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Embracing uncertainty:
A study of organizational search and structure

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Contents

Abstract

Uncertainty avoidance is a central premise of management theories originating in the Carnegie School. Organizational actors cope with uncertainty by drawing on fixed preferences that result from past learning, which allows them to sustain (bounded) rational behavior. Looking beyond coping mechanisms, I address the question how organizational actors can embrace uncertainty. At the heart of this effort lies the notion that environmental uncertainty can be a source of novelty for actors to leverage, instead of a threat to organizational survival that they need to avoid. I argue that this means to account for both assumptions related to uncertainty: the first about actors' ability to predict future consequences of choices *and* the second about their ability to predict future preferences. To develop a concept of *embracing uncertainty* I suggest to extend the sole focus on human actors' cognitive limitations toward considering variable preferences. Adding variable preferences obstructs a computation of choices but it enables human agency in order to create new choices. A focus on preferences means to move beyond problem definition prior to search and allows actors to consider problems and solutions simultaneously. This provides room for imagination and enables actors to leverage uncertain environments as a source of novelty.

I argue that the perception of uncertainty as a source of novelty requires a conceptual shift of our models of organizational search and structure. That is, search changes from a static computation based on inferences from premises to searching as an agentic process that rests on the consideration of reasonable and desirable preferences through which actors generate novel choices. Accordingly, the concept of structure shifts from something that exists prior to search, to something indeterminate that emerges through searching. I develop these arguments in the remainder of this thesis.

In three related studies I examine how organizational actors tackle truly novel, emergent goals and how this affects the design of the (organizational) structures that they create. I develop a set of closely connected concepts that can advance our understanding of how to effectively organize explorative search processes that can lead to novel outcomes. This thesis commences as follows.

In chapter 1, *Organizing in a Simonian world*, I introduce core concepts of organizational search and structure originating in the Carnegie School. I highlight the conceptual constraints of an intentionally (bounded) rational search process and the related assumption about existing (organizational) structure. A focal point

addresses the computational view of search through local action or cognitive augmentation that leads to organizational improvement or novelty as a result of luck.

In chapter 2, *Searching for true novelty*, I depart from these conceptual foundations of search to conceptualize a process of search that is suitable to reaching beyond the computation or random encounter of choices. By drawing on abductive logic and the field of Design Studies, I reimagine how organizational search may generate novelty in the face of uncertainty. Instead of deductively moving from problem-definitions to solutions, I suggest that, triggered by doubt, organizational actors abductively create contextually plausible causal models to link potentially relevant problems and solutions. I elaborate the consequences of this conceptual shift and theorize abductive search activities that explain how actors may simultaniously search for problems, solutions, and links between them. The resulting framework builds on these insights to show how actors can sustain this generative search process or steer it toward closure—at which point search transitions to the process described in standard models of the Carnegie School. I contribute by providing a concept for an explorative search process and discuss implications of this model for theories of strategy, innovation, and entrepreneurship.

In chapter 3, *Thinking, doing, and the emergence of organizational structure*, I build on the insights from chapter 2 and empirically investigate the agency of organizational search, by studying how actors search in uncertain environments and how this shapes the new organizational structures they create. I inductively build theory from longitudinal case data that I collected by closely following the emergence of 35 new ventures over a core period of 2.5 years. I find two contrasting modes of how founders search to develop organizational structure. Both originate from cognitive biases, either toward the future or the past, and affect the emergence of organizational structures: searching backward from future reference points allows founders to identify related strategies to create coherent organizational structures and achieve a stable development. In contrast, when searching forward from past reference points founders pursue opportunistic decisions to meet short-term performance goals, causing incoherent organizational structures and multi-directional development. By opening the black box of organizational search I depict the process as less mechanistic. Especially when triggered by foresight, it is largely influenced by idiosyncratic human agency. I highlight the power of mental representations to search more specifically in highly uncertain environments and to create more novel outcomes.

In chapter 4, *Designing organizations for abstract goals*, I answer the question how actors can deliberately design an organization capable of embracing uncertainty and leveraging endless slack resources. Together with colleagues, I empirically investigate this question by studying Hyperloop Transportation Technologies, a crowd-sourced organization with constantly joining contributors, who shape the development of a new, commercially functional technology ecosystem. Based on extensive field data, we find a form of organizing that builds on a non-modularization of tasks, constant exploration, and the ability to continuously redesign itself—which we label *catalyst organization*. Our insights shed light on organization designs for innovation activity that lie at the intersection of environmental uncertainty and unlimited knowledge supply—two characteristics that have been mainly considered independently. This paper is published in the Academy of Management Discoveries and appears in that exact version in the Appendix B.

I conclude this thesis in chapter 5, *Toward Marchian foolishness: theorizing exploration*, by discussing how to complement theories of search and organization originating in the Carnegie School with a theory of exploration. I suggest to look at organizational processes that lead to novel outcomes through a lens of *embracing uncertainty* instead of retaining the one of uncertainty avoidance. This means accounting for how organizational actors are actually searching. It is central to this view to understand agency as rooted in cognition, search spaces as initially indeterminate, and organizational designs as loosely connected systems. This allows for a base assumption of organizational purpose that reaches beyond survival and novelty as a serendipitous outcome. I indicate how to build on these insights, linking to the literatures in strategy, innovation, and entrepreneurship. Practical implications address the question how human actors may continue to add value if they will be embedded in artificially intelligent systems.

