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OPPORTUNITIES AS ARTIFACTS AND ENTREPRENEURSHIP AS DESIGN

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We combine Herbert Simon's view of design with the common distinction between reality as discovered or created to develop experimentation and transformation as ideal types of entrepreneurial design. Building on the design tradition's view of artifacts, we describe how opportunities-as-artifacts iteratively develop at the interface between organized individuals and their environments, where more or less concrete instantiations are used to drive the process forward. By conceptualizing entrepreneurship as artifact-centered design, we provide an alternative to accounts inspired by economic theory, which have proven conceptually problematic and of limited practical use. We conclude by discussing how uncertainty can be defined and managed, the value of design as a conceptual anchor for entrepreneurship studies, avenues for future conceptual and empirical work, and how the design perspective naturally bridges theory and practice.

The nature of entrepreneurial opportunities, and in particular their relation to entrepreneurial action under uncertainty, is a matter of intense debate. The dominant view has long been that entrepreneurship concerns the discovery and exploitation of profit opportunities that exist independent of individuals because markets are not in equilibrium (Alvarez & Barney, 2013; Kirzner, 1973; Shane & Venkataraman, 2000; Venkataraman, 1997), whereas others have insisted that entrepreneurial processes can also create such imperfections (Alvarez & Barney, 2007; Baker & Nelson, 2005; Sarasvathy, 2003; Schumpeter, 1942; Wood & McKinley, 2010). Whether seen as preexisting causes or ultimate consequences of entrepreneurial action, most scholars have thus agreed on the basic definition of opportunities as constituting "lucrative market imperfections" (Alvarez & Barney, 2010; Davidsson, 2015; Dimov, 2011; Shane, 2012; Venkataraman, Sarasvathy, Dew, & Forster, 2012).

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Despite this high-level agreement, scholars have struggled to conceptualize opportunities in ways that can inform empirical research and guide entrepreneurial practice (Davidsson, 2015; Dimov, 2011). This problem turns on the twin facts that opportunities thus defined can only be known to exist after entrepreneurs have achieved success (Kitching & Rouse, 2017; Ramoglou & Tsang, 2016) and are so abstractly conceptualized that "it will always be possible after an opportunity is formed to describe the actions of a particular entrepreneur in both 'discovery' and 'creation' terms [which,] by themselves, are without empirical content" (Alvarez & Barney, 2007: 12). Consequently, while the opportunity concept can be used to characterize already successful entrepreneurial processes, it does little to guide or improve our understanding of entrepreneurial action leading up to successful (or unsuccessful) outcomes, which is arguably most appealing both theoretically and practically (Dimov, 2011). Many have therefore argued that retrospective accounts of entrepreneurship using abstract opportunity language at best add nothing (Kitching & Rouse, 2017) and at worst do substantial harm by obscuring our understanding of entrepreneurship as a concrete form of management under uncertainty (Foss & Klein, 2020).

These conceptual and pragmatic problems can arguably be traced to the opportunity concept's roots in economic theories (Shane & Venkataraman, 2000;

Venkataraman, 1997). However, much like theoretical physicists sometimes introduce concepts that make their theories work—such as Einstein introducing the cosmological constant into his theory of general relativity to keep the universe static in spite of gravity—opportunities were introduced to economic theories to describe the general tendency of markets to equilibrate (Kirzner, 1973). As a result, economists such as Kirzner have expressed surprise at management scholars' attempts to reify their abstract concept as part of concrete management theories (e.g., Kirzner, 2009; see also Dimov, 2011; Klein, 2008). Birthed from such a "fallacy of misplaced concreteness" (Korsgaard, Berglund, Thrane, & Blenker, 2016; Whitehead, 1925), it is not surprising that efforts to make conceptual and empirical sense of opportunities have failed to make much progress.

Acknowledging these challenges, management scholars have recently sought to make opportunities more managerially relevant by reconceptualizing them as concrete and inseparable from "what aspiring entrepreneurs do" (Dimov, 2011: 75), as relational and inconceivable "independent of a given context" (Venkataraman et al., 2012: 27), and as multifaceted and enacted in "a bundle of more or less clear opportunity perceptions and opportunity projections that become relevant in a variety of situations and for a number of different reasons" (Berglund, 2007: 269–270). By conceptualizing opportunities in relation to human aspirations and concrete situations, these efforts recall Herbert Simon's work on the sciences of the artificial, and in particular his account of design as involving "a relation among three terms: the purpose or goal, the character of the artifact, and the environment in which the artifact performs" (Simon, 1996: 5).

In line with these suggestions, the purpose of this paper is to conceptualize entrepreneurship as a form of design (Berglund, Dimov, & Wennberg, 2018; Dimov, 2016; Ding, 2019; Sarasvathy, 2004, 2008; Romme, 2016; Venkataraman et al., 2012), with special emphasis on how opportunities-as-artifacts iteratively develop at the interface between organized individuals and their environments. To unpack the opportunity concept, we make use of the design tradition's distinction between abstract artifacts and concrete instantiations (Hevner, March, Park, & Ram, 2004). This lets us elaborate how opportunities-as-artifacts exist simultaneously on a spectrum ranging from abstract ideas and visions to the gradually more concrete physical, digital, and narrative artifacts used to drive design processes forward. The value of bringing concrete and material artifacts into our analyses becomes evident if we consider the practice of entrepreneurship and then consider what role, if any, such artifacts may play in it (Leonardi, Nardi, & Kallinikos, 2012; Orlikowski, 2007). To illustrate, consider the following episodes from the development of Dropbox and the iPhone.

> The founders of Dropbox wanted to avoid waking up after years of development to see that nobody wants their product. Therefore, they decided to run a small experiment in order to test the most critical assumption, i.e., if most people have the problem of file synchronization and would give the product a try. They built a three-minute demo video and uploaded it to Hacker news together with a call to action to join the waiting list for the private beta program. The video "drove hundreds of thousands of people to the website", Houston reported after the experiment and continued, "our beta waiting list went from 5,000 people to 75,000 people literally overnight. It totally blew us away." With this experiment, the founders validated the most critical assumption that there was real interest in their product. (Gutbrod, Münch, & Tichy, 2017: 297–298)

In this case, the founders started with a relatively clear opportunity vision and experimentally tested its most critical assumptions by means of a video that detailed the planned feature set and user experience. In contrast, Apple acted on a less distinct opportunity vision. Consequently, the first iPhone was designed to make it easy for users, third-party developers, and others to help transform both it and the emerging smartphone category:

> In his MacWorld presentation, [Steve] Jobs not only collapsed three industry categories, but also sought the support of the user community by noting that Apple had designed its iPhone (e.g., keyboard instantiated in software) to allow for future generations within and outside Apple (e.g., the app development community) to easily add functionalities. In other words . . . affordances built into the iPhone platform would enable the iPhone to be "exapted" for functions through future distributed "reading and writing" never contemplated by Jobs. (Garud, Gehman, & Tharchen, 2018: 503)

In addition to illustrating the centrality of material artifacts to entrepreneurial design, these two accounts highlight the very different roles artifacts can play in such processes—that is, as means of experimentally gathering information and of engaging stakeholders in processes of transformation.

