TOWARDS A DESIGN SCIENCE OF ENTREPRENEURSHIP

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ABSTRACT

This paper outlines a design-science perspective of entrepreneurship. It zooms in on the junction between present and future to distinguish entrepreneurship as a natural and as an artificial phenomenon. While the current study of entrepreneurship speaks to the former, it has been silent on the latter. The paper discusses design as a distinct mode of research, opportunity as a design artifact, and the generative power of recursive action to make the case for problematizing entrepreneurial action as a focus of research. It then defines its research questions, discusses the logic and process for addressing them, and outlines the nature of research outputs.

INTRODUCTION

Entrepreneurs feature prominently in theories of entrepreneurship. Their defining feature is acting in the face of uncertainty in pursuit of opportunities (McMullen and Shepherd, 2006). But an encounter with a real-life entrepreneur – someone who is acting in the face of uncertainty and appears to be pursuing an 'opportunity' – can be an enervating experience. On the one hand, the person is too "rugged" to fit neatly in our theoretical conceptions. S/he invites a complex interplay of multiple theoretical perspectives, each of which can provide a partial understanding of her situation. But perhaps most importantly, the person is not really interesting to us as scholars … unless she completes an action or some outcome transpires, so that we can then focus on explaining what has occurred. In other words, we have to follow a step behind and look backwards rather than forwards in her entrepreneurial journey. Before the entrepreneur acts there is not really a phenomenon to explain.

On the other hand, s/he can seek to engage our research prowess to answer the question

'what shall I do?'. The appeal of this research question depends on implicit norms about the nature and purpose of research. To the extent that research aims to produce propositional knowledge in the form of general theory, whereby the researcher stands independent of the research context, the question has limited appeal. Indeed, to offer an answer would be to "contaminate" the entrepreneur's journey as a potential research setting. And even if an answer were provided, it would be seen as mere deductive application of prior research knowledge, based on the closest match between the current context and the theoretical domains and a *ceteris paribus* proviso. In our encounter, the entrepreneur's practical activity is subsumed by our academic conception, to be represented and not lived (Nicolini, 2012). In the process, we retreat to the "high ground" of well defined problems that lend themselves to technical solutions, while leaving the entrepreneur in the "swampy lowland" of confusing problems that defy technical solutions (Schon, 1987).

We can of course stay in the "swamps" and use our expertise honed in many years of research and teaching to help the entrepreneur understand the situation s/he is facing and consider courses of action. While this can be dismissed as a form of consulting and thus not *bona fide* research activity (i.e. that would lead to publication in a prominent outlet), deliberate, and reflective engagement of this sort can constitute a powerful endeavor that blends the principles of action science (Argyris, Putnam, and Smith et al., 1985) with the creative, purposeful power of design (Simon, 1969/1996).

In the meantime, the entrepreneur may look for answers elsewhere, in the experience and stories of those who have gone and succeeded before them, or in the advice of their trusted friends, colleagues, or professional advisors. Regardless of the sources, the entrepreneur does something … and leaves a trail of sorts. And the trail attracts the scientist who can describe it and explain it. But while the scientist looks backwards, the entrepreneur keeps looking forward, blazing the trail. Now, the trail exists once made but there is nothing natural or pre-existing

about it – it represents a journey of worldmaking (Sarasvathy, 2012), reflecting the idiosyncratic nature of the problems defined, actions taken, advice received and the complexity of the situation in which the action occurred, triggering reactions from other market actors.

In the context of the popularity and widespread use of tools and approaches such as the business model canvas, lean start-up methodology, customer discovery methodology, and design thinking, the question arises of how academic scholars can engage in and contribute to these conversations. This is a crucial question because the formalized toolbox of entrepreneurial practice raises doubts about whether entrepreneurial phenomena are natural in the sense of unfolding out of some universal, law-like necessity, to be studied by detached, impartial observers. To the extent that this is not the case, a new logic of inquiry arises that offers an opportunity for a better alignment between academic scholarship and entrepreneurial practice.

This paper addresses these questions by revisiting the fundamental premises of scholarly inquiry in entrepreneurship and identifying roads not taken. It then sketches out a new logic of inquiry, grounded in design science, and articulates the new types of research activities that comprise it.

NATURAL VS. ARTIFICIAL PHENOMENA

The main starting point for discussion is Simon's (1969/1996) distinction between natural and artificial phenomena, the former defined by "necessity" and the latter by "contingency", molded by goals and purposes. This distinction poses a problem of artificiality related to how to make empirical propositions about contingent phenomena, i.e. those that could turn out differently under different circumstances. The term 'natural' is used here in the sense of *existing,* i.e. what already is, rather than as limited to the realm of the natural sciences

(i.e. biology, chemistry, physics). Thus, phenomena such as an airplane or a new firm can be treated as both natural and artificial. As the former, they are taken for granted and analyzed through the methods of description, modeling and explanation. As the latter, the focus is on how they are designed or constructed, which falls into the realm of the design disciplines (e.g., arts, architecture, engineering).

Entrepreneurial phenomena lend themselves to both natural and design science approaches. Their processes unfold over time and one inevitably has to choose a time reference point in studying them (McMullen and Dimov, 2013). This reference point creates an arbitrary separation between what has already happened and what is yet to happen, both of which can serve as objects of research. A definite outcome, such as an established new venture or a failed effort to do so, is something that can be described and explained retrospectively, as an object of theory grounded in natural science. In contrast, the open-ended process lying ahead offers hardly anything that can be taken for granted, to be described or explained. Thus, scholars operating in the natural-science paradigm only become interested in the acting entrepreneur when something happens that can then become the focus of description and explanation. Until then, s/he is empirically irrelevant.

In the current study of entrepreneurship, the dominant conception is of a natural phenomenon, i.e. one to be described and explained retrospectively. This conception represents a paradigm within which the very nature of the phenomenon under study is taken for granted and rarely questioned. As a result, attempts to articulate entrepreneurship as a science of the artificial (Sarasvathy, 2003; Selden and Fletcher, 2015; Venkataraman et al., 2012) have remained disparate and gathered little traction. What is more, their output can become an easy target of criticism within the existing paradigm. A case in point is the difficulty of understanding the nature and purpose of effectuation as a theoretical perspective (Sarasvathy, 2001). In a recent critical assessment, Arend, Sarooghi, and Burkemper (2015) conclude that

effectuation is an underdeveloped, not yet solid theory, falling short on most criteria for a scientific theory. That this criticism asks the wrong question is not immediately evident.