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Abbreviations

API: Application Programming Interface

ASAP: As Soon As Possible

BTOF: Behavioral Theory of the Firm

CAD: Computer Aided Design

CEO: Chief Executive Officer

CFD: Computational Fluid Dynamics Analysis

CMO: Chief Marketing Officer

COO: Chief Operating Officer

CTO: Chief Technology Officer

FB@Work: Facebook at Work

HR: Human Resources

M: Million

PA: Personal Assistant

R&D: Research and Development

HTT: Hyperloop Transportation Technologies Inc.

3-D: Three Dimensional

1 Organizing in a *Simonian* world

"Every problem-solving effort must begin with creating a representation for the problem, a problem space in which the search for the solution can take place."
(Simon, 1996: 108)

Theories of the Carnegie School[1] are foundational to organization theory. They offer a set of closely connected concepts that are prevalent in the management literature, reaching across and beyond the fields of strategy, innovation, and entrepreneurship (e.g., Argote & Greve, 2007; Dosi & Marengo, 2007; Gavetti, Levinthal, & Ocasio, 2007; Gavetti, Greve, Levinthal, Ocasio, 2012). Central to these concepts is Herbert Simon's seminal and widely influential argument that provides the Carnegie School's theoretical foundation: rational behavior is constraint and merely allows human actors to make satisfactory decisions (1947; 1955; 1956).

Toward Behaviorally Plausible Rational Behavior

Rational behavior builds on two related assumptions (March, 1978). First, a selection among alternative choices is rational when it is based on reason. This assumption refers to the consistency of future outcomes with pre-determined preferences. It relates to what Simon (1947: 55) calls "values"—expectations about the outcomes of decisions. Thus, rational decisions are *"derived from model-based anticipation of consequences evaluated by prior preferences."* (March, 2006: 202). Second, rational behavior contains assumptions about computational power. This relates to what Simon (1947: 55) calls "facts"—the things that principally can be known. To behave rationally, actors need to specify and evaluate (all) alternative choices and select the best

[1] Throughout this thesis, I will refer to the Carnegie School in terms of its three classic volumes: *Administrative Behavior* (Simon, 1947 [original]; 1997); *Organizations* (March & Simon, 1958 [original]; 1993); and *A Behavioral Theory of the Firm* (Cyert & March; 1963 [original]; 1992) as well as its theoretical descendants, such as evolutionary theory (e.g., Nelson & Winter, 1982; Levinthal, 1997), learning theory (e.g., Argote, 1999; Greve, 2003), and the cognition perspective in strategic management (e.g., Gavetti, 2012; Gavetti & Levinthal, 2000).

among them. To do so, requires the ability to anticipate consequences of pursuing a particular choice as well as ordering alternative choices according to preferences. Thus, *"rationality is concerned with the selection of preferred behavior alternatives in terms of some system of values whereby the consequences of behavior can be evaluated."* (Simon, 1997: 84). At the extreme, full rationality refers to omniscient actors who can consider all alternative choices and anticipate the consequences of selecting any of them—or, at least, they get close to this comprehensive idea. Human actors with such capacities can select the best choice to maximize the payoff of outcomes (Savage, 1972).

Simon's (1947) main critique focuses on assumptions about such "global rationality" (Simon, 1955: 99) as neglecting considerations of human actors' actual cognitive capacity. That is, limitations in terms of the amount of accessible individual knowledge (i.e., what actors can know and remember); the ability to pay attention to multiple aspects of a decision context (i.e., how many alternative choices actors can consider simultaneously to evaluate courses of action and predict their consequences); and the capacity to rank and select the best possible alternative (i.e., compare between values) (Simon, 1947; 1956; 1956; 1979; 1991). Given these cognitive constraints, human actors will experience uncertainty about consequences of their action as well as future preferences for the values of alternative choices (March, 1978).

By highlighting these limitations as aspects of human cognition, Simon challenges the model of rationality, prevalent in economic theory at that time. His concern address the sheer computational power of rationality that such operations would require, but he maintains general assumptions about rationality as reason-based behavior. In fact, his main intention is to introduce a model of intentional human behavior that is behaviorally plausible (e.g., Gavetti et al, 2007; Gavetti & Rivkin, 2007; Levinthal, 2011). Accounting for the cognitive constraints to rationality, Simon introduces the concept of bounded rationality, which is central to the way that human

actors are since depicted in the field of management and beyond (Simon, 1955; 1956). The convention stands: human actors achieve an approximation of full rationality. Thus, despite their computational limitations they are intentionally rational.

Behaviorally plausible rationality requires changes to the model of rational choice. Because bounded rational actors lack the *"complete knowledge and anticipation of the consequences that will follow on each choice"* (Simon, 1947: 93) they cannot evaluate all possible choices beforehand to select the best. Instead, actors need to *search*: sequentially examine alternative choices until they identify an appropriate one (Simon, 1955; 1956). The concept of search depicts a discovery process that results from bounded rationality and is central to the shift in conceptualizing actors' behavior. It addresses assumptions about the computational capabilities of rationality not those of preferences.