To flesh out this preliminary sketch of entrepreneurship as artifact-centered design, the paper is organized as follows. First, we discuss how natural and artificial sciences differ, specifically highlighting the latter's triadic account of design, in which artifacts are seen as purposively developed at the *interface* between *inner* and *outer* systems. Then, starting from the established distinction between reality as discovered or created (cf. Hacking, 1999; Searle, 1995; Alvarez & Barney, 2007), we outline two quite different approaches to entrepreneurial design that we call *experimentation* and *transformation*. The bulk of the paper is then spent combining existing entrepreneurship theory with insights from design, information systems, and practice theory in order to elaborate experimentation and transformation as ideal types that rest on fundamentally different assumptions regarding: the individuals involved in the venture and how they are organized (the inner system), the environments in which they operate (the outer system), and the design artifacts and design principles through which these are related (the interface). We conclude by discussing how uncertainty can be defined and managed; the advantages of the design triad over the nexus view as a conceptual anchor and integrative framework for entrepreneurship studies; conceptual and empirical avenues for future research; and how viewing entrepreneurship as design naturally bridges the gap between academic research and entrepreneurial practice.

SCIENCES OF THE ARTIFICIAL AND THE NATURAL

Most entrepreneurship research is conducted within a "natural science" paradigm (Dimov, 2016; Romme, 2016) that is premised on the assumption that by better understanding natural phenomena and how they relate to one and other we will be able to better predict what will happen in the future (Kerlinger & Lee, 1999; Simon, 1996). The term natural is here taken to mean phenomena that researchers treat as naturally existing and as governed by general mechanisms. As such, natural phenomena are not exclusive to the natural sciences (e.g., physics and chemistry) but can include phenomena studied by social scientists (e.g., economics and sociology) and humanists (e.g., history and philosophy) to the extent that they are treated as natural kinds. Examples from the entrepreneurship field include theories explaining how levels of social and human capital can predict entry into nascent entrepreneurship (Davidsson & Honig, 2003), and how self-efficacy can moderate the effect of perceived environmental state uncertainty on the number of opportunities entrepreneurs identify (Schmitt, Rosing, Zhang, & Leatherbee, 2018).

In contrast, scholars operating within a design paradigm (Gregor & Hevner, 2013; March & Smith, 1995; Simon, 1996; Vincenti, 1990) treat phenomena as artificial—that is, as designed to achieve particular goals in light of environmental circumstances. While unusual in the entrepreneurship field (see however, Berglund et al., 2018; Dimov, 2016; Ding, 2019; Romme, 2016; Sarasvathy, 2004, 2008; Venkataraman et al., 2012), this approach is quite common in other professionally oriented disciplines such as architecture, engineering, information systems, and medicine, where scholars are concerned not primarily with the world as it is, but as it ought to be in terms of better buildings, cars, databases, or medical treatments (Niiniluoto, 1993; Simon, 1996).

Design is unfortunately a term that carries heterogeneous connotations ranging from intuitive artistic creation and esthetics to disciplined engineering and analysis. However, from the perspective of the sciences of the artificial (Simon, 1996), all design is structurally similar in that it concerns the *interface* between *inner* and *outer* systems, where design is defined as the gradual development of an artifact that is made to fit with and thereby connects the two. To illustrate, the design of a knife as an artifact entails its gradual adaptation to the material from which it is made as well as to the material it cuts and the hand that holds it, all the while guided by the purpose of the designer (Simon, 1996: 6). Since goals and purposes are not always clear from the outset (Baldwin & Clark, 2000), design processes are frequently guided by quite abstract goals and vague notions of "interestingness" (Simon, 1996), which are themselves clarified with the aid of intermediate artifacts employed throughout the process (Schön, 1983; Vincenti, 1990). Our knife designer may thus start with a vague idea for a new kind of knife and then instantiate it in stories, sketches, mood boards, CAD designs, and physical models in order to reflexively clarify his or her thinking, solicit feedback and commitments from others, and more generally move the process forward (Lim, Stolterman, & Tenenberg, 2008; Schön, 1983). In design-oriented disciplines, such movement between parts and the whole is commonly described in terms of *abstract artifacts*, which are often quite vague concepts or ideas, and more *concrete instantiations* through which they are expressed and developed (Gregor & Jones, 2007; Hevner et al., 2004; Lim et al., 2008; March & Smith,

1995; Roozenburg & Eekels, 1995; Vincenti, 1990; Werle & Seidl, 2015; Winter, 2008). Data scientists thus develop abstract artifacts, such as procedures for data mining (e.g., Agrawal, Imieliński, & Swami, 1993), through an interplay between ideas, theories, pseudocode, and operational software adapted to both the internal workings of computers and the external structure of large databases (Gregor & Hevner, 2013). Architects similarly refine initially vague ideas for buildings by using artifacts ranging from "sketches made on pieces of hotel stationary" to increasingly complex digital and physical models adapted to both the "conditional, technical aspects of building" as well as "the context and the people" that will use it (Liedtka, 2000: 16; see also Comi & Whyte, 2018). Using architects as exemplars, Simon also described how the

> emerging design is itself incorporated in . . . sketches, floor plans, drawings of utility systems, and so on. At each stage in the design process, the partial design reflected in these documents serves as a major stimulus for suggesting to the designer what he should attend to next. (Simon, 1996: 92)

In sum, design concerns artifacts that are gradually developed at the interface of inner and outer systems, where more or less concrete instantiations—including narrative accounts, physical sketches, and digital models—are essential drivers of the process. Next, we combine this design triad with views of the world as existing and created to develop experimentation and transformation as ideal types of entrepreneurial design.

ENTREPRENEURSHIP AS DESIGN

In developing the design perspective of entrepreneurship, we take as our point of departure the established distinction between viewing the external environment as discovered or created (Hacking, 1999; Searle, 1995; cf. Alvarez & Barney, 2007), which translates into very different ways of conceptualizing and managing environmental uncertainty. Stated briefly, with a discovery view, uncertainty is epistemic in the sense that it is overcome through the discovery of information about an in-principle knowable and independently existing environment. With a creation view, uncertainty is instead ontological in the sense that it is overcome by creating the environment anew.

This is then combined with Simon's tripartition of design into inner systems, outer systems, and the artifacts designed at their interface. This distinguishing of opportunities-as-artifacts from both individuals and the environments in which they operate lets us theoretically unpack these concepts and their interrelations in some detail. Specifically, we show how opportunities-as-artifacts exist simultaneously in a number of incarnations ranging from the abstract notion of a successfully exploited market imperfection to gradually more concrete artifacts, such as new venture ideas (Davidsson, 2015), entrepreneurial theories (Felin & Zenger, 2009), symbolic blueprints (Dimov, 2011), venture pitches (Lounsbury & Glynn, 2001), business models (Osterwalder, 2004), product prototypes (Bogers & Horst, 2014), landing pages (Camuffo, Cordova, Gambardella, & Spina, 2019), etc. It is on this material level of analysis that the contrast between experimentation and transformation becomes clear, in terms of the different qualities that allow artifacts to productively relate organized individuals and their environments and also in terms of the radically different principles needed to effectively govern the iterative way this is accomplished. Consider once more the cases of Dropbox and iPhone. The Dropbox founders wanted to discover whether market demand existed and therefore used a detailed and distinct video to experimentally gather information that let them test the attractiveness of their product vision. Apple instead made the first iPhone mutable and actively invited a broad set of stakeholders into the process of cocreating both the iPhone and the emerging smartphone market.

Elaborating this simple framework, we spend the remainder of the paper developing two ideal types of entrepreneurial design, termed *experimentation* and *transformation*, that in different ways theorize the interface between organized *individuals* and their *environments* in terms of opportunities as *design artifacts* and the *design principles* that govern their iterative development (see Table 1). We do so by combining existing entrepreneurship literature with contributions from related fields, such as design (e.g., Norman, 1988; Schön, 1983; Vincenti, 1990), information systems (e.g., Jarvenpaa & Standaert, 2018; March & Smith, 1995; Nambisan, Lyytinen, Majchrzak, & Song, 2017), and practice theory (e.g., Carlile, 2002; Knorr Cetina, 2001; Orlikowski, 2000), in which artifacts, boundary objects, and situated practices have long been central to accounts of development and change.

