problem space through a series of events called a 'deep dive' (Kelley 2005).
- Learning from prototyping—Designers develop solutions based on what is learned from immersion in a problem space. A defining aspect of design is the creation of prototypes, which are physical representations of the solution (Cross 2011).
- Learning from feedback—Designers seek the feedback of others who may have insight into the efficacy of the solution (Dougherty 1992).

These specific sources of learning are critical to converting ideas into form. It should be noted, however, that while a learning orientation is helpful throughout, design relies, in part, on intuition. As opposed to mechanistic problem solving in which one solution is right, design is an intuitive problem solving process with many possibilities for what may constitute a good solution.

Design: a path for opportunity development

The initial starting point for all good designs is a concept. A concept is an idea for how to solve a problem, or provide a new benefit, in a way that can guide design decisions. In most cases, a concept is derived from an identified customer problem or customer need—sometimes referred to as the problem definition. Most often, specific users or customers

and their specific problems are the focus of good design concepts. Domains and stakeholders that appear relevant to the problem are targeted for exploration and study. It is important to keep in mind that a defined problem and a new concept for solving that problem are only starting points. The business concept may change as knowledge is gained during the design process (Aulet 2013; Atuahene-Gima, Slater, and Olson 2005; Huston and Sakkab 2006; Katila and Ahuja 2002).

One way business concepts (as well as products and services) can change is through iteration. Among the greatest promises of design principles is the iterative milestone-based approach used to transform ideas into form. For example, before there is a well-defined problem to solve, designers begin their work at the 'fuzzy front end' of the process (Smith and Rinertsen 1992, 44). As Griffin et al. (2009, 225) explain, 'The fuzzy front end is the messy "getting started" period when the concept is still very fuzzy.' Iterations are the repeated acts of capturing, digesting, and addressing the feedback and suggestions of others to incrementally modify a solution (Goldsby and Nelson 2012). The learning and understanding that comes from iterations reduces the fuzziness of the problem space being studied.

The challenge for designers becomes taking an initial concept idea, moving it forward, and developing a proof of concept that eventually elicits predominantly positive feedback from relevant stakeholders. To accomplish this, several overlapping criteria must be met including concept feasibility, concept desirability, and concept viability (Menold, Simpson, and Jablakow 2016; Brown 2009). These are the area where design principles, such as iteration can be applied.

- Proof of concept feasibility—Answers the question of whether a potential solution can be produced or is functionally possible within the foreseeable future.
- Proof of concept desirability—Answers the question of whether a potential solution is desirable to specific users or customers. In other words, does the solution meet or exceed customer expectations? Form, function, and aesthetics are considered, as well as seamless interaction with user behavior.
- Proof of concept viability—Answers the question of whether the concept can produce viable economic outcomes. Concept viability addresses the financial reality of a solution.

Simply put, successful design has taken place when a proof of concept evidences that a product or solution can be made, that it is desirable to customers, and that it makes financial sense. It is largely up to the discretion of the designers as to what feedback, learning, and suggestions they choose to use in iterative versions of their solutions. Consequently, designers make judgment calls as to when good, better, or best solutions are reached. Gestalt moments of insight and understanding (Rindova, Ferrier, and Wiltbank 2010) affect the process and indicate when a solution is ready for implementation (Aboulafia and Bannon 2004).

Among the limited resources entrepreneurs are often faced with is domain-specific knowledge. We argue that design-centered entrepreneurship is an approach that can assist with overcoming a lack of specific knowledge to facilitate the development and fulfillment of venture opportunities. If we take the view that venture opportunities are an artifact designed by an entrepreneur, design principles can guide the startup process. In the following section, we explain how a design approach is beneficial to entrepreneurs, regardless of background or experience, in starting businesses.