Bounded rational actors quantify their preferences ex ante to escape the maximization of search outputs in rational choice models. What needs to be achieved is clearly known and measurable: a quantification of preferences increases the likelihood of triggering search (Cyert & March, 1963; Greve, 2003; Simon, 1964). Actors state these measures in the form of aspiration levels or goals (hereafter used interchangeably) that direct search and provide a target to work toward (Bromiley & Harris, 2014; Cyert & March, 1963; Greve, 2003). *"By goals we shall mean value premises that can serve as inputs to decisions."* (Simon, 1964: 3).

Through establishing goals, actors constrain the space to search, which allows them to cope with the amount of potentially available choices (e.g., Simon: 1956; 1964; 1979).[2] *"As long as aspirations are fixed, the planning horizon is limited"* (Simon, 1956: 131). Likewise, the introduction of an aspiration level creates a threshold that determines a minimum acceptable

[2] It has been argued that decision environments in economics (i.e., static, stylized, small number of alternative choices) also imply simplification—not omniscience—to explain value maximizing decisions (Grandori, 2010).

outcome (Greve, 2003). Thus, aspiration levels provide premises (*good enough measures*) from which actors can infer decision rules for stopping search: select whatever is satisfactory to meet a pre-determined goal. This decision rule, termed satisficing (Simon, 1955; 1956), constitutes a fully specified model of behaviorally plausible rationality and builds on the concept of bounded rationality (i.e., *"theory of the second best"* Bromiley, 2015). In a *Simonian* world, behavior is *"purposive in so far as it is guided by general goals or objectives; it is rational in so far as it selects alternatives which are conducive to the achievement of the previously selected goals"* (Simon, 1997: 4).

Search and satisficing rest on the conceptual distinction of the constituent factual and value components of any choice situation (Simon, 1947). Building on positive ontology, factual components refer to principally empirically testable statements (i.e., what is) that are either true or false. Value components, in contrast, represent actors' preferences (i.e., what should be) that are not empirically testable but require judgment. (Bounded) rational behavior demands value components to remain constant during search,[3] such that for any choice, means (i.e., actors' behavior) and ends (i.e., the consequence of this behavior) are stably linked and actors can search for satisfactory means suited to meet focal ends. Thus, any choice can be conceived of as exogenous and objectively comparable—versus contextually tied to actors' individual values (i.e., ends as well as means would be variable) (Simon, 1947; also see Cohen, 2007).

Focal ends are often only intermediate and leading toward a more final objective, because bounded rational actors cannot consider value components associated with this cognitively more distant end (Simon, 1947). They determine new ends by building on previous choices so that sub-goals are connected and leading toward the final goal, which suggests to think of *"a series, or*

[3] Although preferences—expressed through goals—are artificially defined by actors, they can only be adapted prior to a search process.

hierarchy, of ends" [and] "each level to be considered as an end relative to the levels below it and as a means relative to the levels above it." (Simon, 1997: 73- 74). In this hierarchy, ends are consistently linked (i.e., stable values) and actors achieve (bounded) rational choices through the stepwise discovery of the most appropriate means to the next end down this hierarchy of ends, thus pursuing chains of related choices based on reason: *"[...] rationality has to do with the construction of means-ends chains"* (Simon, 1997: 73). Although such means-ends chains should be treated as loosely coupled, this notion based on stable and pre-determined values provides a bases on which to explain how (search) efforts of multiple actors can be consistently integrated.

What follows from this view is the concept of an organization as behaviorally plausible when it builds on individual actors' bounded rational cognition. Central to this concept is the process of search through which human actors eventually decide on particular choices to reach a goal. Given that ends are fixed, action consequentially follows from choice, for example, executing on a strategy that has been evaluated as the most appropriate means (Simon, 1947). Thus, studying organizations in terms of decision making, means focusing on the fundamental activity of purposive action (Cyert & March, 1963; March & Simon, 1958; Simon, 1947). Rather than an abstract entity, organizations should be conceived of as micro founded: comprised of the bounded rational behavior of multiple actors, and firm behavior as an aggregation of these lower-level organizational processes (March & Simon, 1958; Simon, 1947). This concept is well-suited for studying small and large organizational forms, only excluding extremes at the macro level (Greve, 2013).

To summarize, theories of the Carnegie School fundamentally build on Herbert Simon's concept of bounded rationality as a characterization of human actors cognitive capacities and satisficing as a decision making heuristic they will apply. Yet, they do not—and were not intended to—provide one coherent theory (Simon, 1999: in Augier & Kreiner, 2000). So far, I

have emphasized the central and interconnected concepts of search (referring to decision making) and structure (referring to the choice environments as well as the design of the organizations operating in these environments). In the remainder of this chapter, I will provide a basic understanding of these central concepts and point out limitations that I will address in this thesis.

Organizational Search: A Concept of Bounded Rational Behavior

Search is a powerful metaphor that allows to describe bounded rational actors' behavior under uncertainty (Cyert & March, 1963; March & Simon, 1958; Simon, 1955; 1956). I refer to *uncertainty*[4] as settings in which actors lack relevant knowledge (i.e., known-unknowns, unknown-knowns, or unknown-unknowns) to anticipate consequences of their action—for example through a probability assessment (Alvarez & Barney, 2005; Knight, 1921; Langlois & Cosgel, 1993). In such settings, at the extreme, choice and outcome sets are open (i.e., "absolute uncertainty": Packard et al., 2017: 845). Actors experience uncertainty as a result of their limited computational power. Behaving rationally in such conditions is expensive, but it can be achieved through a simplification of decision making (Greve, 2003; March, 2006). The concept of organizational search captures a decision making process that explains how actors allocate their limited attention to identify and evaluate appropriate alternative choices.