To best clarify how they differ, we introduce experimentation and transformation in parallel, starting with relatively brief introductions of environments (discovered or created), and organized individuals (hierarchies or heterarchies), before moving on to a more detailed discussion of the interface between these two under the rubrics of design artifacts (distinct or mutable) and design principles (adaptation or negotiation).

TABLE 1
Summary of Experimentation and Transformation

		Experimentation	Transformation
Outer System	**Environments**	*Discovered*: the world has independent existence.	*Created*: the world is constructed.
Interface	**Design Artifacts**	*Distinct*: artifacts are focusing devices that enable the efficient execution of experiments.	*Mutable*: artifacts are boundary objects that facilitate as well as transform in interaction.
	Design Principles	*Adaptation:* uncertainty is epistemic and overcome through information gathering.	*Negotiation:* uncertainty is ontological and overcome through world-making.
Inner System	**Individuals**	*Hierarchies:* founder leads subordinated employees.	*Heterarchies:* heterogeneous stakeholders organically coordinate.

Environments as Discovered or Created

Discovered. Experimentation is premised on the idea that relevant aspects of the external environment—such as technologies, institutions, demographic trends, consumer sentiments, and market demand (Drucker, 1985; Shane, 2003)—exist independently of the perceptions and actions of the entrepreneur (Dean & McMullen, 2007). The environment therefore provides the enablers and constraints (Davidsson, 2015) that determine the fundamental viability (Ramoglou & Tsang, 2016) and circumscribe the potential value (Shane, 2003, 2012) of any envisioned opportunity. Entrepreneurship scholars have variously attributed such environmental realness to empirically observable entities (Alvarez & Barney, 2010), in principle unobservable mechanisms (Ramoglou, 2013), and stable yet socially constructed institutions (Tolbert, David, & Sine, 2011). However, as long as the external environment can be treated as objective and independent, such meta-theoretical differences are inconsequential from the perspective of entrepreneurship as design.

Created. Transformation is premised on the idea that relevant aspects of the world—such as industry standards, regulations, market segments, and product categories (Lane & Maxfield, 2005; Santos & Eisenhardt, 2009)—exist primarily as social constructions that are sustained or altered through ongoing human action and interaction (Dew & Sarasvathy, 2007; Garud, Jain, & Tuertscher, 2008). Precisely because they are historically and contingently evolved, they are also seen as rife with tensions and contradictions that entrepreneurs can leverage to effect desirable environmental change (Barley & Tolbert, 1997; Fligstein, 1997; Seo & Creed, 2002). From the perspective of entrepreneurship as design, the environment is thus very much open to influence (Engel, Kaandorp, & Elfring, 2017; Sarasvathy & Dew, 2005a). Hence, uncertainty is overcome not by gathering correct information about the external environment but by participating in a process of gradually transforming it (Aldrich & Martinez, 2003; Alvarez, Young, & Woolley, 2015; Santos & Eisenhardt, 2009; Uzunca, Rigtering, & Ozcan, 2018; Wiltbank, Dew, Read, & Sarasvathy, 2006). Here, it should be noted that participation in processes of social construction are difficult to constrain, which makes it hard to draw a sharp line between the environment as an outer system and the individuals making up the inner system (Baker, 2007; Garud et al., 2008; Sarasvathy & Dew, 2005a; West, 2007). As we will see in the discussions of *heterarchies* and *negotiation*, this blurring of boundaries is central to many aspects of transformation.

Individuals Organized in Hierarchies or Heterarchies

Hierarchies. Experimentation assumes that a real and independent external environment exists, and that entrepreneurs only have limited information about this environment (Milliken, 1987). Specifically, opportunities are subjectively envisioned (Packard, Clark, & Klein, 2017) on the basis of experiential and observational fragments (Felin & Zenger, 2009) that are accumulated and reinterpreted over an entire life history (Berglund, 2015). Since the veracity of such subjective opportunity visions cannot be established using rational arguments and public information (Knight, 1921) they cannot easily be traded (Foss & Klein, 2012). As a result, entrepreneurs must pursue their opportunity visions themselves, and in doing so need to rely on charisma,

persuasion, and other nonrational sources of authority to attract resources and more generally convince others to commit to their opportunity vision (Burns, Barney, Angus, & Herrick, 2016; Dobrev & Barnett, 2005; Foss, Foss, & Klein, 2007).

Importantly, what we have in mind is the functional role of visionary leadership. It makes no difference for our argument whether this role is performed by a tightly aligned founding team or even by different individuals at different times. The result is in each case an organization where ultimate authority derives from a central and subjective vision (Foss & Klein, 2012; Witt, 2007) and where everyone else is a subordinate whose task it is to help test and adapt the envisioned opportunity in light of the external reality (Grimes, 2018; Ries, 2011). A central entrepreneurial challenge is therefore to organize operations so that planning and execution of experiments to test and refine the opportunity are conducted as effectively as possible (Gruber, 2007; McGrath, 1999; Sull, 2004). More often than not, this entails delegating rights to exercise local judgment and to control activities in relation to specific domains of operation (Foss et al., 2007), resulting in an organization characterized by speed and flexibility yet subordinated the central vision (Bremner & Eisenhardt, 2019).

Heterarchies. Whereas experimentation rests on an organizational principle of *subordination*, transformation assumes heterogeneous individuals who, based on high-level alignment of interests and goals, laterally *coordinate* their resources, information, and perspectives (Dahlander & O'Mahony, 2011; Sarasvathy & Dew, 2005a; Stark, 2009). The result is a less planned and more emergent process where control is distributed rather than delegated (Lane & Maxfield, 1996) and where "judgments are made not only by individual putative entrepreneurs, but by the entire emergent entrepreneurial ecosystem" (Lounsbury, Gehman, & Ann Glynn, 2019: 1229). The formal leadership that exists is therefore procedural (Wenger, McDermott, & Snyder, 2002) and has been likened to that of a cocktail party host who is

> identifying the "guests," bringing them to the party, suggesting who should talk to whom and what they might talk about, intervening as necessary to keep the conversations flowing, and generally navigating between the shoals of boredom and hostility, either of which would cause the party to break up and the participants to leave. (Lester & Piore, 2004: 11)

In contrast, substantive leadership emerges spontaneously in relation to specific tasks that require particular competencies (Dahlander & O'Mahony, 2011; Lane & Maxfield, 1996; Stark, 2009). As in science (Galison, 1997) and markets (Hayek, 1945), individual heterogeneity is considered essential for progress and novelty. And as in these institutions, the dynamism and creativity of the collective relies on actors capable of both influencing and being influenced by others (Sarasvathy & Dew, 2005a).

Transformation thus relies on a heterarchical form of organizing (Hedlund, 1986; Stark, 2009; see also Garud, Kumaraswamy, & Karnøe, 2010; Pearce & Conger, 2002) where an evolving network—often extending beyond the boundaries of the formal organization (Powell, White, Koput, & Owen-Smith, 2005)—creatively interact under the guidance of a shared sense of direction and a general interest in working together (Garud et al., 2008; Hargadon & Bechky, 2006; Lane & Maxfield, 1996; Sarasvathy & Dew, 2005b). As more and more stakeholders, including customers, suppliers, partners, and regulators, self-select or are invited to join the emerging venture (Alvarez et al., 2015; Santos & Eisenhardt, 2009; Sarasvathy, 2008; Verganti, 2008), the group as a whole gets access to more diverse information and more varying perspectives, which fuel the ongoing negotiations that are central to entrepreneurship as a collective process of both artifact and environment design (Sarasvathy & Dew, 2005a; Garud et al., 2008; Townsend, Hunt, McMullen, & Sarasvathy, 2018; West, 2007).