Nevertheless, there is a strong momentum towards developing a perspective of entrepreneurship as a design activity. One thrust has come from embracing the open-ended, worldmaking nature of entrepreneurial action based on the logic of non-predictive control (Sarasvathy, 2012). Another has come from the importance of design thinking in teaching entrepreneurship (Neck and Greene, 2011). As they stand, both of these lines of thought are limited to articulating a generic sense of unbounded possibilities, i.e. entrepreneurial action for its own sake. What they lack is the sense of purpose that defines individual entrepreneurs and gives some focus and meaning to their efforts. Indeed, artificial phenomena are to be understand through the goals and purposes molding them (Simon, 1969/1996). By making purpose front and central, we can position the intellectual effort away from non-committal speculation, as a focused, deliberate, qualitatively different branch of inquiry. Contextualizing the 'artificial' aspect of entrepreneurship can preempt its treatment as an offshoot of the existing paradigm, and thus its rendering as a misfit on the basis of the fundamental logic that defines the paradigm. The next section attempts to provide such contextualization.

DESIGN AS A DISTINCT MODE OF RESEARCH

Romme (2003) outlines three ideal-typical modes of engaging in research. The first two, science and humanities, are well familiar and present in entrepreneurship research. The science mode is oriented towards explaining phenomena through uncovering general patterns, while the humanities mode is oriented towards describing the human experience. The third, design mode is distinct in that it studies systems that do not yet exist. Its orienting question is 'will it work?' rather than 'is it valid or true?'. Its view of knowledge is pragmatic, driven by whether

knowledge is useful for action towards a particular purpose. As such, it fits with design and engineering disciplines as well as the creative arts.

Among the business-related disciplines, design has been a dominant mode of inquiry in information technology and information systems research, based on the recognition that it studies artificial phenomena, must be grounded in real-world problems, and thus must create artifacts that serve human purposes (March and Smith, 1995). As March and Smith (1995) argue, design and science are interrelated in three ways: (1) the artifacts created through design can become the subject of scientific inquiry; (2) artifacts are created with understanding of natural laws; (3) the effectiveness of artifacts can provide substantive tests for (natural) science research.

In a similar manner, Vincenti (1993) draws a distinction between engineering and scientific knowledge. The former is developed for practical utility, to solve particular problems, while the latter is developed for the sake of understanding. In turn, engineers use knowledge to design artifacts, while scientists use it to derive new knowledge. Although there is great overlap between the two in terms of the knowledge generation activities carried out (i.e. methods), the epistemological distinction between the two categories is derived from priority and purpose. In the context of entrepreneurship, this distinction raises the simple question of whether scholars of entrepreneurship should be seen as scientists or engineers. There is clearly room for both roles, even though over time the quest for academic standing and legitimacy has led to a dominant identity as scientists.

Given the distinct nature of design knowledge, it is useful to understand the nature of activities associated with its generation. March and Smith (1995) provide a research framework that distinguishes research activities and research outputs and, further, maps these to the domains of natural and design science. Research activities include build, evaluate, theorize, and justify. The first two belong to the design science, pertaining respectively to the

construction of specific artifacts and demonstrating that they meet the desired goals or performance criteria. The latter two belong to natural science, pertaining to developing theoretical explanation of how something works and validating that explanation with empirical data. This framework is presented in Table 1.

-- Insert Table 1 about here --

Research outputs include constructs, models, methods, and instantiations. These apply to the full range of research activities, but can play slightly different role depending on whether the research efforts are grounded in natural or design science. *Constructs* represent the basic vocabulary of the domain in thinking about and describing the phenomenon at hand. Examples in the entrepreneurship space include customers, value proposition, business model, business plan, etc. *Models* capture relationships among constructs as a way of representing the situation at hand. Natural scientists use models as a synonym for theory to inform their empirical research, while design scientists use models to define the problem at hand and thus inform its solution. Thus, while in the former conception, a model constitutes a rigid representation that needs to be verified, in the latter conception it is a fluid marker of emergent possibilities. In the context of entrepreneurship, an example of the formal is a relationship between human capital and business planning on venture development or performance; an example of the latter is a sketch of how a venture is to operate or of the customer journey in engaging with a product.

Methods refer to the set of steps necessary to carry out a task. Natural scientists are primarily users of methods, whereas design scientist produce as well as use them. For instance, the former may look at methods for data collection and analysis, while the latter may consider ways of visualizing data or gathering novel data that, although not suitable for testing hypotheses, facilitates decisions. Finally, *instantiations* refer to the realization of artifacts, such as the creation of product prototypes, eliciting reactions or parameters for commitment by customers, partners or investors or simply getting a yes/no closure on such commitments.

These represent the forging of a path of history, whereby multiple possibilities at a given junction are subsumed under what actually happens. These are carried out primarily by design scientists although, once introduced, studying them can advance both natural and design science.

In his discussion of the 'anatomy' of engineering knowledge, Vincenti (1993) identifies different categories of knowledge as well as different forms of knowledge-generation activities. The knowledge categories include: (1) fundamental design concepts; (2) criteria and specifications; (3) theoretical tools; (4) quantitative data; (5) practical considerations; and (6) design instrumentalities. *Fundamental design concepts* refer to operational principles and configurations. In the entrepreneurship context these are reflected, for example, in the notions of profitability and firm, and are well articulated in the business model canvas as an operational model of a business with all the inter-relationships among its activities.

Criteria and specifications refer to the goals at hand. In entrepreneurship, these can pertain to the economic, social, or environmental impact of the venture as well as the specific psychic income that the entrepreneur may derive from these activities (Gimeno et al., 1997). *Theoretical tools* facilitate thinking about design and the making of relevant design calculations. Relevant examples include the fundamental constructs through which we describe entrepreneurship (e.g. opportunity, customer, value), theories from marketing and operations that inform the design of the venture as well as financial tools such as capital planning and discounted cash flow that inform financing and valuation. *Quantitative data* refer to accumulated evidence about the effectiveness of various venture parameters.

Practical considerations pertain to the tacit understanding that originates from practice and is often codified in rules of thumb used by practitioners. For example, the VC method of valuation has arisen from the difficulty of valuing early-stage companies in the face of uncertainty and lack of operating history. Other examples include specific milestones such as

incorporation, IP protection, 2-year survival, reaching revenue stage, cashflow positive, certain revenue stages ($100k, $1m) or opening a second location. *Design instrumentalities* pertain to procedural knowledge or the way of doing things. These comprise procedures, ways of thinking, and judgment skills. Examples include building a minimum viable product and gathering customer feedback, running small product trials, building a financial model, resource planning for expansion, assessing total market size, thinking about how easy it is for competitors to replicate or retaliate, or staying true to one's passion.