Two prevalent understandings of organizational search exist, which vary in their assumptions about organizational actors limited computational power (i.e., as variable or not), and based on that, in how they conceptualize the simplification of decision making and its respective procedure (Gavetti & Menon, 2016). Accordingly, search can be conceived of as *action-based and*

[4] The concept of uncertainty is central to this thesis. Depending on the focal question in each chapter, I will either use this definition of uncertainty or apply a broader one that also comprises the concept of ambiguity and thus unknown future preferences (e.g., March, 1978; 1994; Santos & Eisenhardt, 2009). I will state this accordingly.

experiential (e.g., Denrell, Fang, & Winter, 2003) as well as *cognition-based and augmented* process (e.g., Gavetti, 2012): actors either pay attention to choices relating to aspiration levels or mental maps, which they either evaluate through experimentation or heuristics.

Despite the distinct assumptions of actors' cognitive bounds, these concepts of search should be treated as complementary models of human decision making; which can be simultaneously present in real contexts (Gavetti & Levinthal, 2000). Both concepts build on a logic of reason: decision making based on evaluating consequences of choices with respect to premises (Simon, 1947; 1973). Both concepts provide process models that explain a simplification of decision making though bypassing uncertainty, in which satisficing eventually leads to accepting particular choices (Cyert & March, 1963; Simon, 1991). Recent research emphasizes the complementary nature of action-based and cognitive approaches for strategy formation under uncertainty (Eisenhardt and Bingham, 2017; Gavetti & Rivkin, 2007; Ott, Eisenhardt, & Bingham, 2017).

Search as action-based and experiential process. Building closely on bounded rationality, this view of search is strict about actors' abilities to pursue foresight: they are negligible (e.g., Cyert & March, 1963; Denrell et al., 2003; Denrell, Liu, & LeMens, 2017). Instead, this view emphasizes short-termism and a close monitoring of organizational aspiration levels to maintain organizational performance above these thresholds. Aspiration levels provide a demarcation line through which actors measure acceptable performance (March & Simon, 1958). A decline of performance below aspiration levels triggers search, which is targeted at restoring short-term performance above it (Cyert & March, 1963; Greve, 2003). When directed toward aspiration levels and triggered by decreasing organizational performance, search is considered *problemistic* (Cyert & March, 1963; Posen, Keil, Kim, & Meissner, 2018). Problemistic search is a cybernetic

process, regulated through aspiration levels. They determine the starting point of search when performance is below, and they define its end when performance is (equal or) above them. Aspiration levels are flexible such that organizational actors can adapt them relative to performance feedback. Accordingly, they increase as a response to positive and decline in response to negative performance (Greve, 2003; Levitt & March, 1988).[5]

The aspiration level provides direction for where to search for solutions and guidance for selecting among alternative choices (Knudsen & Levinthal, 2007). Attention is local: focused on problems that may cause the performance shortfall as well as the current knowledge base (e.g., strategies, products, practices) as a starting point to search for solutions. Thus, actors screen their local environment for alternatives. This proximity to current solutions fosters exploitation and leads to improvement (March, 1991). Until performance is restored, actors gradually increase the proximity of search relative to their current knowledge base (Cyert & March, 1963; Greve, 2003). Such an increase in distance equates to an increase in the risk associated with accepting potential solutions (Bromiley, 1991; Greve, 1998). Evaluation is local too: bounded rational actors focus on actions taken and assess their success or failure (Greve, 2013). In a trial-and-error (e.g., Bingham & Eisenhardt, 2011; Bingham, Eisenhardt, & Furr, 2007) or experimentation process (Brown & Eisenhardt, 1997; Levinthal & March, 1981), they sequentially pursue one choice at a time and measure its implication on performance (Cyert & March, 1963; Greve, 2003; Levitt & March, 1988). By running through these learning circles actors accumulate experiential knowledge (e.g., Argote, 1999; Levinthal, 1997; Levitt & March, 1988).

[5] Reaching beyond the focus of this review, a rich literature in strategic management focuses specifically on questions related to the formation of aspiration levels (e.g., Kuusela, Keil, & Maula, 2017; for a review Posen et al., 2018). For the argument I present in this thesis, it is sufficient to refer to the broad sources of reference based on which organizational actors form aspiration levels (i.e., quantified goals): common sense based on the status quo, the organization's historical performance, the performance of social comparison groups, the organization's direct learning, or a combination of these sources (Cyert & March, 1963; Greve, 2003).

As a continuous learning process, problemistic search increases efficiency and supports an evolutionary and path dependent development based on a myopic image of the search environment (Levinthal & March, 1993). Thus, organizational actors can eventually abandon local search processes, and instead, react to (supposedly) familiar stimuli (i.e., particular problems) with automatic action patterns: like standardized practices (Simon, 1947), operating procedures (March & Simon, 1958), programs (Cyert & March, 1963), or routines (Nelson & Winter, 1982).[6] Such rule-based responses, represents coping mechanisms and sustain uncertainty avoidance (Cyert & March, 1963; Gavetti et al., 2012). They can thus be regarded as *"[...] embodiments of "once and for all" decisions" and applying them in particular circumstances is a decision"* (Simon, 1997: 89). Rule-based responses direct actors' attention backward to solutions of the past, which they apply to present problems (Gavetti & Levinthal, 2000).