Design Artifacts as Distinct or Mutable

Scholars have recently begun to conceptualize opportunities as complex artifacts that exist simultaneously on a spectrum ranging from holistic systems and abstract ideas to piecemeal and concrete artifacts (e.g., Dimov, 2016; Nambisan, 2017; von Briel, Davidsson, & Recker, 2018). In the context of digital entrepreneurship, Nambisan (2017) thus discussed opportunities in terms of a layered modular architecture where more concrete applications develop in tandem with broader platforms and systems. Dimov (2016) similarly asserted that opportunities must be conceptualized as both holistic activity systems and as the set of actors, entities, and relationships that make them up, concluding that an opportunity "cannot exist without its elements; but, equally, it cannot be seen without 'drawing' the relationships among them" (Dimov, 2011: 12).

Importantly, processes of entrepreneurial design are also fueled by a wide range of intermediate artifacts, such as business models, pitches, prototypes, and landing pages, that fulfill practical as well as

cognitive functions (Kirsh & Maglio, 1994; Lim et al., 2008). Practically, artifacts fulfill the straightforward and somewhat mundane function of gradually bringing about changes in the world, thereby moving the design process closer to its final state. Perhaps more interestingly, artifacts can also function as cognitive scaffolds where the main purpose is to alter not the world, but the way we think. Simply put, externalizing our thoughts enables a "reflective 'conversation' with the materials of a design situation" (Schön & Wiggins, 1992: 135; see also Clark & Chalmers, 1998).

While similar in this general sense, the specific qualities that make design artifacts effective drivers of experimentation and transformation are quite different. These differences will be elaborated next. Simply stated, in experimentation, artifacts should be distinct representations of the central vision, expressed with a minimum of interpretive flexibility, in order to enable reliable information gathering. In transformation, artifacts should instead be made mutable and have reasonably high interpretive flexibility in order to stimulate creative interactions among heterogeneous stakeholders.

Distinct. In experimentation, envisioned opportunities are relatively coherent by virtue of being grounded in the founder's judgment (Klein, 2008; Witt, 2007), but are also epistemically uncertain since such judgment is based on limited environmental information (Felin & Zenger, 2009; McGrath, 1999). To assess whether and how an envisioned opportunity needs to be adapted to the external environment, entrepreneurs must be clear about what is known and what is only assumed (Gaglio, 2004; McGrath & MacMillan, 1995; Shane & Delmar, 2004). To ensure this is the case, and to ensure that effective information gathering experiments can be conducted (Contigiani & Levinthal, 2019; Gavetti & Levinthal, 2000; McGrath, 1999; Ries, 2011), the founder's abstract opportunity vision is broken down into distinct components that are easier to test, all the while paying attention to their relations and dependencies (Dimov, 2016; Osterwalder, 2004; Vincenti, 1990).

It is only after such analytical decomposition that the resulting material artifacts can be used to effectively elicit feedback from the environment, thereby gradually reducing environmental uncertainty (McGrath & MacMillan, 1995). These artifacts can take many forms, including *physical artifacts,* such as low-fidelity paper prototypes used to test features and interfaces (Lim et al., 2008), and product prototypes or user-interface wireframes used to assess product attractiveness and usability (Andries, Debackere, & Looy, 2013; Bogers & Horst, 2014); *digital artifacts,* such as landing pages used to test value propositions, willingness to pay, etc. (Camuffo, Cordova, Gambardella, & Spina, 2019; Ries, 2011), and crowdfunding campaigns used to raise capital and test consumer demand (Ahlers, Cuming, Günther, & Schweizer, 2015; Belleflamme, Lambert, & Schwienbacher, 2014; Gafni, Marom, & Sade, 2017); and *narrative artifacts,* including written business plans (Gruber, 2007) and verbal pitches (Lounsbury & Glynn, 2001) used to get feedback, attract partners, and secure resources.

Regardless of form, the purpose of a concrete artifact in experimentation is always to isolate and evaluate one or a few specific aspects of the abstract opportunity in order to gather valuable and reliable information from the environment. To do this as effectively as possible, the entrepreneur needs to work with distinct artifacts that enable information to be gathered with a minimum of interpretive flexibility on the part of the external actors involved (Camuffo et al., 2019; Contigiani & Levinthal, 2019).

Mutable. In transformation, individuals with shared high-level goals and understandings, but without the guidance provided by a central opportunity vision, develop local artifacts that are intentionally incomplete (Dew, Grichnik, Mayer-Haug, Read, & Brinckmann, 2015; Lane & Maxfield, 2005; Orlikowski, 2006). By being ambiguous and mutable (Ewenstein & Whyte, 2009; Knorr-Cetina, 2001), such artifacts invite individual and collective processes of "relentless de-framing and reframing" (Nambisan et al., 2017: 229; see also Hargadon & Bechky, 2006) in which the material artifact, the abstract opportunity vision, as well as the identities and preferences of the involved stakeholders are liable to be transformed (Doganova & Eyquem-Renault, 2009; Garud, Kumaraswamy, & Karnøe, 2010; Giovannoni & Quattrone, 2018; Grimes, 2018; Lester & Piore, 2004). To actively facilitate such transformations, the ambiguity and mutability of artifacts are qualities to be leveraged (Lester & Piore, 2004; Stark, 2009), since it is only by "unfolding continuously, raising questions and prompting answers [that] they enable practitioners to provisionally grasp their object of inquiry" (Comi & Whyte, 2018: 1060).

Such transformation-inducing opportunity instantiations include *physical artifacts,* such as incomplete and suggestive sketches, mood boards, prototypes, and cultural probes that spawn and

stimulate open-ended ideation and cocreation processes (Comi & Whyte, 2018; Dew et al., 2015; Lester & Piore, 2004; Stigliani & Ravasi, 2012; Verganti, 2008); *digital artifacts,* such as software development kits (Franke & Piller, 2004; Von Hippel & Katz, 2002), open platform architectures (Garud et al., 2018; Nambisan, 2017), and digital probes (Jarvenpaa & Standaert, 2018) whose reprogrammability, recombinability, and expansibility explicitly afford distributed manipulation and development (Nambisan, 2017; Von Hippel & Katz, 2002; Zittrain, 2006); and *narrative artifacts,* such as metaphorical, analogical, and sometimes intentionally incomplete opportunity descriptions (Cornelissen & Clarke, 2010; Garud et al., 2008) that trigger the imaginations of others (Berglund, 2007; Lounsbury & Glynn, 2001) and invite creative engagement with the perceived opportunity (Garud, Kumaraswamy, & Karnøe, 2010). In contrast with traditional venture pitches, entrepreneurs can actively "ask" external stakeholders to come up with personal reasons to contribute, thereby offering them the possibility to "help shape the venture in return for their commitment to become involved in some way" (Dew, Ramesh, Read, Sarasvathy, & Virginia, 2018: 400).

Regardless of form, the purpose of artifacts in transformation is to facilitate processes of joint sensemaking and cocreation. This in turn requires artifacts that are sufficiently clear to enable meaningful communication among heterogeneous actors (Carlile, 2002; Star & Griesemer, 1989), but are also sufficiently incomplete, mutable, and question-begging to stimulate creative transformations (Doganova & Eyquem-Renault, 2009; Ewenstein & Whyte, 2009; Garud et al., 2008; Knorr Cetina, 2001; Miettinen & Virkkunen, 2005; Nambisan et al., 2017; Venkataraman et al., 2012).