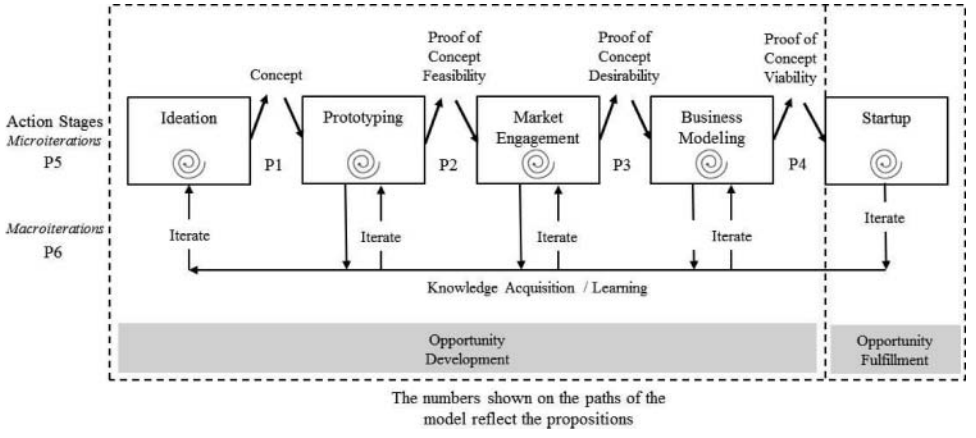

Figure 1. Design-centered entrepreneurship.

Explicating design-centered entrepreneurship: a conceptual model

Figure 1 introduces the design-centered entrepreneurship conceptual model. In essence, the entrepreneur applies design methods in four action stages of developing an opportunity. Ideation involves taking action to learn what the customer problem is and generating an initial solution that culminates in a venture concept for further development. The prototype action stage addresses the technical issues of the concept, and ensures that a feasible product or service can be made and delivered. The market engagement action stage refines the concept for the customer, as well as contributing to the acquisition of knowledge, or learning, from early users. The business model action stage completes the development of the opportunity by identifying the varying components of the model that will need to be in place for the concept to be financially viable. Once the entrepreneur has developed a business concept that appears feasible, desirable, and viable, startup activities bring about the fulfillment of the opportunity.

Utilizing design principles and methodologies within each action stage aids in creating a distinctive proof of concept that assists in developing a venture idea. Microiterations are continuously performed to move the artifact closer to the intended outcome of each action stage. The first action stage creates a concept that intellectually engages the entrepreneur and their relevant stakeholders and warrants investing resources to pursue further. The second focuses on prototyping and the practical realities that will have to be addressed to prove the concept is technically feasible. The prototype is presented to potential customers in the third stage of design-centered entrepreneurship, and their feedback enables the entrepreneur to iterate the concept further. When the concept is deemed desirable by potential customers, the entrepreneur systematically addresses the different components of a business model to ensure the concept is economically viable.

As the entrepreneur enters a new action stage of opportunity development, they may learn that their previous concept has problems, in which case they may decide to undertake a macroiteration by reverting back to an earlier stage of the process. We should point out that design theory does not view a macroiteration back to an earlier stage as a negative event. Also, although the entrepreneur is *informed* by the feedback of stakeholders in deciding how to build a product or service, it is not design by consensus. This distinction is vital. Succeed or fail, it is usually the entrepreneur, and only the entrepreneur, by right of his or her own unique investment in the venture concept, who decides what will be

developed and what will not. Additionally, each action stage brings knowledge gathered about the market that can be helpful in reshaping and adding value to an idea.

Design-centered entrepreneurship is iterative, which broadly includes two types: microiterations and macroiterations. Microiterations take place 'within' each action stage, in an effort to improve the outcome of each stage. Conversely, macroiterations involve moving from one particular action stage back to a previous stage for further development to address issues or new possibilities. Both microiterations and macroiterations involve taking action, learning, and refinement. Design theory views microiterations within a stage and macroiteration back to an earlier stage as beneficial to the process. All iterations reveal new knowledge that can contribute to the concept's future success.

In the following sections, we discuss each action stage of design-centered entrepreneurship and put forward propositions to guide research and practice. We review the action stages, the outcome pursued in each stage, and how the design principles and practices can be applied throughout.

Opportunity development

Design-centered entrepreneurship begins within opportunity development. The objective of opportunity development is to create an opportunity that can be used to start a venture. In doing so, the entrepreneur proceeds through specific action stages of developing a venture concept, building a model of the company's product or service, ensuring there is a customer for the product or service, and evidencing economic value for the company through a comprehensive business model. Each stage involves taking action and learning, and we outline specific mechanisms to promote these outcomes. Once an aspiring entrepreneur has passed through these four action stages making up opportunity development, the resulting proof of concept enters opportunity fulfillment where startup activities initiate.