I will treat this static and feedback-based process as the baseline model of organizational search. This evolutionary view is central to the influential research streams on organizational learning and routines (Argote & Greve, 2007; Gavetti et al., 2007) and also provides the fundamental logic of the entrepreneurship concepts of *bricolage* (Baker & Nelson, 2005) and *effectuation* (Sarasvathy, 2001), and, resonates with beliefs held in the popular practitioner literature in this field (Blank & Dorf, 2012; Ries, 2011; Osterwalder & Pigneur, 2012).

The process through which aspiration levels and performance get aligned is at the core of action-based and experiential models of search. The focus of previous paragraphs was on the

[6] The enormous body of research that developed on organizational routines (Nelson & Winter, 1982) also highlights its (internally) dynamic properties that can lead to organizational change (e.g., Feldman & Pentland, 2003; Feldman, Pentland, D'Adderio, & Lazaric, 2016; Rerup & Feldman, 2011; Salvato & Rerup, 2018). But even if flexible, each routine only produces a specific and automatic action pattern (Greve, 2013). Here, the emphasis is on the triggered reactions based on learning, not on actors' cognitive representations of the search space, which are merely basic.

predominant view that search is triggered by low performance and undershot aspiration levels. However, if organizations perform above these thresholds they can accumulate excess resources that are not considered vital to organizational survival: organizational *slack.* This slack can be absorbed, that is, fixed in the administrative structures of the organization, or unabsorbed, that is, take the form of flexibly allocable financial or temporal resources and untapped technological opportunities (Cyert & March, 1963; Levinthal & March, 1981).

Unlike performance below aspiration levels, slack does not trigger an inevitable response—it is the strategic decision of some actors (or specific organizational units) to apply it (Greve, 2003; Levinthal & March, 1981; March, 1994). First, actors may decide to preserve slack and use it as a cushion to draw on when performance drops below aspiration levels; and they cannot adjust these downward (Cyert, Feigenbaum, & March, 1959; Cyert & March, 1963; March, 1994). Second, performance above aspirations increases the toleration of organizational behavior that is not contributing to short term performance and which is thus less directly tied to the organizational goal (Cyert & March, 1963). When values are not entirely fixed, this relaxes rationality such that actors can pursue their own preferences,[7] but still within the general boundaries of the goal (March, 1994). Thus, slack increases risk taking not the tolerance of uncertainty: actors pursue solutions that have a lower probability of success (Cyert & March, 1963; Greve, 2003).

This slack induced search is distant to an organization's current knowledge base. However, because actors are cognitively constraint, they cannot anticipate these distant choices or the consequences of pursuing them and thus engage in random action (i.e., "long jumps"; Levinthal, 1997: 938); for example through improvisation (Miner, Bassof, & Moorman, 2001). Thus, positive search outcomes must be attributed to luck. Such discoveries can provide solutions that

[7] At the extreme, a relaxation of rationality leads to foolishness and play (March, 1988; 2006).

enhance organizational performance in the long term, but given that they are less tied to organizational goals, for these solutions no problems may exist and they may be initially ignored (Knudsen & Levinthal, 2007; March, 2006). Slack search explains how actors explore and thus how they deliberately reach beyond incremental improvement which can lead to radical innovation (March, 1991). As compared to the sequential learning in problemistic search, slack search is not a path dependent but potentially path creating activity (Adner & Levinthal, 2008; Bhardwaj, Camillus, & Hounshell, 2006).[8]

To summarize, most literature that builds on search as action-based assumes a problemistic search process and thus contains a proximity bias: solutions that are temporally and spatially close as well as a focus on short term success (i.e., exploitation) (Levinthal & March, 1993; March, 1991). However, long term survival requires organizations to also engage in slack search (i.e., exploration) and thus we may think of search in terms of balancing both search activities (March, 1991). Building on central conceptual differences, an extensive literature in strategic management discusses how organizations may simultaneously achieve exploration and exploitation, (for a review: Lavie, Stettner, & Tushman, 2010). First, exploration and exploitation can be seen as fundamentally different activities that compete for scarce resources within an organization and thus represent a tradeoff (e.g., Levinthal & March, 1993; March, 1991). Similarly, if resource constraints do not apply, both activities can be considered as complementary and occurring simultaneously (e.g., Baum, Li, & Usher, 2000; Katila & Ahuja, 2002). Second, and relatedly, building on a punctuated equilibrium model, organizations can be treated as achieving a balance between the two forms of search through temporal alteration

[8] The behavioral theory of the firm conceptualizes a third form of search: institutionalized search. It constitutes a continuous search process organized in dedicated units; like research and development. Institutionalized search may also include problemistic and slack search activities, yet, it is neither responsive to performance feedback nor directly affected by resource availability (Greve, 2003).

(Levinthal & March, 1993; Tushman & Romanelli, 1985) as compared to when building on a model of ambidexterity, where both forms can be spatially divided across an organization and occur at the same time (Benner & Tushman, 2003; Levinthal, 1997). The application of these conceptual views is an empirical question that may significantly depend on the size of the focal organization (Gupta, Smith, Shalley, 2006). Current theory focuses on large organizations and search as a means for organizational learning and adaptation, while neglecting search as a means for organizational growth (for an exception: Andries, Debackere, & van Looy, 2013).