In sum, experimentation uses distinct artifacts to test clear hypotheses that reflect specific aspects of the central opportunity vision. In contrast, transformation rests on artifacts that need to be "underspecified, left incomplete, and retain tension" (Weick, 2004: 43) to fulfill their function. Whether distinct or mutable, artifacts become relevant when enacted as part of experimental and transformational design processes. We discuss these next under the headings of adaptation and negotiation.

Design Principles Governing Adaptation and Negotiation

Design generally deals with situations that require heuristic design principles employed iteratively for their resolution so that "the real result of our actions is to establish initial conditions for the next succeeding stage of action" with the ambition of taking the next step "with a better body of knowledge and a greater capacity for experience" (Simon, 1996: 163). Like design artifacts, principles of design are defined and developed in relation to inner and outer systems (Simon, 1996). As examples of bounded rationality, they are thus shaped "by a scissors whose two blades are the structure of the task environments and the computational capabilities of the actor" (Simon, 1990: 7). Unfortunately, the tendency to equate bounded rationality exclusively with limited "computational capacities of the actor" has led most scholars to downplay its ecological character (Felin & Zenger, 2017; Todd & Gigerenzer, 2003; Townsend et al., 2018).

However, to understand rational behavior in uncertain (broadly defined) environments, it is instructive to focus on procedural rationality in the form of relatively simple heuristics evolved in response to reasonably specific contexts (Gigerenzer, Todd, & The ABC Research Group, 1999; Simon, 1978; Sull & Eisenhardt, 2015). To illustrate, consider the seemingly random journey of an ant trying to traverse a rugged beach (Simon, 1996: 51–53). Seen as a goal-oriented (cross the beach) and contextual (character of the ant and the terrain) activity, the ant's complex and irregular movements can be explained fairly well as the application of a few heuristics (e.g., try to climb obstacles; if that fails, detour; if that fails, go back and take the first other path leading forward) to the complex environment of the beach. Such simple principles have been used to model and design effective human behavior in a wide range of contexts (Gigerenzer et al., 1999), including cricket players catching a ball by fixating on and running toward it while adjusting speed to keep the angle of gaze constant (McLeod & Dienes, 1996), nurses using simple bedside exams that outperform more complex analyses for determining whether dizziness is caused by stroke (Kattah, Talkad, Wang, Hsieh, & Newman-Toker, 2009), and movie studio executives who apply a few simple criteria to determine which films to make (Sull & Eisenhardt, 2015).

While such pragmatic and contextual design principles often resonate with practitioners, scholars in the "natural science" paradigm often find them imprecise and unscientific due to their pragmatic and contingent nature (cf. Arend, Sarooghi, & Burkemper, 2015; Read, Sarasvathy, Dew, & Wiltbank, 2016). However, there is ample evidence that simple heuristics are not just "good-enough" fallback

alternatives used by practitioners who cannot avail themselves of more sophisticated methods. In fact, simple heuristics frequently outperform comprehensive optimization techniques that seek to incorporate more relevant information, and especially so in uncertain and complex environments where historical data are easily overfitted (Gigerenzer & Brighton, 2009; Mousavi & Gigerenzer, 2014; Townsend et al., 2018). In the context of experimentation and transformation, design principles tend to be focused on adaptation and negotiation, respectively.

Adaptation. Premised on entrepreneurs as visionary leaders operating in a world to be discovered, design principles in experimentation are analogous to those of scientists who gradually adapt and refine their tentative theories by articulating and iteratively testing the underlying assumptions on which they are based against empirical reality (Camuffo et al., 2019; Contigiani & Levinthal, 2019; Eisenhardt & Bingham, 2017; Felin & Zenger, 2009; Grimes, 2018; Koppl & Minniti, 2010; McGrath & MacMillan, 1995; Murray & Tripsas, 2004; Sull, 2004). While acknowledging that our ability to predict is severely limited, experimentation is nevertheless teleological in its reliance on a clear vision operationalized in distinct opportunity instantiations used to adapt the abstract opportunity to the environment. Entrepreneurs are in this sense likened to "'empirical theorists' who engage in developing and empirically testing theories and models of value creation" (Furr, Nickerson, & Wuebker, 2016: 2). Going beyond metaphor, Felin and Zenger (2009: 131) asserted that while "the theorizing efforts of entrepreneurs differ from those of scientists [since] entrepreneurs may not have the time to fully vet the implications of their theories given the need for action . . . on the whole, similar theorizing processes are evident" (see also Felin, Gambardella, Stern, & Zenger, 2019).

Concretely, entrepreneurial experiments should seek to efficiently gather information about critical areas of environmental uncertainty (McGrath & MacMillan, 1995; Sull, 2004). To prioritize activities, the abstract opportunity should be analytically broken down into more tangible components (Contagiani & Levinthal, 2019; Felin & Zenger, 2017; McGrath & MacMillan, 1995; Osterwalder, 2004), which in turn makes it easier to "define clear hypotheses, conduct rigorous tests to prove or disprove them, measure the results of the tests, and make decisions" (Camuffo et al., 2019: 2). Depending on factors such as the cost and lead time of testing, available knowledge and resources, the modularity and independence of business model components, and the character of the external environment (Baumann & Siggelkow, 2013; Ethiraj & Levinthal, 2004; Levinthal, 1997; Pich, Loch, & Meyer, 2002), information gathering experiments can: be partial and focused on discrete deal-killers or holistic and addressing more systemic issues (Sull, 2004); be conducted in parallel or sequentially (McDonald & Eisenhardt, 2020); extend the known terrain incrementally, or be bolder and more speculative (Andries et al., 2013); test well-defined hypotheses or exploratively "double click" some aspect of reality to gain deeper understanding (Fiet, 2007; Gavetti & Porac, 2018).

Regardless of whether the founder conducts or delegates experimentation (Foss et al., 2007), the process must be centrally controlled to ensure continuous incorporation of new information into the central opportunity vision and related business model assumptions. McGrath and MacMillan (1995: 54) thus recommended that organizations "designate a *keeper of the assumptions*" who maintains version control and ensures that the next round of experiments is based on the most up-to-date information available. The processes must also be unbiased, meaning that processes of experimentation should entail the dispassionate gathering of unbiased information about matters of fact that are relevant to the opportunity pursued (Grimes, 2018). To ensure that such processes are not corrupted, individuals and organizations must guard against common biases such as anchoring, representativeness, generalization from small samples, escalation of commitment, self-justification, etc. (Eisenmann, Ries, & Dillard, 2012; Furr et al., 2016), which are quite likely to affect entrepreneurs given their emotional commitments and uncertain environment (Baron, 1998; Cornelissen & Clarke, 2010; Keh, Foo, & Lim, 2002).

Negotiation. Transformation assumes that heterogeneous individuals engage in creative negotiations mediated by ambiguous and mutable artifacts (Carlile, 2004; Lainer-Vos, 2013). The aim of design principles is thus not to gather information by conducting unbiased tests that adapt a central and singular opportunity vision to an existing environment. On the contrary, transformation thrives on heterogeneity of both knowledge and perspectives (Cornelissen & Clarke, 2010; Lane & Maxfield, 2005; Sarasvathy & Dew, 2005a; West, 2007) with the overarching aim of design principles being "to keep multiple evaluative principles in play and to exploit the resulting friction of their interplay" (Stark, 2009: 15). To accomplish this, it is important to create and

nurture "zones of indeterminacy" (Lainer-Vos, 2013: 515) where original ideas and subtle differences in perspective are given room to cross-fertilize and grow. Maintaining a certain measure of ambiguity is thus a virtue in transformation, whereas demands that ideas be clearly explicated and rapidly validated may cut short potentially valuable creative dialogues (Lester & Piore, 2004; Padgett & Ansell, 1993).