Ideation

The first action stage of developing an opportunity is to create an initial concept of a potential solution to a customer problem. This may involve a product, service, a new way of doing something, or something in between. The concept should involve resolving customer frustrations or provide them with new possibilities. What often starts in the design process is transformed into a new possibility. A person utilizing a design approach enters a domain and proceeds to have 'a reflective conversation with the situation' (Schön 1983, 151). Kelley (2005, 21) captures this approach saying, 'You have to get out of the office, corner the experts, and observe the natives in their habitat.' The situation within an entrepreneurial context is a customer's problem space that is to be studied and understood (Newell and Simon 1972). Problems in a problem space are challenges to be solved (Basadur 2016), and are either well-structured or ill-structured (Voss 2014; Simon 1977). Well-structured problems have an orderly nature to them with existing solutions available, whereas ill-structured problems, also known as 'wicked problems' (Churchman 1967), are more ambiguous and incur greater effort in solving them (Dorst 2006). Solutions for ill-structured problems are difficult to conceive, but once developed are considered more innovative and have the potential for more economic value (Newell and Simon 1972).

An entrepreneur's reflective conversations in a problem space during the ideation stage will focus on generating an understanding of customers, their problems, and

possible solutions for them. These conversations happen primarily with potential customers on one hand, and subject matter experts on the other. Many design-oriented firms utilize field research and ethnographic methods to understand customers in a problem space (Rosenthal and Capper 2006). Field research requires getting close to customers through 'a deep immersion in others' worlds in order to grasp what they experience as meaningful and important. With immersion, the field researcher sees from the inside how people lead their lives, how they carry out their daily rounds of activities, what they find meaningful, and how they do so' (Emerson, Fretz, and Shaw 2011, 3). While many other search processes exist, the core objectives at this stage are: (1) to become acculturalized and accepted into the market and; (2) to garner deep insights into how consumers experience products or services, currently deal with problems, and interact with their environment (Rosenthal and Capper 2006).

Proposition 1a: *The use of (ideation activity) customer field research will lead to venture concepts that customers are likely to want, need, and prefer.*

Experts on the problem space are another valuable source of information in the ideation stage. Experts are anyone who may have extensive knowledge about the customer, problem, and/or existing solutions, but can also be expanded to include external problem solvers from analogous domains who can offer novel solutions overlooked in the industry (Rosenkopf and Nerkar 2001; Stuart and Podolny 1996). Pyramiding is a particularly effective method for finding and learning from experts on a range of subjects (Stockstrom et al., 2016; Poetz and Prugl, 2010). It is a search process based on the premise that 'people with a strong interest in a topic or field tend to know people more expert than themselves' (Von Hippel, Franke, and Prugl 2009, 1397). With some persistence, most entrepreneurs should be able to find an expert in a field to interview. Once this initial step has been accomplished, the entrepreneur can initiate a 'search on the fly' by concluding the interview by asking the expert, 'Who in your organization or elsewhere do you think has more insight on this problem?' (Poetz and Prugl 2010, 899).

Experts at the top of the pyramid will typically suggest an expert in an analogous field, since they may not be aware of anyone having more knowledge in their own domain (Von Hippel 2005). The movement from one domain pyramid to another offers divergent possibilities for new insights into the problem space, and, in the process, the entrepreneur learns the vocabulary and perspectives of the experts. With a thorough immersion, an entrepreneur gains trust among relevant stakeholders by speaking their language. Engaging stakeholders in this way will later prove useful when the entrepreneur seeks resources and support for starting the business. After entrepreneurs understand who the customers are and what problems they have, they can turn to studying the solutions companies currently provide. Entrepreneurs need not start from scratch in generating solutions.

Proposition 1b: *The use of (engaging with experts) customer field research will lead to venture concepts that customers are likely to want, need, and prefer.*

Prototyping

Once a concept is developed that appears to recognize an interested customer, a significant problem that that customer has, and a solution for that problem, the entrepreneur will develop the idea into a more advanced form in the prototyping stage. Design thinking involves 'thinking with the hands' (Pallasmaa 2009, 1). Once future entrepreneurs develop concepts they must not merely work with the idea in their minds, but give it physical representation as well. Cross (2011, 12) notes that, 'The activity of sketching,

drawing or modeling provides some of the circumstances by which a designer puts him- or herself into the design situation and engages with the exploration of both the problem and solution. There is a cognitive limit to the amount of complexity that can be handled internally; sketching provides a temporary, external store for tentative ideas, and supports the 'dialogue' that the designer has between problem and solution.'