Search as cognition-based and augmented process. The basic model of problemistic search builds on austere assumptions of actors' cognition: it is effectively absent and dispenses actors from anticipating the future. Instead, they react to performance feedback by looking backward to experiential knowledge and reinforcing successful action. A more elastic view of bounded rationality acknowledges that, although human cognition is constraint, it can be variable, and enable actors to look forward into the future (e.g., Gavetti, 2012; Gavetti & Levinthal, 2000; Gavetti & Menon, 2016). To do so, they extend their search space through mental representations (Csaszar & Levinthal, 2015; Levinthal, 2011; Simon, 1947).

Mental representations are simplifications of a conceptually objective environment: low-dimensional images that bounded rational actors can compute and that provide approximations of reality (Csaszar & Levinthal, 2015; Gavetti & Levinthal, 2000; Levinthal, 2011; Thagard, 2005). Although mental representations are potentially incomplete and vary with regard to the level of representational detail—which improves through experience (Thagard, 2005)—these cognitive models constitute copies of the real environment that capture its central causalities (Simon, 1956). Thus, mental representations can be treated as equivalent to it and as determining actors' search space (Newell & Simon, 1972; Simon, 1947; 1991).

By cognitively augmenting their search space, actors can reach beyond the neighborhood of related solutions and consider more distant alternatives. They engage in foresight by imagining future consequences of decisions based on their mental representations (Gavetti & Levinthal, 2000; Simon, 1947). Actors evaluate alternative solutions through thought experiments and planning instead of action only (e.g., trial & error), which allows them to investigate multiple solutions in parallel instead of merely sequentially (e.g., Andries et al., 2013; Gruber, MacMillan, & Thompson, 2013; Mintzberg, Raisinghani, & Théorêt, 1976; Nelson, 1961). This practice is distinct from slack search, where actors openly explore their environment for potentially relevant solutions (Cyert & March, 1963; Greve, 2003). Cognition-based search constitutes a conscious process in which mental representations determine actors' starting points for search. They allow for their imagination to reach more distant places in the solution space, while preventing them from searching in less attractive areas (Gavetti et al., 2005; Gavetti & Levinthal, 2000; Nickerson & Zenger, 2004). Thus, superior mental representations enable actors to excel at this type of search and find potentially novel solutions (Csaszar & Levinthal, 2015; Gavetti, 2012).

When originating from mental representations, novel solutions are not purely random outcomes but result from an associative process (Gavetti, 2012; Gavetti & Menon, 2016). Actors select, through analogy, an existing mental representation they consider as identical to a currently encountered uncertain context (Thagard, 2005). Through this procedure they establish causality between past and current causes and infer similar effects (Gary, Wood, Pillinger, 2012; Gavetti, Levinthal, & Rivkin, 2005; Gick & Holyoak, 1980; Lovallo, Clarke, & Camerer, 2012). Analogies, like any heuristic, provide cognitive shortcuts, that, similar to the automatic responses generated through routines, provide a basic structure through which cognitively limited actors can cope with uncertainty rationally. Thus, familiar mental representations replace responses by pre-determined action. Novelty results from re-contextualizing these cognitive frameworks or

leveraging the variance within them (e.g., Simon, 1973; Fernandez & Simon, 1999). Current literature on simple rules in strategy and entrepreneurship provides evidence for the effective use of heuristics that can trigger multiple behavioral responses to achieve such outcomes (Bingham & Eisenhardt, 2011; Davis, Eisenhardt, & Bingham, 2009; Eisenhardt & Bingham, 2017; Eisenhardt & Sull, 2001).

Search as problem solving. Although the cognitive view of search enables imagination and augments actors' intelligence, it fundamentally remains a rational choice process that builds on the assumption that actors make inferences from premises (Cohen, 2007; Simon, 1947). These premises, like aspiration levels when search is local, originate from *"a well-defined, stable, and consistent preference ordering"* (March, 1972: 419) that is captured in mental representations. Accordingly, rationality refers to the justification of internally consistent decisions that are deductively accurate (Grandori, 2010; Simon, 1947). *"A rational choice processes requires an a priori act of problem framing and representation before the execution of a rational choice calculus can be carried out."* (Levinthal, 2011: 1517). This also applies to bounded rational actors.

Problems can be considered to vary in complexity and accordingly range on a *"continuum of degrees of definiteness"* (Simon, 1973: 183; also Macher, 2006) with which actors can define them. Thus, irrespective of a problems' complexity, actors can generate a mental representation of it, which constitutes an approximation when complexity is high and gets closer to the actual problem when complexity decreases: the underlying logic of the actual problem (i.e., the root cause) can be principally discovered. A recent stream of research specifically focuses on the importance of strategically formulating problems (Baer, Dirks, & Nickerson, 2013; Nickerson, Silverman, & Zenger, 2007; Nickerson, Yen, & Mahoney, 2012) as a main activity through which solutions eventually become obvious; it is an activity equivalent to problem-solving

(Leiblein & Macher, 2009; Nickerson & Zenger, 2004; Simon, 1947). *"Solving a problem simply means representing it so as to make the solution transparent."* (Simon, 1996: 132). This notion of search as problem-solving emphasizes problem representations and thus the starting points of search, treating organizations as problem solving entities (Cyert & March, 1963; March & Simon, 1958). *"Once organizational objectives and decision strategies are determined, the organization can be viewed as an information-processing and decision-rendering system."* (Cyert & March, 1992: 21).