The result is a more holistic and dialogical view of the design process compared to experimentation; one that cannot be reduced to the independent effects of individuals, artifacts, or environments but rather entwines all three in ongoing negotiations over the what, as well as why, of the entrepreneurial project (Gaglio & Dimov, 2018; Garud et al., 2008; Lane & Maxfield, 2005; Stark, 2009). To drive such negotiations, transformational design principles aim to support the *formation* and *stimulation* of productive heterarchical networks.

First, stakeholder networks with transformational potential must be: *appropriately heterogeneous*, in that actors should have different experiences and competencies, but not be so heterogeneous as to hinder productive communication and interaction; *broadly aligned*, in that actors should share a fundamental world view and find the same general issues appropriate and worthy of attention; and *motivated to interact*, in that actors should be willing to collaborate on the task at hand (Carlile, 2004; Ehn, 2008; Kelley, 2001; Lane & Maxfield, 2005; March & Olsen, 1989; Stark, 2009; Verganti, 2008). Such stakeholder networks can either form through self-selection (Dew & Sarasvathy, 2007; Wood & McKinley, 2010; Engel et al., 2017) or be actively orchestrated (Kelley, 2001; Lainer-Vos, 2013; Lane & Maxfield, 1996; Verganti, 2008). Examples of the latter go beyond recruitment of formal employees to also include aspects such as the curation and management of external networks of collectively creative "interpreters" (Lester & Piore, 2004; Verganti, 2008), the sharing of mutable artifacts with user or developer communities to leverage their collective creativity (Franke & Piller, 2004; Garud et al., 2008; Shah & Tripsas, 2007), and the creation, by venture capital firms, of affiliate funds to align successful non-portfolio entrepreneurs' interests with those of current portfolio companies (Lane & Maxfield, 1996).

Second, to leverage the transformational potential of heterogeneous stakeholders (Dimov, 2011; Nambisan et al., 2017; Stark, 2009), individuals should be encouraged to act on their values and passions and to voice their ideas (Cardon, Post, & Forster, 2017; Edmondson & Lei, 2014) in ways that lead to productive and constructive negotiations (Carlile, 2004; Tsoukas, 2009). While such sensemaking and sensegiving negotiations happen naturally in social interactions (Gioia & Chittipeddi, 1991), they can also be actively stimulated by introducing suitably ambiguous and mutable physical, digital, or narrative artifacts (Comi & Whyte, 2018; Nambisan, 2017; Zittrain, 2006). Mutable artifacts can both stimulate and evolve through the "practices, norms, and perspectives of people using (or interacting with) such artifacts" (Nambisan, 2017: 12), and by doing so facilitate the development of a shared discourse within which the meaning and significance of the emerging opportunity can be more fully understood (Cornelissen & Clarke, 2010; Lane & Maxfield, 2005; Tsoukas, 2009).

Finally, as the opportunity begins to stabilize, the balance between "sensemaking for oneself and sensegiving to others" (Cornelissen & Clarke, 2010: 542) begins to shift to the latter as founders seek to amplify the natural reach of the emerging opportunity by actively seeking to transform the environment with the help of their growing stakeholder network (Lester & Piore, 2004; Verganti, 2008); for example, by enlisting their support in defining and legitimizing new market and product categories (Cornelissen & Clarke, 2010; Santos & Eisenhardt, 2009); orchestrating broader industry networks (Berglund & Sandström, 2013; Santos & Eisenhardt, 2009); and influencing norms, standards, and legislation (Alvarez et al., 2015; Uzunca et al., 2018).

Experimentation and Transformation as Ideal Types

As developed here, experimentation and transformation are ideal types of entrepreneurial design,

> formed by the one-sided *accentuation* of one or more points of view and by the synthesis of a great many diffuse, discrete, more or less present and occasionally absent *concrete individual* phenomena, which are arranged according to those one-sidedly emphasized viewpoints into a unified *analytical* construct. (Weber, 1904/1949: 90)

Consequently, their value turns on the ability to combine parsimony and complexity in analytically productive ways (Doty & Glick, 1994; Fiss, 2011; Van de Ven & Poole, 1995). The framework developed here should therefore be used as an abstract template that may be laid over more historically

specific accounts in order to organize data and provide analytical points of comparison (Weber, 1904/1949).

Exactly how this is done will depend on scholars' knowledge interests and empirical foci. Longitudinal analyses may thus find that entrepreneurial processes oscillate between more transformational and more experimental periods, whereas detailed case studies of individual ventures may find the descriptive validity and prescriptive value of experimentation and transformation to be contingent on industry structure, organizational characteristics, firm priorities, etc. As with other typologies that broadly contrast history-dependent negotiation and future-oriented adaptation, it may be tempting to subsume one side as a special case of the other (March, 1994). It can thus be argued that transformation merely describes a subset of design options available to entrepreneurs in the context of a design process that is fundamentally hierarchical and experimental. Similarly, experimentation can be seen as describing tactics employed by different actors who are themselves heterarchically organized in higher-order processes of transformational design. In developing our argument, we hope to have shown that such conflation would be a mistake, that the analytical value of experimentation and transformation is in fact high, and that remaining imprecisions and inconsistencies suggest avenues for further development. These are issues we turn to next.

DISCUSSION

In this paper we have developed experimentation and transformation as ideal types of entrepreneurial design. Combining the Simonian design tradition (Simon, 1996) with views of reality as discovered or created, we thus proposed two ideal types of how opportunities-as-artifacts iteratively develop at the interface between organized individuals and their environments. Next, we discuss implications for theory and research in terms of how uncertainty can be conceptualized and managed, the design perspective as a conceptual anchor for the entrepreneurship field, avenues for future conceptual and empirical work, and design as a bridge between theory and practice.

Design and Uncertainty Management

We believe that by emphasizing artifacts and principles of design, the idea that entrepreneurship concerns action under uncertainty is made more managerially relevant and analytically clear. Different accounts of uncertainty have often been conflated in the entrepreneurship field (Packard et al., 2017; Townsend et al., 2018). This has led some to propose nuanced uncertainty categories (Packard et al., 2017) and others to differentiate uncertainty from complexity, ambiguity, equivocality, ignorance, etc. (e.g., Townsend et al., 2018). Grounded primarily in economics and decision theory (e.g., Ellsberg, 1961; Knight, 1921; Von Mises, 1949), such efforts have provided valuable conceptual clarity to the entrepreneurship discourse, and have also provided practical advice by suggesting ways of matching kinds of entrepreneurial situations with appropriate decision-making logics (Packard et al., 2017) and action principles (Townsend et al., 2018). While these categories partly overlap with the types of uncertainty proposed here, their largely cerebral accounts of how to overcome uncertainty nevertheless fit poorly with the basic assumptions underpinning entrepreneurship as artifact-centered design. Indeed, by stressing the role of artifacts and materiality, the design perspective is fundamentally premised on the idea that the isolated brain is no place for serious thinking; that dealing with all but the simplest and most familiar tasks requires external artifacts that complement and economize on what goes on "inside the ancient fortress of skin and skull" (Clark, 2001: 18; see also Orlikowski, 2006; Simon, 1996). However, despite rich literature on situated and distributed cognition, it is still surprisingly rare to see materiality directly implicated in theories of entrepreneurial cognition and uncertainty management (cf. Dew et al., 2015).