In regard to knowledge-generation activities, Vincenti (1993) discusses the following categories: (1) transfer from science; (2) invention; (3) theoretical research; (4) experimental research; (5) design practice; (6) production; and (7) direct trial. *Transfer from science* refers to theories and empirical findings from scientific studies that can inform problem definition and solving in the context of design practice. Although perhaps not directly translatable, in its classic form, to entrepreneurship, *invention* refers to the creation or serendipitous discovery of fundamental concepts. This may resonate with entrepreneurial efforts with serendipitous beginnings where market validation is provided for concepts previously not considered probable or viable. In a broader sense, we can also consider the invention of different uses for a given product or technology. *Theoretical* and *experimental research* corresponds to familiar activities in scientific practice, except that their focus is more explicitly on application rather than understanding. *Design practice* refers to day to day practice that can hone judgment and develop rules of thumb that can motivate further research. Classic examples are the abilities of angel and VC investors to screen out investment proposals and of experienced mentors to identify gaps in reasoning or potential hurdles. *Production* can codify experience into various kinds of quantitative data such as customer acquisition costs or gross margin. *Direct trial* pertains to the testing of products with potential users to reveal if their performance is as intended. It is a fundamental part of contemporary entrepreneurial practice as exemplified by

the lean start-up or customer discovery methodologies.

Vincenti maps research activities onto the various forms of knowledge that they can generate, as shown in Table 2.

-- Insert Table 2 about here --

Clearly, there are sets of activities and outputs that, while important for entrepreneurial practice, currently do not represent legitimate forms of entrepreneurship research. In other words, the core issues here are the meaning of the term "research", the relative standing and interrelationship of basic and applied research, and whether an academic engaging in such activities can be deemed to be research active. These activities fall within the realm of design science and are represented as the shaded areas in Tables 1 and 2. Although ostensibly of applied nature, they provide context for reflection that can make a contribution as basic research.

In Table 1, the activities of building and evaluation stand out as a blindspots for entrepreneurship research. Whereas an arts academic can deliver a piece of composed music as research output, can an entrepreneurship academic's contribution to start-up efforts be seen in the same light? In Table 2, the activities of design practice, production, and direct trial are of similar nature. But there are also two knowledge categories – practical considerations and design instrumentalities – that do not live up to their full potential in current research. While the examples of these categories, as specified above (milestones, planning, etc.) certainly do show up as constructs or variables in current research, they do so in categorical rather than qualitative sense. Thus, the research questions around them have been poised in terms of whether these factors make a difference without consideration of how they are used or of can be used better. A good example relates to the theoretical question of whether having a business plan (regardless of the nature of the plan) matters of performance as opposed to the practical

question of what makes a good business plan, ascertained through its use. Before discussing how these outputs can be implemented in entrepreneurship research, it is necessary to define the context in which they will arise.

OPPORTUNITY AS DESIGN ARTIFACT

In its natural-science mode, entrepreneurship research seeks to connect the present and the future by explaining the link between the present and the past. Compared to the past, the present always contains novel elements: new goods, new services, new raw materials or new organizing methods (Casson, 1982) as well as various artifacts of failed efforts. Their presence now suggests that they have been possibilities of a past future, a set of lucrative opportunities (Venkataraman, 1997), whether perceived or mis-perceived, exploited or blundered. The aim of entrepreneurship theory has been to explain how, starting from the past, such opportunities come to be realized; and then use this knowledge to project the process forward. This question has proven elusive to conceptual assimilation, despite being tackled from different directions.

One line of analytical attack has been to define the nature of opportunities as endpoints of a process and then portray entrepreneurial activity accordingly. The ideas of Austrian economists – and particularly the notion that entrepreneurs are alert to and discover profit opportunities (Kirzner, 1979) – have been seminal in the field. Although this notion had been put forward as a metaphor for the micro drivers of the economic system (Kirzner, 2009), as the field moved from economics to management, this metaphor has been reified and its literal interpretation has made opportunities an exogenous endpoint: "objective phenomena that are not known to all parties at all times" (Shane and Venkataraman, 2000: 220). In this sense, they are deemed to be discovered, evaluated, and exploited by enterprising individuals (Venkataraman, 1997).

In contrast, opportunities can also be seen as endogenous endpoints, defined while pursued, within the worldview of individual entrepreneurs. In this sense, opportunities lie at the tail end of a stream of continuously developed and modified ideas (Davidsson, 2003; Dimov, 2007). Until realized, they exist in the imagination of entrepreneurs (Klein, 2008; Shackle, 1955) and thus cannot be separated from them (Companys & McMullen, 2007; Sarason, Dean, & Dillard, 2006). In the way that they ultimately become known to external observers, they are subject to path dependent formation from the actions of entrepreneurs (Alvarez, Barney, and Anderson, 2013).

Although each view highlights important aspects of the individual-opportunity link – objective boundaries and subjective process – neither view provides empirical content, i.e. to enable the entrepreneurial process to be specified or observed, let alone applied. Whether opportunities are found or formed is but a semantic link between process and outcome in the sense that the process is defined only in terms of what it is supposed to achieve (Drazin and Sandelands, 1992). Thus, when opportunities are seen as fixed endpoints, they are associated with a process of discovery; when they are seen as path-dependent creations, they are associated with a process of formation, development or design. Because these semantic descriptions are cast in a generic sense – of the process as a whole – they do not offer a substantive account of what is actually happening or achieved (Dimov, 2011), i.e. what does opportunity discovery or opportunity creation really mean? How does one know that s/he has discovered / created an opportunity? As such, they do not offer any tangible markers for acting towards a future not yet known; they are inherently retrospective.

In response to this, recent work has sought to identify empirical premises for the entrepreneurial process. It is triggered by venture ideas, driven by actions from these ideas, and instituted in market exchange relationships that become the tangible markers of an opportunity

(Dimov, 2011). Similarly, opportunities can be portrayed as artifacts arising from the actions and interactions of entrepreneurs (Venkataraman, Sarasvathy, Dew, and Forster, 2012). What is missing from this line of thought, however, is a sense of defining boundary, a purpose or driving logic to the actions and interactions that would enable a set of discrete, seemingly idiosyncratic actions and events to be strung together in a coherent entrepreneurial process. In other words, what can we learn from one realization of the process to another? What actions or interactions are relevant or useful?

So, what is an opportunity? Let's answer this question by attempting to construct one. We need two sets of elements, agents and artifacts. Some of the agents act as consumers and what they consume is an artifact, i.e. product or service. Other agents act as providers of labor or other artifacts to help produce the artifact to be consumed. The entrepreneur(s) is yet another agent who controls the focal product or service and thus brings together the production and consumption sides. The opportunity is not the simple collection of such agents and artifacts. Its essence lies in the set of particular relationships created among them. Each relationship denotes a pattern of interaction between actors. It represents an ongoing exchange activity such as employment, supply, production, distribution, and consumption and is an indelible part of the realization of the opportunity.

Described in such concrete terms, an opportunity is a social structure. It is a meso-level, macroscopic structure, above the individual agents but below the economic system as a whole. Except for some novel artifacts, its elements can be largely deemed to exist. It is their weaving into the particular relationship pattern that constitutes the construction of the opportunity. In this sense, an opportunity is an emergent entity – more than the collection of its individual parts and arising from the interactions among them. Similar to other social structures such as organizations, an opportunity is both objective and subjective: it cannot exist without its

elements; but, equally, it cannot be seen without "drawing" the relationships among them (Drazin and Sandelands, 1992).