In this view, cognition is programmed (Kilduff, 1993) and human brains treated as functioning like computers (March & Simon, 1958). Once a problem is defined, search constitutes an automatic process that is comparable to how a search engine operates. In this deductive process, and building on the premise of a problem, human actors could extend their limited cognitive capacity through artificial computational power (Newell, Shaw, & Simon, 1958; Newell & Simon, 1972; Simon, 1996). At the extreme one may argue that in this setup, humans become insignificant for the actual search process of identifying a best possible solution. Thus, the formalization of search as problem-solving creates an objective, analytical, quantifiable, and scientific process that builds a foundation for artificial intelligence (Newell & Simon, 1972; Simon, 1973; 1996).

Problem Structure and Organizational Structure for Search

Organizational search and structure are closely connected concepts: both relate to actors' bounded rationality (March & Simon, 1958; Simon, 1947; 1962). *Structure*, on one hand, refers to a given problem (i.e., ill- or well-structured; Simon, 1973) and respective alternative solutions (i.e., existing environments of activity choices; Kauffman, 1993; Levinthal, 1997). On the other hand, structure relates to how actors design their organization to search for solutions (i.e., the

division of tasks to pursue common goals; Nickerson & Zenger, 2004; Rivkin & Siggelkow, 2003). Any such structure can be viewed as an inherently complex system of which actors are part and which exist independently of their agency (Simon, 1962; 1996). Complexity refers to a large number of elements, comprising such systems, which have high interdependencies and interact in a non-trivial way (Ethiraj & Levinthal, 2004; Kauffman, 1993; Simon, 1962). Because of actors' cognitive constraints, they cannot easily understand, decompose, or predict the development of any complex structure and thus experience uncertainty.

Problem structure. First, the structure of problems and respective solutions depends on the interdependencies between pieces of knowledge, necessary to define them (e.g., Gavetti & Levinthal, 2000; Newell & Simon, 1972; Nickerson & Zenger, 2004). The total number of distinct configurations of such knowledge sets can be pictured as residing on landscapes, which can vary in terms of the degree of interdependency between pieces of knowledge (Macher, 2006). If such interactions are high, so is the complexity of a problem, and the respective landscapes offer multiple valuable solutions (i.e., configurations of knowledge). Such landscapes can be described as rugged, consisting of multiple peaks that represent multiple valuable solutions, as compared to a less complex problem where solution landscapes just consist of one peak (Levinthal, 1997; Kauffman, 1993; Rivkin, 2000). For cognitively constraint actors, rugged landscapes are difficult to oversee, which is why they search, and rugged knowledge landscapes are commonly used as a conceptual foundation of how search processes unfold (e.g., Afuah & Tucci, 2012; Baumann, Schmidt, & Stieglitz, 2018; Baumann & Siggelkow, 2012; Billinger, Stieglitz, & Schumacher, 2014; Gavetti & Levinthal, 2000; Levinthal & Posen, 2007; Rivkin & Siggelkow, 2003; Siggelkow & Levinthal, 2003; Siggelkow & Rivkin, 2005).

Following from this conceptualization, problems with low complexity and thus low interdependencies of knowledge sets can be decomposed into sub-problems and then individually solved (i.e., well-structured problems). Yet, all but the very trivial problems are well structured (Levinthal, 2011; Simon, 1973). Ill-structured problems, however, are complex and like any such system they have a hierarchical structure (Anderson, 1999; Ethiraj & Levinthal, 2004; Simon, 1962). Hierarchy refers to *"a system that is composed of interrelated subsystems, each of the latter being, in turn, hierarchic in structure until we reach some lowest level of elementary subsystem."* (Simon, 1962: 468). A unique property of hierarchical systems is their near decomposability, which means that links and interactions within subsystems are higher than between them (Simon, 1962). This characteristic allows actors to still comprehend ill-structured problems through the application of mental models. Even if within lower level subsystems interactions are multitudinous, unknown or potentially unknowable, actors can apply a mental representation they possess at a higher hierarchical levels of the ill-structured problem (e.g., Simon, 1973; Thagard, 2005). Thereby, they establish an approximation of the structure of the actual problem and thus interdependencies of knowledge sets at that specific hierarchical level (Simon, 1962). From there, they can search downwards for interdependencies between lower level subsystems of the ill-structured problem and toward a consistent solution (Simon, 1973).

Organizational structure. Actors not just experience structure through their bounded cognition as the part of the environment they attend to, but they also deliberately create the decision-making structures through which they govern search (i.e., their organization design; March & Simon, 1958; Simon, 1947). I define organizational structure as a *"stable pattern of interactions between individuals or groups of individuals, where an interaction is interdependence, influence or both."* (Puranam, 2018: 8). So far, I have elaborated that actors

search is guided by a purpose or goal that is consistently held within the organization.[9] Accordingly, they are also expected to design their organization with regard to the goal it should achieve (March & Simon, 1958; Simon, 1947).