A partly related reason why kinds of uncertainty are often conflated has to do with the way new entrepreneurship theories have been framed. Effectuation, creation theory, discovery-driven planning, and the lean startup have all been contrasted with accounts of management under risky or known conditions. Since the risk–uncertainty distinction is defining of entrepreneurship as an economic function (Kirzner, 1973; Knight, 1921; Mises, 1949), this is understandable. However, it has also led to much confusion since any differences between these management theories—in terms of how uncertainty is defined and overcome—are dwarfed by their commonalities when contrasted with action under risky situations. To illustrate, consider the following description of effectuation as essentially similar to the experimental information gathering of the lean startup:

> Effectuation builds on the decision theory literature that suggests that if decision makers believe they are

> dealing with relatively unpredictable phenomena, they will try to *gather information about future trends through experimental and iterative learning* [emphasis added] (e.g., Ries, 2011). The elements of effectuation are enactments of experimental and iterative learning techniques that enable entrepreneurs to *discover information about the future* [emphasis added] as time passes. (Fisher, 2012: 1025)

Contrast this with Sarasvathy's (2008: 26–27) own clarification of how effectuation differs from the information gathering approaches deemed suitable in knowable but poorly known environments:

> If decision makers believe they are dealing with a measurable or relatively predictable future, they will tend to do some systematic information gathering . . . if they believe they are dealing with relatively unpredictable phenomena, they will try to *gather information through experimental and iterative learning techniques* [emphasis added] . . . I began to see that [there was] a *third category* consisting of a future that was *not only unknown, but unknowable* [emphasis added] in principle . . . I called that logic effectuation.

We suspect that such conflation will likely continue so long as uncertainty and its management are discussed primarily in the cerebral realm of economics and decision theory. If, instead, uncertainty management is discussed in terms of concrete principles and material artifacts of design, such differences quickly become clear. Consider, for instance, the common advice to quickly seek feedback on ideas by talking to potential customers. While sounding straightforward, the devil is in the details. There is a radical difference between, on the one hand, presenting a high-fidelity fake product to a potential customer in order to assess their willingness to pay, and, on the other hand, engaging the same potential customer in an open-ended whiteboard session with the expectation that the form, content, and significance of the product may be radically transformed as a result.

In light of these observations, we argue that the notions of epistemic and ontological uncertainty—as derived from the distinction between reality as discovered and created—provide a simple yet useful way to distinguish between the kinds of environmental uncertainty entrepreneurs seek to overcome, and one that fits with the design perspective's concrete and material focus. As the design perspective develops it may become necessary to introduce more nuanced uncertainty categories. However, if this is done, it should be in conjunction with careful consideration of related principles and artifacts of design. For now, we believe that the simple distinction between epistemic and ontological uncertainty clarifies the essential difference.

From Economic Nexus to Design Triad

We believe much can be gained from replacing the economics-inspired dual nexus—with its subsumption of opportunities under environmental conditions or individual beliefs—with the design-inspired triad proposed here. Such a move lets us retain the core insight of the nexus view—that theories of entrepreneurial action must consider both individuals and environmental conditions (Eckhardt & Shane, 2013; Venkataraman, 1997)—while also making analytical sense of opportunities by treating them as artifacts designed at their interface. Indeed, this view mitigates many criticisms leveled at the opportunity concept, such as its retrospective definition (Davidsson, 2015; Dimov, 2011), its intractability to empirical operationalization (Alvarez & Barney, 2007), and its limited relevance for practice (Berglund & Korsgaard, 2017; Braver & Danneels, 2018; Foss & Klein, 2019).

More proactively, we believe our ideal typical framework can serve as a valuable heuristic (Weber, 1904/1949) in the development of more specific entrepreneurship theories with an ambition to describe and prescribe managerial practice. Specifically, such development can be achieved by indicating areas where particular theories offer strengths and weaknesses, and consequently how these theories might be developed. To illustrate, we will consider effectuation and the emerging "judgment-based approach." Effectuation (Sarasvathy, 2008) provides nuanced elaborations of individuals, environments, and design principles. However, while design artifacts are central, they primarily figure as final outcomes in the form of new firms and markets. Our framework suggests that effectuation can be developed by also considering intermediate artifacts employed throughout the process. Here, ongoing work to contrast two narrative design artifacts, the "causal pitch" and the "effectual ask" (Dew et al., 2018), holds promise. The judgment-based view (Foss & Klein, 2012) centers on judgmental decision making about the assembly, coordination, and deployment of heterogeneous resources under conditions of uncertainty (Foss & Klein, 2012). A recent special issue suggested that developing this perspective further should entail

> making the judgment construct more concrete, looking in greater detail at processes of mobilizing resources in

> the pursuit of entrepreneurial ideas, and examining the process of groping towards those governance structures, contracts and so on that can best assist the formation and realization of such ideas. (Foss & Klein, 2015: 595)

Given that resource attributes are seen as subjectively determined and evolving through processes of groping toward an uncertain future, such development may benefit from explicitly conceptualizing its resource bundles as material artifacts. In particular, it could be valuable to consider the ways in which the materiality of particular resources influences the formation of entrepreneurial judgments, as opposed to regarding resource attributes and combinations merely as the result of mental processes of judgmental decision making.

We also believe that the design perspective can be used to reinterpret specific concepts and phenomena in ways that improve analytical clarity and pragmatic utility. Here, the contested notion of business plans can serve as an illustration (Brinckmann, Grichnik, & Kapsa, 2010; Burke, Fraser, & Greene, 2010; Gruber, 2007). Scholars have long sought to understand the effects of business plans and business planning on venture performance (Delmar & Shane, 2003; Honig & Karlsson, 2004), but empirical results have been inconclusive. Most of the sometimes heated debates boil down to methodological questions concerning self-selection bias (Burke et al., 2010); how to deal with left and right censoring in longitudinal data (Delmar, 2015; Honig & Samuelsson, 2014); what activities can properly be considered and measured as planning (Davidsson & Gordon, 2012; Gruber, 2007); how to control for the effects of individual experiences, venture characteristics, and industry effects (Brinckmann et al., 2019; Burke et al., 2010; Gruber, 2007); and whether outcome variables should focus on engagement, persistence, progress, or success (Davidsson & Gordon, 2012). If business planning was instead theorized from a design perspective, the challenge would not primarily be to hypothesize, operationalize, and empirically justify stable correlations or causal mechanisms. Instead, business planning and business plans would be conceived of in terms of principles and artifacts of design, whose utility would depend on how well they helped actors perform given tasks in given situations (Berglund et al., 2018; Dimov, 2016; March & Smith, 1995). In light of our ideal types, we might say that for the purposes of experimentation, business plans should be distinct and compelling in order to accomplish intended goals. To secure an initial meeting with a potential angel investor, the business plan might thus be instantiated in a succinct and self-explanatory slide deck. For the purposes of transformation, a business plan should instead be intentionally mutable and incomplete so as to engage others in creative negotiations. To brainstorm strategic options when meeting a potential angel investor in person, the business plan might therefore be instantiated in a whiteboard and developed in dialogue.

As illustrated throughout this paper, our design framework—with its decomposition of artifacts into distinct and mutable; abstract and concrete; and physical, digital, and narrative—also provides a categorization scheme that can be used to conceptually anchor and integrate many existing, albeit often unrelated, strands of research. Going forward, the design perspective may thus provide a research program that can integrate broad theories, such as discovery driven planning (McGrath & Macmillan, 1995), lean startup (Camuffo et al., 2019; Ries, 2011), the judgment-based view (Foss & Klein, 2012) the theory-based view (Felin & Zenger, 2017), bricolage (Baker & Nelson, 2005), and effectuation (Sarasvathy, 2001), as well as more specific concepts and phenomena, such as business models (Doganova & Eyquem-Renault, 2009), pitches (Lounsbury & Glynn, 2001), product prototypes (Bogers & Horst, 2014), and business plans (Gruber, 2007).