In between the unconnected elements and their connected structure operates an evolving entrepreneurial intent (McMullen and Dimov, 2013) as well as an organizing process (Weick, 1979) marked, aside from its intentionality, by the combination and control of resources, establishment and maintenance of boundaries, and engagement in exchange relationships (Katz and Gartner, 1988). The entrepreneur is effectively a progenitor of this social structure in the sense that s/he "sees" possible relationships among currently unconnected actors and artifacts and works on establishing them. Sometimes they arise as envisioned, other time they do not and are possibly replaced by other, more workable relationships. Thus, the ultimate social structure may bear little resemblance to the one envisioned at the start. In this sense, opportunity as social structure is a design artifact that arises at the intersection of entrepreneurial intent with the constraints of the economic, social, and technical context.

The current difficulty for entrepreneurship theory in taming the opportunity construct lies in its grounding in natural science, i.e. in the need to take opportunity for granted, as something that is, as something to be described and explained through some inevitable, law-like tendency. The first part, taking opportunity for granted, works as long as an opportunity is already realized. Indeed, opportunities are retrospectively clear but prospectively opaque (Dimov, 2011). The second part, however, remains elusive in the sense that retracing the history of an opportunity readily reveals the contingent nature of its path, i.e. that it could have turned out differently if different decisions had been taken at various junctions (Sarasvathy et al., 2008). Precisely because the developmental path of an opportunity is marked not by a single decision but by a series of decisions, each contingent upon the previous (Dimov, 2007) in a

constantly extending 'corridor' (Ronstadt, 1988), the idea of an overarching law as a relationship between inputs and outputs may be the problem itself. The next section develops the notion of recursivity as a different generative source.

RECURSIVE ACTION AS GENERATIVE MECHANISM

Drazin and Sandelands (1992), synthesizing a vast array of prior work in both natural and social science disciplines, distinguish three levels of social structure: observed, elemental, and deep. The *observed* level is the one at which an observer can make out a social fact such as an organization or an opportunity. This is the level at which the opportunity is perceived in a holistic sense, as a single entity, and at which the arguments about the nature of opportunities reside. At the *elemental* level, one observes the states and interactions of the actors that compose the observable structure. The elemental structure thus consists of what entrepreneurs do and with whom they interact. Empirical studies of the nascent entrepreneurial process as a series of actions and milestones (e.g. Carter, Gartner, and Reynolds, 1996; Davidsson and Honig, 2003) effectively map out the elemental structure of opportunities.

The *deep* structure is not observable. It pertains to the (tacit) rules and positional information that drive the actions and interactions of the actors that create the elemental structure and, over time, give rise to the observed structure. As actors have bounded rationality and only partial, limited information, these rules are simple but recursive in nature, i.e. they are applied repeatedly to the changing circumstances of the actor. Another key feature of deep structure is the actor's positional information, i.e. the knowledge and information available to the actor at a given point in time. It reflects the actor's personal knowledge, experience, and social network. In this sense, deep structure pertains to how actors decide what to do based on the information they have at that moment, as repeated enactment of simple rules.

To specify the deep structure of opportunity requires an elaboration of the considerations or rules that different actors – for example, entrepreneurs and prospective customers – follow in their actions and interactions. These rules are applied to their positional information to determine their response. In turn, their responses as well as exogenous developments, change their positional information and thus give rise to new responses when the rules are applied recursively, i.e. when the output of one action becomes the input to the next. The power of recursivity lies in its ability to open non-linear paths and generate complex structures.

The idea of recursivity is linked to the broader notion of iterated functions as simple dynamical systems. Under the logic of a covering law as a linear relationship between inputs and outputs (nomothetic explanation), explaining a complex phenomenon necessarily triggers a search for a complex set of causes. The study of simple dynamical systems, however, suggests that simple, deterministic rules, when applied recursively can lead to non-predictable outcomes that are highly sensitive to initial conditions (May, 1976). Indeed, May's concluding statement has become seminal:

> The fact that a simple and deterministic equation can possess dynamical trajectories which look like some sort of random noise has disturbing practical implications. It means, for example, that apparently erratic fluctuations in the census data for an animal population need not necessarily betoken either the vagaries of an unpredictable environment or sampling error: they may simply derive from a rigorously deterministic population growth relationship (1976: 8).

A core issue with nomothetic explanation is the search for a deterministic relationship between inputs and outputs. However, they belong to different sets – expanded both in space and time. That is, outcomes reflect factors from outside the factor space and from the way this space has changed over time. In addition, theoretically, the relationship works as a one-time shot. What is missing is the recursive nature of the expansion of the space-time domain. In

contrast to a nomothetic explanation based on causal regularities, generative explanation is based on specifying the mechanisms that give rise to a macroscopic regularity (Cederman, 2005). One core mechanism is the recursive nature of entrepreneurial problem solving, i.e. the idea that entrepreneurs repeatedly seek to solve the problems that arise from their actions. It is therefore essential to understand how problems and actions are intertwined in an entrepreneurial setting.

PROBLEMATIZING ENTREPRENEURIAL ACTION

Tracing the development of an entrepreneurial endeavor is likely to reveal a winding path. The path in between is marked by actions and interactions driven by some underlying, evolving purpose (Venkataraman et al. 2012). In other words, each stage of the path represents a snapshot of the entrepreneur "doing" something. But a sequence of behaviors can appear meaningless to an external observer without accounting for their underlying purpose. Rather than simply enlist the nature and sequence of actions, we need to account for the evolving symbolic blueprint behind them, i.e. how the entrepreneur defines them and deliberates them at each step of the way. To use the metaphor of driving a vehicle off road, in addition to simply describing the twists and turns of its path, it is also useful to try to capture the forging of the path through the eyes of the driver. That path is an artifact of sort and, as such, lies at the intersection of inner and outer environments: the former reflects the purpose behind the effort and the latter the molding effect of the terrain (Simon, 1969; Selden and Fletcher, 2015). In this sense, the path is jointly created by two forces, one pushing forward (purpose) and the other backward (constraints, obstacles, or lack thereof). In other words, each action can be seen as purposeful, forward pushing against constraints… just like the flow of water.