A prototype, therefore, is a physical representation of an idea that illuminates with rich detail what the entrepreneur hopes to sell. It is not necessarily the actual product or service, but is constructed with enough specificity to provide clarity of intent of what it will be (Aspelund 2014). As such, it is useful for attaining valuable feedback from experts and customers. After the prototype has been shared with these stakeholders, entrepreneurs capture and digest what they have learned, and then address the feedback in their next microiteration. The pyramiding method can once again be applied by revisiting experts and customers and searching for others who may have insights on new developments. Continued visualization, modeling, and testing take place until the proof of concept receives feedback that is more positive in nature. Positive feedback from customers indicates that the idea is feasible from a market perspective. The incremental improvements that arise from prototyping blend the entrepreneur's new concept with existing market expectations. Balancing the new with the tried and true is the ultimate design challenge (Kuratko, Hornsby, and Goldsby 2011).

Prototypes that receive approval from experts on the practicality of the concept will demonstrate proof that the idea is technologically feasible. If the experts contend that the concept is not grounded in the reality of what is needed to bring it to market, the entrepreneur should consider going back to the ideation stage and reexamining their concept. However, if a prototype is compelling, and seems possible, then the entrepreneur is warranted in moving forward and engaging customers with the concept.

Proposition 2: *Prototyping facilitates concept feasibility.*

Market engagement

In business, a desirable product, service, or business idea is one that makes money. At some point after the initial iterations of concept development and during prototyping, it will become necessary to bring the concept and its eventual customers together in order to determine if the concept is desirable. An important criteria for meeting proof of concept status in this stage is that the product or service is appealing to a customer. In the market engagement action stage the process is more art than science. Customers make judgments in this stage at a more emotional, non-cognitive level, as a well-designed concept just 'feels right' and elicits positive responses (Norman 2004). Creating a concept that generates a positive emotional response from customers will serve as an indicator that the concept is working. When the market is completely defined this is often referred to as test marketing (Nijssen and Lieshout 1995), but if the market is, to some degree, undefined, then this consumer testing can potentially be used to alter the eventual target market, as well as the product. At this point, neither the product nor its market is completely defined. According to Bhattacharya, Krishnan, and Mahajan (1998), this real-time adaptation of the product definition process to the market (and vice-versa) resolves uncertainty. Thus, the product and the market are iteratively created. We refer to this process as market engagement; that is, the concept is being iterated through engagement with potential customers.

Defining an ideal customer so precisely allows the individual to make vital product and marketing decisions (Aulet 2013). The entrepreneur can now possibly determine how big his potential market is, and just contact a sample of those potential customers who would benefit from his product and determine their level of interest. This assessment allows him to first come to a decision on price, and second to determine if, at the specific price his customers are willing to pay, if it is profitable to produce the product as planned. If it is, production will commence soon. If not, the entrepreneur must consider other options to engage the market and can continue with product prototype iterations, redesigning the product in a more economical manner, or increasing the value proposition in some way. Alternately, the entrepreneur could redefine the market somehow. When customers have been found that evidence strong interest in the product, proof of concept of customer desirability has been met and the entrepreneur considers other components of bringing the business into existence.

Proposition 3: *Market engagement increases concept desirability.*

Business modeling

Through the ideation, prototyping, and market engagement action stages the entrepreneur collects, analyzes, and reflects upon gathered information in order to begin to develop an idea about how the nascent venture should work. Using what he or she has learned, a business model can be proposed. This model can then be iteratively improved, just as the product or service idea was (and will continue to be), resulting in a proof of concept for the business model (Martins, Rindova, and Greenbaum 2015). The important criteria for meeting proof of concept status in this stage is that the product or service is feasible from an economic standpoint. Because the business model helps to explain how a venture is expected to create a profit (Afuah 2000; Chesbrough 2003; Hedman and Kalling 2003), it can be both a barometer of the business's feasibility, and a second, concomitant place to employ the design concepts mentioned above. Specifically, the value proposition portion of the business model, once determined, gives the entrepreneur some idea as to the eventual profitability of the enterprise. And the value proposition can be iteratively modified, in conjunction with the product or service being designed, in order to maximize overall value.

A narrow viewpoint of the business model would conclude that the business model is simply the value proposition, but a more thorough review of the literature finds that the term 'business model' can refer to a range of ideas from 'how a company does business' (Gebauer and Ginsburg 2003) to an emphasis on an inclusive model (Osterwalder 2004). A popular framework for business models, and one especially good for a design-centered approach, is provided by Osterwalder, Pigneur, and Tucci (2005). It presents a company's business model as typically addressing nine components: key activities, key partners, key resources, cost structure, customer relationships, customer segments, value propositions, channels, and revenue streams. Developing a business model using these building blocks as guidelines results in a thorough business model, which can be iteratively designed by modifying individual components as needed in order to 'fit' the model to both the market and the product.