Developing the Design Perspective

We believe that further development of the design perspective will benefit from a combination of conceptual elaboration and empirical research. Conceptually, our emphasis on artifact-centered design clearly resonates with many ideas in the vast and varied literatures that detail how "action depends in essential ways upon its material and social circumstances" (Suchman, 1987: 50; see also Clark, 1998; Engeström, 1987; Hutchins, 1995; Norman, 2014; Schatzki, Knorr Cetina, & von Savigny, 2001; Schön, 1983). Indeed, much of our argument rests on the assumption that both individual cognition and social interaction are complemented and augmented by design principles and artifacts. To further unpack these ideas, scholars may look to the literature on distributed cognition and dig deeper into the nuts and bolts of how artifacts serve as cognitive scaffolds that not only economize on but also expand the creative potential of our limited mental capacities (Clark, 1998; Lane & Maxfield, 2005). Familiar examples include pen and paper, to-do lists, and computer applications that are necessary for many advanced human practices (Clark, 1998; Kirsh &

Maglio, 1994; Orlikowski, 2006). In an influential study, Hutchins (1995) thus described how the navigation of large ships required a distributed "cognitive system" that included several individual minds combined with artifacts in the form of tools (e.g., sextants and alidades) and media (e.g., maps and charts) (see also Suchman, 1997). Others have detailed how material artifacts can enable collective development and criticism (e.g. soliciting product feedback based on a prototype), make it easier to connect and integrate previously unrelated ideas and concepts (e.g. brainstorming business ideas using mind-mapping software), and make it easier to rerepresent and simplify complex ideas (e.g. writing down business model assumptions using a framework to cluster and reduce them) (Kirsh, 2010; Simon, 1996: 131).

A further step can be to ask how artifacts should be designed to best serve as effective drivers of experimental or transformational design processes. Entrepreneurship scholars have often described how different technologies, products, relationships, etc. are put to novel and often surprising uses as part of entrepreneurial processes (Baker & Nelson, 2005; Dew, Serasvathy, & Venkataraman, 2004; Grimes, 2018). Building on the idea that all artifacts (and natural things) tend to enable certain behaviors while constraining others (Gibson, 1979; Goel, 1995), such affordances can to some extent be designed (Garud et al., 2008, 2018; Norman, 1988). Borrowing the term from ecological cognition (Gibson, 1979; cf. Von Uexküll, 1934/1992), design theorists commonly define an artifact's affordances as the "perceived and actual properties of a thing, primarily those fundamental properties that determine just how the thing could possibly be used" (Norman, 1988: 9). However, and as touched on already, scholars in various fields discuss affordances in different ways depending on their goals. Designers of stovetop controls, graphical user interfaces, and other artifacts that should primarily be easy to use will thus stress affordances such as discoverability, visibility, intuitiveness, and ability to provide feedback (Norman, 1988). In contrast, designers of open-source software projects and other artifacts that should afford transformation focus on leveragability, recombinability, adaptability, transferability, etc. (Zittrain, 2006). Similarly, scholars exploring how information technologies can drive organization-wide behavioral change have classified their affordances as individualized, collective, and shared, since these are most relevant for their purposes (Leonardi, 2013). Building on these insights, it may also be valuable to develop a vocabulary for speaking of affordances in the specific context of entrepreneurial design.

To develop the design perspective, we need to combine conceptual development with empirical investigations. A natural next step is therefore to describe and analyze how various physical, digital, and narrative artifacts are used to drive entrepreneurial design processes. Here, inspiration can be found in practice scholars' ethnographies of specific artifacts. For example, Kaplan (2011: 320) studied the role of PowerPoint in a strategy-making process to find that its affordances both "enabled the difficult task of collaborating to negotiate meaning in an uncertain environment" and supported efforts "to draw boundaries around the scope of a strategy, certifying certain ideas and not others." An alternative approach can be found in Comi and Whyte (2018: 1056), who followed an entire architectural design process to study how engagements with a broad range of physical and digital visual artifacts—that is, "all the drawings, models and sketches that practitioners use in crafting what is 'not yet'"—were variously used during different parts of the process. Similarly, Doganova and Eyquem-Renault (2009) followed a technology startup during its first years to describe how business models, broadly defined, were instantiated and used in different situations.

Bridging Theory and Practice

Finally, we believe that treating entrepreneurship as design naturally bridges theory and practice. While some have argued that scholars and practitioners belong to incommensurable epistemic worlds (Kieser & Leiner, 2009), we naturally follow Simon (1967, 1996), who saw scholarship in engineering, management, architecture, and other professional fields as appropriately concerned with the production of practically useful design theories that incorporate both disciplinary and practitioner knowledge but are irreducible to either (Berglund et al., 2018; Romme, 2016). Since both academic and practitioner theories of design have the same generic structure—that is, artifacts are developed at the interface between inner and outer systems—there is a natural isomorphism between theory and practice. It is therefore unsurprising that many influential practitioner theories of entrepreneurship describe how individuals with certain resources and goals (*inner system*) are encouraged to design profitable businesses (*abstract artifact*) by building "prototypes" (Savoia, 2019), "minimum feature sets"

(Blank & Dorf, 2012), and "minimum viable products" (Ries, 2011) (*concrete artifacts*), that are used as part of "pretotyping" (Savoia, 2019), "customer development (Blank & Dorf, 2012), or "build, measure, learn" (Ries, 2011) processes (*design principles*), the goal of which is to iteratively reach "product–market fit" (*adaptation of the artifact to the outer system*) (Andreessen, 2007; Blank & Dorf, 2012; Ries, 2011; Savoia, 2019).

In addition to entrepreneurs, such bridging of theory and practice may be especially relevant for entrepreneurship educators, accelerator managers, and others who are in positions to advise and guide entrepreneurial processes (Blenker, Korsgaard, Neergaard, & Thrane, 2011; Cohen, Bingham, & Hallen, 2019; Mansoori, 2017). Just as engineering and medicine builds on insights from science and biology to develop principles and artifacts of design, but remain mindful of their differences (Niiniluoto, 1993; Simon, 1996), so should entrepreneurship educators borrow from and remain mindful of differences with more "natural science"–oriented entrepreneurship research. By proposing experimentation and transformation as ideal types of entrepreneurial design, we hope to have clarified this general distinction and also provided some concrete points of departure for future pedagogical and didactic work. Indeed, while we have spent the bulk of the paper arguing for the scholarly merits of conceptualizing opportunities as artifacts and entrepreneurship as design, the ultimate benefits lie in the potential of our work to yield professionally useful knowledge about "how to make artifacts that have desired properties and how to design" (Simon, 1996: 111).

CONCLUSION

In this paper, we have introduced experimentation and transformation as ideal types of entrepreneurial design that describe how material artifacts play a central role in overcoming epistemic and ontological uncertainty. By conceptualizing entrepreneurship as design, we have departed from a tradition of research that emulates the natural sciences by pursuing stable correlations and causal mechanisms. Building on this, we have also provided an alternative conceptual anchor to the economics-inspired dual nexus, which has proven theoretically problematic and of limited practical use. We have also suggested several more specific advantages of the design perspective, one of which concerns the question of what opportunities really are. Here, our answer has been deceptively simple: we make opportunities real by treating them as artificial.

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