A flow of water seeks to retain its circular shape against the shape of the vessel in which it flows, thereby creating various forms of turbulence (Schwenk, 1969). In a similar fashion, the entrepreneurial process can be portrayed as flow working against constraints. The impetus for the flow is the entrepreneur's quest to complete a sense of wholeness via new relationships. This quest represents, more broadly, an adaptive tension as an energy differential (McKelvie, 2004) or, more specifically, an opportunity tension as an internal drive (Lichtenstein, 2009). It can arise from a variety of factors such as desire for financial wealth, need for recognition, sense of role fulfillment, or social values (Carter, Gartner, Shaver, and Gatewood, 2003), which create the forward flow. The sense of purpose is expressed in a symbolic blueprint of what the ultimate relationships would look like (Dimov, 2011). The inertial force of the status quo acts to constrain the flow in the sense that the envisioned relationships are unlikely to arise unless proactively instituted. The flow is ultimately realized in the creation of new artifacts that complete these relationships and the exchanges inherent to them (Venkataraman, Sarasvathy et al., 2012). The process is open ended in the sense that the set of directions and outcomes is unbounded, generated from the constant interaction of emerging constraints and the evolving momentum of the flow.

Collectively, the process is described by all its twists and turns. Each of these, in turn, represents a momentary realization of the flow-constraint interaction, akin to the notion of a derivative of a function at a particular point (i.e. it represents the slope of the function or the "direction" of its travel at that point). Therefore, the recursive nature of the process lies in the repeated interaction between flow and constraints. At each point, this interaction is represented by what the entrepreneur is trying to do or achieve and by the degree to which the outer environment yields. The move by the entrepreneur is a key focal point as it not only elicits a response by the outer environment but also reflects the way the entrepreneurs views the situation at hand and defines what problem to tackle. Indeed, while the overarching purpose to

the journey may be clear, what to do in each particular situation (i.e. which of several possible paths to take) may not be.

Problem setting or framing is a key aspect of action (Argyris, Putnam, and Smith, 1985) and problem solving (Newell and Simon, 1972). There are different ways to make sense of a situation, to define the problem to be solved, and to enlist possible actions. This is consistent with the chaotic nature of the early stages of the entrepreneurial process (Cheng and Venkataraman, 1996). The idiographic nature of the entrepreneur's positional information and his or her sense for what to do in the particular situation interplay at full force, reflecting a wealth (or lack thereof) of life experience. In this regard, constructs such as prior knowledge, intuition, and judgment are simply collective descriptions of the unbounded nature of the sets of prior experience and actions undertaken. Thus, the generalized statements that entrepreneurs make sense of the situation, define a problem they wish to solve, and act according to their intuition or judgment are simply placeholders for a closer and more elaborate description of their deliberation.

The above arguments suggest that to understand why an entrepreneur engages in a particular action, we need to account for the problem that the entrepreneur is trying to solve, i.e. for the way s/he is framing the situation at hand. For instance, while the fact that one entrepreneur looks for a premise and another files a patent application poses the issue of unfathomable heterogeneity among entrepreneurs, both activities can be represented as solutions to problems that the entrepreneurs face. Thus, when we seek to draw inferences from observed action, we need to be conscious of the fact that the problem towards which the action is directed – as defined by the entrepreneur – most often remains hidden.

Figure 1 represents the interplay between entrepreneur, situational framing / problem definition, and action. The top part shows the situation as we currently experience in empirical

research, whereby we observe entrepreneurs and their actions but the problems for the sake of which actions are undertaken are entirely subsumed in the entrepreneur and thus unobservable to us. Thus, to use the earlier terminology, while we observe the elemental structure of the entrepreneurial effort (i.e. the actions undertaken), we cannot observe its deep structure, i.e. how the entrepreneur links positional information to action through the framing of the situation and definition of a problem.

-- Insert Figure 1 about here --

It is therefore essential to bring the underlying framing / problem definition to the fore, by examining it separately from the entrepreneur, as shown in the bottom part of Figure 1. The figure recognizes not only that the given problem (Framing 1) is solved by the particular entrepreneur through the given action ($Action_0$), but also that it is possible to undertake other actions to solve the particular problem ($Action_1$) as well as to pose different problems in the given situation (Framing 2) which in turn would lead to different actions ($Action_2$). Indeed, if other entrepreneurs were put in the same situation, they are likely to act differently, whether because they choose different actions for the same type of problem or see different problems in the same situation.

The underlying questions therefore relate to examining the merits of (1) an action given a particular framing of the situation and (2) a framing of the situation given an overarching purpose. In terms of theory of action, the first question represents single-loop learning, while the second double-loop learning (Argyris and Schon, 1978). In current research, these question do not arise as we take the entrepreneur's actions for granted, regardless of their 'quality'. In other words, we do not take into account what the entrepreneurs are trying to do in undertaking the particular actions. This suggests that, within a conception of an individual-opportunity nexus in which we look to identify the characteristics of lucrative opportunities on the one hand and enterprising individuals on the other (Venkataraman, 1997), significant variability can

arise from an examination of the actions that comprise an entrepreneurial effort (cf. Ramouglou and Tsang, 2015).

The separation of the problem from the entrepreneur addresses a blindspot in current research. More importantly, the definition of the problem and the way to solve it can be turned into an object of research. As an endeavour motivated by pragmatic use, it belongs to the domain of design science in the sense that it deals with the creation of artifacts and builds upon the foundations laid by action science in the sense that it requires knowledge in the service of action (Argyris, Putnam, and Smith, 1985). It is therefore possible to define a research program by elaborating the distinct nature of its knowledge-generating activities and outputs.

TOWARDS A DESIGN SCIENCE OF ENTREPRENEURSHIP

The primary mission of design-oriented disciplines, such as medicine and engineering, is the creation of preferred futures, driven by search for solutions to real-world problems (Van Aken and Romme, 2012). In a similar vein, a design-science approach to entrepreneurship would focus on the effort to envision and generate products, services, ventures, firms and other artifacts that do not yet exist, oriented towards the fulfillment of specific purpose. The consideration of purpose is key since the question of how things ought to be can be raised only in reference to that purpose (Simon, 1969/1996). In this sense, the design-science approach described here is situated in a broader realm of 'worldmaking' (Sarasvathy, 2012) but is anchored by purpose that makes some futures preferred to others and oriented towards informing and being informed by specific actions. Thus, while goals do emerge in the worldmaking process as enacted through the principles of effectuation (Sarasvathy, 2001), these principles leave significant leeway for the formulation of specific actions and there is no

feedback loop whereby they can be questioned or modified in the light of the consequences of the action.

Therefore, the starting point to a design-science inquiry would be some initial or preliminary business idea that contains a sense of product or service and a reason for its use (e.g. a need). The business idea represents a concrete path towards the fulfillment of a broader purpose such as the solution of a social or other real-world problem, desire for autonomy or desire for financial gain. In view of this, there are two relevant questions that can be asked:

1. Does the realization of the particular business idea fulfill the broader purpose?

2. Given the business idea, what shall one do to realize it?

Although this section focuses largely on the second question, the first question itself can also be the basis of a design inquiry, albeit of a different nature. It relates to how to identify possible entrepreneurial solutions to real-world aspirations or challenges. It also acknowledges that solutions need not be necessarily entrepreneurial and that entrepreneurial solutions need not necessarily be possible. Thus, it helps contextualize the second question as representing a developmental loop embedded within a broader solution loop. In other words, it represents an important place for retreat and reflection when current entrepreneurial efforts reach an impasse or a dead end.