Proposition 4: *Business modeling increases concept viability.*

Opportunity fulfillment

Once an acceptable fit has been achieved, the entrepreneur can feel comfortable moving into startup activities and the opportunity fulfillment phase. This does not mark the formal end of incremental improvement of any aspect of the development process, but it is an important transition from a primarily internally focused (our company, our product) set of activities to a more externally focused set, briefly described below. Opportunity fulfillment is the process of exploiting the developed opportunity and enacting the created business model. The enactment of a business model (starting a venture) typically demands an aggressive entrepreneurial strategy with a singular focus on launching the venture (Kuratko 2009). This typically begins with the accumulation, development, and expansion of resources needed to bring the concept to market (Chandler 1962). These resources include human capital such as a management team and other external stakeholders, and physical capital such as funding, land, and equipment to complement the previously developed intellectual capital (the business model). Paramount during this stage tends to be marketing and financial considerations (Covin, Slevin, and Heeley 2000).

To organize and assist with this task a formal business plan is often written and followed. In addition to organizing and formalizing the business model and searching for capital, the business plan also delineates the enterprise's general philosophy, mission, scope, and direction. It is not within the confines of this paper to detail startup activities. However, it is our contention that the developed opportunity will be a good foundation for building the business having used the design approach.

We contend that design-centered entrepreneurship is an iterative practical approach beneficial to progressing the overall process and proof of concept—to a point. However, it is important to note that these iterations vary in terms of microiterations and macroiterations and their implications may vary. We expect an iterative approach to be initially beneficial in terms of both microiterations (that is, within each action stage) and macroiterations (that is, returning to previous action stages). However, we assert that there will be a reduced benefit to iterations at some point. As discussed in the Lean Startup methodology (Ries 2011), developing a minimally viable product requires action to avoid over-iteration. Therefore, we conclude our model with the following two propositions:

Proposition 5: *The relationship between microiterations and opportunity fulfillment is curvilinear (inverse U-shaped).*

Proposition 6: *The relationship between macroiterations and opportunity fulfillment is curvilinear (inverse U-shaped).*

Conclusion

From Edison's famed discovery of 10,000 ways not to make the incandescent light to Google's ever developing value proposition, opportunities rarely present themselves fully formed. Simple or complex, made or found, well or ill-structured, opportunities are messy, incomplete, and imperfect. This paper introduces a design-centered approach into the entrepreneurial opportunity recognition literature as a prescription for this messiness. Further, this paper expands on the design-centered model of entrepreneurship by moving the conversation towards testing the efficacy of design processes in entrepreneurship. Processes to apply iteration, and propositions to guide testing have been offered at every transition in the model. All have potential to be useful to the entrepreneur in developing a

business. Perhaps most interesting is the idea of iterating a business model. Outside of the very broad lean canvas framework, this is unusual.

The application of design-centered entrepreneurship reduces the uncertainty surrounding entrepreneurial opportunity. In this paper, the design process is applied to a business idea to develop a proof of concept within an entrepreneurial context. By design standards, a successful proof of concept addresses technical feasibility, customer desirability, and venture viability (Brown 2009). Such a business design should prove to be advantageous when building a business and entrepreneurs will know they are close to proof of concept by such indicators as positive feedback and relatively minor criticism from relevant stakeholders. We encourage future studies to investigate the effectiveness of design-centered entrepreneurship by assessing perceived market value of the business concepts generated in opportunity development.

There are classroom applications for design-centered entrepreneurship as well. Entrepreneurial skills are quite often developed through practice, even in an educational setting. Because of the experiential nature of entrepreneurship, prescriptive research such as this has direct application for student entrepreneurs as well. Future research could include best practices for including design principles in entrepreneurship education, as well as investigation into the effectiveness of such inclusions.

In sum, our goal has been to detail a practical design-centered theory to opportunity development that applies the principles and methodologies utilized in the design fields. We reviewed key aspects of the design process and explicated design principles across an iterative opportunity development process. We detailed how ideation, prototyping, market engagement, and business modeling can promote aspects of opportunity development. Perhaps most importantly we highlight the value of working towards a 'proof of concept' and how concept feasibility, desirability, and viability detail a milestone approach for entrepreneurial practice. While we encourage a variety of approaches, we believe the design-centered approach holds great promise for enabling individuals, with limited knowledge, in their effort to turn ideas into promising ventures.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on Contributors

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