It is important to reiterate here that the design science perspective developed here is intended to complement rather replace the natural science perspective. The distinction between the two lies in the choice by the researcher to study entrepreneurship "as it is" or "as it could be". The choice of direction brings with it a distinct purpose for the research efforts, distinct role of the researcher in the research process, and distinct research outputs. These can be seen in the inter-relationships between the community of inquiry, i.e. those undertaking the research efforts, and community of practice, i.e. the entrepreneurs. A choice to study entrepreneurship-

as-it-is presupposes a defined object, an end point or a stable state toward which the explanation needs to converge. It allows for the two communities to be kept separate, whereby the community of inquiry can focus exclusively on precision in causal explanation, by isolating factors and thereby downplaying practical considerations (Argyris Putnam, and Smith, 1985).

But if one studies the world-as-it-could-be, it is not possible to specify a steady state, since the focus is on intended, not yet existing changes that may or may not materialize, subject to both intended and unintended dynamics. In this setting, the two communities cannot be separated and the aim is to form a community of inquiry within the community of practice and thus generate knowledge in the service of action (Argyris et al., 1985). The relevant focus here is on learning about the situation by exploring it through different framings and different actions, while being aware of the implicit assumptions (tacit knowledge) behind each framing and action and reflecting on the consequences to generate new frames and new actions.

Research questions

In focusing on how to realize a particular business idea, given the earlier discussion of the generative power of recursive action, the unit of analysis is the momentary problem or task that an entrepreneur faces in pushing forward. The definition of the problem arises from the way the entrepreneur frames the situation at hand, thereby making some features of the situation salient. This corresponds to dealing with the issue of isotropy (i.e. what is relevant?) as a fundamental element of the entrepreneur's design space (Sarasvathy, Dew, Read, and Wiltbank, 2008). I propose three general framings or meta-categories of design problems as pertaining to the entrepreneurial space: market desirability, operational or technical feasibility, and financial viability. These reflect the basic definition of opportunity as profitable introduction of new products or services (Casson, 1982), prior discussions on the conditions for the existence of entrepreneurial opportunities (Shane, 2012) and the earlier notion of

(realized) opportunity as social structure and capture the different relationships in that structure. In other words, there needs to be actual demand for the product or service in the market (someone needs to buy it), the product or service need to be made of a requisite quality and price to meet that demand (someone needs to make it), and the economics of the effort need to work out over time (the effort needs to be profitable). Successful entrepreneurial efforts lie at the intersection of these challenges, as represented in Figure 2.

-- Insert Figure 2 about here --

In view of this, the following specific research questions emerge in the context of the broader question of what to do in order to realize a business idea:

1.   What shall one do to establish market desirability?

2.   What shall one do to establish operational / technical feasibility?

3.   What shall one do to establish financial viability?

4.   How (in what order) should the above design sub-problems be tackled?

Logic of inquiry

The previous discussion of the research questions underpinning a design-science perspective highlights the interplay between problem framing and action, whereby different actions can be considered within a particular framing and different framings can be considered within the broader purpose (each giving rise to a new set of actions). The same logic of inquiry arises from the design literature, albeit operating at a different level of abstraction and with different terminology. This section thus represents an opportunity to bring the two together.

Dorst (2011) describes the core design challenge as one of applying abductive reasoning, that is creating value through identifying relevant means and working principles, neither of which are given at the start. He uses a simple framework – the equation WHAT + HOW = OUTCOME – to contrast different formal logics of reasoning. WHAT pertains to

people and things, representing different means or elements that can be put together to achieve an outcome. HOW pertains to the interactions and relationships between these elements. OUTCOME pertains to the result of the ensuing process.

In deductive reasoning, knowing the WHAT and HOW enables one to predict the result. In inductive reasoning, by knowing the WHAT and the OUTCOME one can propose a set of working principles (HOW) that links the two. These two approaches largely reflect the dominant logics within a natural science paradigm. In abductive reasoning, one aims for a particular result and looks to identify appropriate WHAT and HOW. In its closed form, designers operate within a given set of working principles (HOW) and aim to identify a set of means that can achieve the outcome. In an open-form abductive reasoning, however, the working principles are not known or chosen and thus have to be identified in conjunction with the means. This view is well captured by Schon (1987):

> In contrast to analysts or critics, designers put things together and bring new things into being, dealing in the process with many variables and constraints, some initially known and some discovered through designing (p. 42)

Dorst refers to the combination of HOW and OUTCOME as a "frame", a particular way of looking at the problem situation and acting within it, building on earlier ideas by Schon (1983) that the ability to frame problem situations represents is a core skill of designers. It is notable that the concept of frame is a point of convergence. Dorst (2011) describes frame as a hypothesis that a particular set of relationships (working principles) can create a desired outcome. Schon (1983) discusses frame as the naming of a problem situation, which creates implications for how it should be approached. Argyris, Putnam, and Smith (1985) discuss framing as the tacit assumptions that underlie one's approach to the situation at hand.

The identification of a frame thus represents a major milestone of design enquiry. Indeed, design problems are unstructured or wicked problems (Martin, 2009). In their seminal discussion of wicked problems, Rittel and Webber (1973) identify several key features that

define them. Such problems have no definitive formulation and are thus both susceptible to multiple framings (based on the viewpoint of the observer) and not understood until a solution is formulated. They have no stopping rule, i.e. there is no clear sense of when the problem is solved. As a consequence, their solutions cannot be judged as right or wrong but as good or bad, depending on the results achieved. The set of potential solutions is not enumerable which makes it impossible to derive an "optimum" solution. Every problem is novel and unique and attempted solutions work as "one-shot operations". That is, an attempted solution can give rise to new problems and these have to be handled; it is impossible to re-set the process, to return to the original point and thus avoid experiencing the new problem.

The conception of wicked problem readily applies to entrepreneurial situations. Indeed, Sarasvathy at al. (2008) point out that such situations are characterized by uncertainty, goal ambiguity, and isotropy (no clear sense of what information is relevant). Framing the situation, the imposition of a structure on it, is thus an essential component of the entrepreneurial process. It allows specific problems to be formulated and triggers search for solutions. This aligns with Dewey's definition of inquiry as "the controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole" (1938/1991: 108).

But crucially, frames should be seen as working hypotheses, to be tested and refined, discarded or replaced. Action or intervention represents the means for doing so, akin to experimentation in the natural-science domain (Argyris et al., 1985). In the spirit of Lewin, this represents a quest to understand something by attempting to change it. The design enquiry rests on awareness of and reflection on the tripartite role of such action: (1) to test a hypothesis, (2) to explore the situation, (3) to change the situation (Schon, 1983).

Role of researcher

A design perspective requires a fundamental shift of role for the researcher, from independent observer to active and engaged stakeholder, leading the scholarly enquiry from within (rather than without) the domain of entrepreneurial practice. It is clear from the nature of the research questions and the (open) abductive logic of inquiry that the exercise of judgment is fundamental to the design approach. Thus, the researcher needs to be as close to the formation and evolution of judgment as possible, in order to capture and reflect on the tripartite role of the action it informs. Aside from acting as an entrepreneur herself, the researcher can work closely with entrepreneurs, whether in a standalone collaborative effort or as part of the experiential activities in an entrepreneurship class. The latter represents a fusion of research and teaching. It links to recent work on a practice-based approach to teaching entrepreneurship that emphasizes the practices of play, empathy, creation, experimentation, and reflection (Neck, Greene, and Brush, 2014).

Fundamental to understanding the judgment behind each entrepreneurial action is what Schon (1987) describes as reflection-in-action, i.e. thinking what one is doing while doing it. This entails continuous consideration of current choices and the tree of further choices they open up. The evaluation of possible moves in terms of the desirability of their consequences, conformity to implications set by earlier moves, and in terms of their potential for opening new problems and moves. The tangible marker in this process becomes the decision that forges a particular path forward. Schon (1987) provides a vivid description of its nature:

> "At some point, he must move from a "what if?" to a decision, which then becomes a design note with binding implications for further moves. Thus, there is a continually evolving system of implications within which the designer reflects-in-action." (p. 100)

In addition, the researcher needs to maintain a reflective stance – reflection-on-action (Schon, 1987) – that enables her to inform the next moves of the entrepreneur. The consequences of action generate information about (1) the situation, (2) suitability of the framing, (3) suitability of the action, as inferred from whether its consequences are 'good' and

'bad' (Argyris et al., 1985). Reflecting on these can help formulate tentative action principles for future situations. As these principles become field-tested over time, their (pragmatic) validity increases (Van Aken and Romme, 2012). Therefore, the role for the researcher in a design enquiry can be seen as one of facilitating reflection and mindful selection of frames and actions to apply in given situations as well as of reflecting on their usefulness and retaining / modifying them for future use.

Research Outputs

The outputs to design inquiry reflect the type of the knowledge that arises from it. Synthesizing the frameworks by March and Smith (1995) and Valenti (1993) there are three categories of knowledge that can arise from design inquiry. They build upon the foundations laid by the worldmaking persective (Sarasvathy, 2012) and the principles of effectuation (Sarasvathy, 2001) by articulating a more precise role for their service of action towards a given purpose.

Constructs. These represent some basic vocabulary for representing the phenomenon at hand (March and Smith, 1995). This also captures Valenti's (1993) notions of *fundamental design concepts.* Constructs allow diverse phenomena or experiences to be seen in the same way. Examples of such constructs include value proposition, business plan, pivot (Ries, 2011) or affordable loss (Sarasvathy, 2001). Although constructs are also essential to a theory-driven, natural-science inquiry, they need to have pragmatic utility in a design mode. In other words, they have to be tangible and meaningful to a prospective entrepreneur, and this is where the opportunity lies to expand the design enquiry.

The articulation of new constructs arises from close interaction with the entrepreneurial practice community and entails capturing and synthesizing the various terms used by them. For instance, in providing feedback to aspiring entrepreneurs, experienced entrepreneurs or

investor would probe them on customer acquisition costs, the customer pain they are solving, the size of the opportunity or an exit multiple. Another investor would refer to a framework of angle, opportunity, timing, and people. With such diversity and overlap of constructs, the academic community can play an important role in developing shared understanding.

Models. These capture relationships among constructs as a way of representing the situation at hand (March and Smith, 1995). They also reflect what Vincenti (1993) refers to as *practical considerations*, i.e. rules of thumb that arise from practice. Again, the formulation of a model allows meaning to be transferred from one design situation to another. A prominent example of a model is the business model canvas developed by Osterwalder & Pigneur (2009) and informed by Osterwalder's (2004) doctoral dissertation on business modeling. Curiously, this dissertation was developed within the domain of information systems and focused on developing a business model ontology as a basis for a programming effort. The notion of a model is used in a relatively loose sense here and thus includes any type of framework for making sense of of a situation at hand and thus inform action. Thus, the primary function of a model is to help structure the decision space to help highlight the relative importance its different aspects and the inter-relationships among them.

Another example of a model is the 7-domains framework for opportunity assessment (Mullins, 2003), which arose from synthesizing the approaches by investors in evaluating opportunities. The framework brings together market (demand), industry (competition), and team considerations as well as distinguished macro and micro levels of assessment, each posing distinct questions. More broadly, new models can arise from a design enquiry as a means to make sense of and direct attention to various factors at various junctions of the entrepreneurial process, e.g. when articulating and sifting through ideas or when looking to grow a business that has been proven on a smaller scale.

Methods. These refer to the set of steps necessary to carry out a task (March and Smith, 1995). They also comprise what Vincenti (1993) refers to as *design instrumentalities*, which also include ways of thinking and judgment. Methods can be proposed in the form of design propositions or principles on the basis of review and synthesis of prior research findings (e.g. Van Burg & Romme 2014). An example of this are the set of design principles for university spinoff creation initially developed by Van Burg et al. (2008). Methods can also be proposed based on extrapolation from entrepreneurial practice, such as synthesizing the expertise of serial entrepreneurs in the principles of effectuation (Sarasvathy, 2001) or the formulation of the lean start-up methodology (Ries, 2011).

As these knowledge outputs become applied, the researcher aims to answer the questions "Does it work?" and "Is it helpful?". Because these questions are posed in the context of a specific framing / action hypothesis, by reflecting on what has worked and what has not, the researcher can then suggest ways to refine, extend or otherwise improve these models as well as to specify the contextual conditions in which they work. An important question here is drawing the distinction between failure (deficiency) of the model/method itself and failure in its application. This in turn can lead to new constructs, models or methods. In addition, observed regularities can give rise to new research questions from a natural-science perspective in search of the theoretical explanation of the mechanism generating them. Once developed, these explanations can become incorporate in new design proposition.

It is clear that the outputs discussed above need different forms of dissemination. They do not readily fit the criteria set by top academic journals, which typically emphasize theoretical contribution based on seeing theory as an end in itself. While books and practice-oriented journals represent viable dissemination outlets, the question of their perceived value in assessing academic performance looms large. Although citation counts may represent a useful proxy for dissemination, much of the pragmatic value may be associated not with a

bibliographic reference but with direct application. In addition, while evidence-based approaches to entrepreneurship research can also facilitate the systematic accumulation of knowledge (Frese et al., 2012), the constructs, methods, and models they evaluate are largely limited to those articulated within a mainstream science perspective. To the extent that they focus on design-related knowledge, this may be in terms of categorical rather than substantive use. These considerations call for different metrics.

CONCLUSION

From the position of the present, at the interface between past and future, one can look in two directions: towards the past, to make sense of what has happened, or towards the future, to enact a purpose. Mainstream scholarship in entrepreneurship delineates the former as a domain of inquiry and the latter as a domain of practice. Thus, while an entrepreneur is interested in facing and acting towards the future, an empirically-minded academic may be drawn by prevailing norms towards explaining the past, waiting for the entrepreneur to create a new "past" and thus maintaining a stance of impartial observer. This paper seeks to close the separation between entrepreneur and academic, blending the domains of inquiry and practice, by orienting inquiry towards the future and positioning the academic as an active and engaged stakeholder in the entrepreneurial process.

The paper scopes a design science of entrepreneurship, focused on the enactment of entrepreneurial purpose, i.e. on the reasoning, action, and reflection of the next step. It blends a perspective of action as both a mode of experimentation and a generator of new information with the nature of design as the creation of artifacts towards a purpose. To derive its focus, the paper draws together a variety of perspective that can help put entrepreneurial phenomena in a new light.

First, it outlines the distinction between natural and artificial phenomena, the former taken for granted and the latter contingent on purposes and the process of enacting them. Second, it discusses design as distinct mode of research, driven by pragmatic considerations in the name of a given purpose and associated with specific knowledge outputs and knowledge generation activities. Third, it portrays a realized entrepreneurial opportunity as a design artifact, a social structure arising in behalf of an entrepreneurial purpose. Fourth, it offers a generative explanation for social structures based on recursive action. Fifth, it articulates the recursive, generative mechanism of an entrepreneurial process as the problem solving activity of the entrepreneur, operating as a flowing interplay between forward (purpose) and backward (inertial constraints) forces. The core of a design science approach to entrepreneurship lies in separating the problem from the entrepreneur, thereby turning the action deliberation into an object of systematic inquiry and putting knowledge in the service of action.

The ultimate benefits of the adoption of a design science approach to entrepreneurship lie in reducing or even closing the gap between theory and practice, as currently evident in discussions of rigor vs. relevance. The more specific benefits along the way include (1) turning real world problems into questions for entrepreneurship research via the design of entrepreneurial solutions; and (2) developing new theories and methods and thus a richer, more collaborative research ecosystem in which researchers with different philosophical orientations can come together to define problems, enact solutions, and reflect on their consequences.

In closing, the academic study of entrepreneurship is pulled apart on the one hand by striving for academic legitimacy within the University and, on the other hand, by needing to demonstrate practical relevance outside it. Acknowledging that these forces cannot be contained within a single paradigm is an important step towards balancing them. To the extent that they represent competing conceptions of entrepreneurial scholarship, there are winners and losers. Instead, they should be seen as complementary, symbiotic activities, enabling one

another towards greater fulfillment: natural-science scholars can ask more meaningful research questions, while design-science scholars can follow a more rigorous process and develop better outputs.

There is a broader institutional challenge around recognizing the design-science perspective on equal footing with a natural-science perspective. This is essential for the long-term future of universities, as recently captured in a Financial Times special report: "The world is in the business of finding solutions to multi-faceted problems and yet universities are still in the business of finding applications for curiosity-driven research… The threat is not recognizing this and becoming less and less relevant as time goes on" (Financial Time, 2014: 9).

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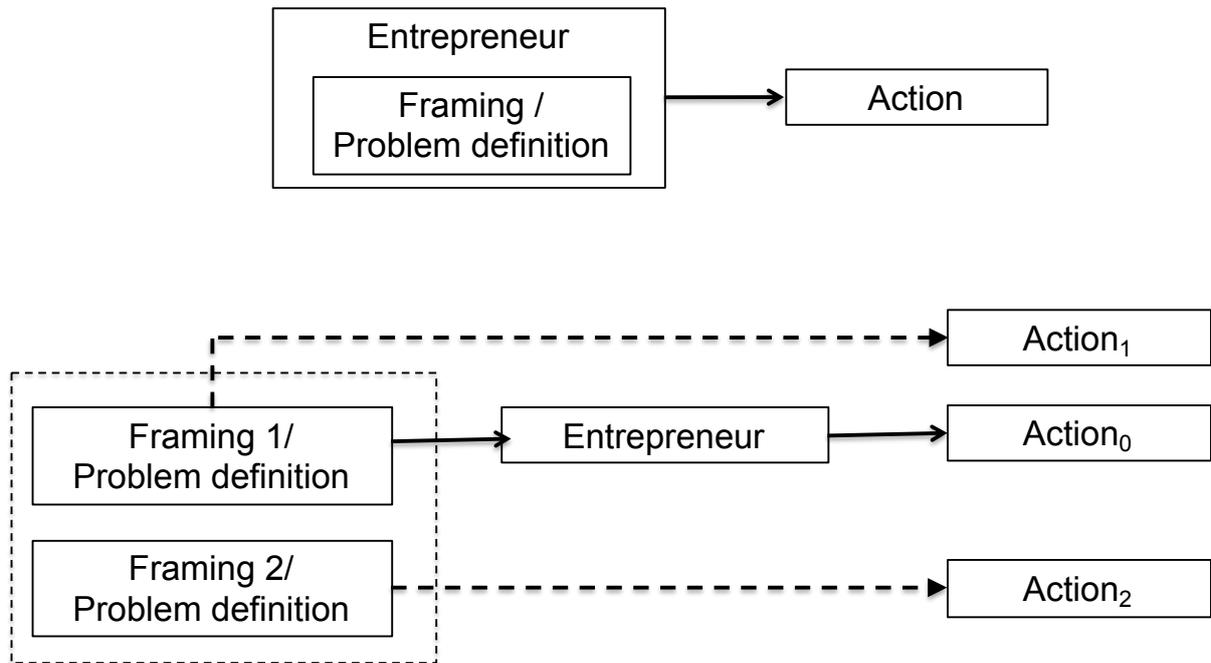
Table 1: Research activities and outputs (adapted from March and Smith [1995])

	Constructs	Model	Method	Instantiation
Build	Design science			
Evaluate				
Theorize	Natural science			
Justify				

Table 2: Knowledge-Generation Activities and Knowledge Categories (adapted from Vincenti [1993])

	Fundamental design concepts	Criteria and specifications	Theoretical tools	Quantitative data	Practical considerations	Design instrumentalities
Transfer from science			X	X		
Invention	X					
Theoretical research	X	X	X	X		X
Experimental research	X	X	X	X		X
Design practice		X			X	X
Production				X	X	X
Direct trial	X	X	X	X	X	X

Figure 1: Separating Problem from Entrepreneur

Figure 2: Archetypal design problem in entrepreneurship

Market desirability

Financial viability

Operational / Technical feasibility