In this view, goals are treated like problems, rendering the process of organizing actors as problem-solving (Puranam, Alexy, & Reitzig, 2014). Thus, goals have a hierarchical and near decomposable structure and actors can generate mental representations at the level of tasks, required to achieving the goal—like any mental representation, these are approximations of the actual tasks (Puranam, 2018). Once tasks are delineated, they can be assigned to specific actors who, by executing them, will individually contribute to achieving the organizational goal (March & Simon, 1958; Puranam et al., 2014). Through this division of labor, actors can establish decision-making constraints that reduce redundancies (Ethiraj & Levinthal, 2004; Simon, 1962), and make organizational design choices to coordinate search activities (Simon, 1947).

This conceptualization links organizational structure to bounded rationality (also see Ethiraj & Levinthal, 2004; Kilduff, 1993). That is, the specialization of individual actors leads to a simplification of search and the re-aggregation of information occurs through hierarchical decision-making structures (Simon, 1947; also see Weber, 1947). Hierarchical structures enhance the information processing capacities within the organization which are required to achieve the organizational goal and surpass individual actors cognitive bounds (Simon, 1962). This is particularly important for complex or ill-defined goals where interdependencies between relevant pieces of knowledge are high and addressing them necessitates coordination between actors (Macher, 2006; Nickerson & Zenger, 2004). Any hierarchical organizational structure can be

[9] Individual actors may hold idiosyncratic goals that result in conflicting interests (a caveat, added by Cyert & March (1963) and March (1962) to the Simonian account of goals as existing). But this view concludes that actors (at least temporarily) resolve any conflict among competing goals (Cyert & March, 1963) and, by committing to pursue one, can form an organization and search (Puranam et al., 2014). This point is about the main goal, not various sub-goals.

regarded as a bottom up aggregation of multiple actors or identical micro-organizations respectively (Puranam, 2018).

Building on these premises, current literature centers on organizational structure as the means through which search is organized: conceptually, structure precedes search. Researchers study how to design appropriate organizational designs to carry out search processes, focusing on how varying arrangements influence search outcomes. For example, how a spatial, temporal, or domain specific balancing of local and distant search affects organizational performance (e.g., He & Wong, 2004; Lavie & Rosenkopf, 2006; Lavie, Kang, & Rosenkopf, 2011; Lavie et al., 2010; Tushman & O'Reilly, 1996); through which organizational structures to solve different kinds of problems (Macher, 2006; Nickerson & Zenger, 2004) or evaluate identified choices (Knudsen & Levinthal, 2007); or, how centralized and decentralized organizational structures (Siggelkow & Levinthal, 2003; Rivkin & Siggelkow, 2003) or intra organizational dynamics (Baumann, Eggers, & Stieglitz, 2018; Knudsen & Srikant, 2014) affect search results.

Finally, I can conjecture the reasons for this emphasis on structure. First, in Simon's view of limited individual cognition, mental structures within which computational search process unfold are central to the concept of (bounded) rational choice (e.g., Simon, 1973). Second, building on the fixed assumption of bounded rational actors, the focus on search moved from the individual to the organizational level. Thus, originating from the seminal writings of *Administrative Behavior* (Simon, 1947), through *Organizations* (March & Simon, 1958), and toward *A Behavioral Theory of the Firm* (Cyert & March, 1963), search became a problem of organizing multiple cognitively constraint actors through the division of labor and the integration of effort toward a common goal (Puranam, 2018; Puranam et al., 2014). This emphasis on organization design, gradually developed into a perspective that puts the adaptation of complex organizational systems to changing environmental contingencies center stage (Burns & Stalker, 1961; Galbraith,

1973; Khandwalla 1973; Lawrence & Lorsch, 1967; Mintzberg 1979; Thompson, 1967). The focus shifts from actors' cognition to organizational structure and the balancing of too much and too little of it, in order to survive in fast changing and uncertain settings (Davis et al., 2009).

From Search to Searching and Emerging Structures: Boundaries of a *Simonian* World

Prior theories of organizational search and structure are widely influential in the fields of strategy, innovation, and entrepreneurship. Yet, they have inherent conceptual constraints that limit our understanding of truly novel results and the organizational processes through which these come about.

At the core of these conceptual constraints lies the preservation of intentional rationality (i.e., bounded rationality) through the exclusion of uncertainty. Uncertainty exists when cause-effect relationships are unknown. This affects assumptions about future consequences of choices as well as assumptions about future preferences (values) (March, 1978). Theories of search, as described above, account for the first assumption. To establish behaviorally plausible rationality, these theories include the computational limitations of human cognition to fully anticipate alternative choices and their consequences in complex environments. However, they do not suggest any changes to the second assumption. They maintain that search is based on inferences from premises, achieved through fixing preferences (i.e., by defining problems or specifying goals). When preferences are constant, actors can infer alternative choices and search for the most appropriate one: there is no uncertainty.

However, this view was not developed to explain how actors can actually deal with uncertainty, and instead, suggests coping mechanisms that ensure organizational survival. Relying on such mechanisms (i.e., local search; routines; mental representations) is conducive to explaining how actors make efficient and reliable choices but it is insufficient to explaining

novelty (also see Felin et al., 2014; March, 1988; 2006). It reduces the origins of novelty to serendipitous discoveries of existing alternatives (Winter, 2012); through pre-adaptation (Denrell et al., 2003), temporal availability of choices (Cohen, March, & Olsen, 1972), or distant search (Levinthal, 1997). In a logic of inferring choices from fixed preferences, luck is a result of actors' cognitive constraints. It describes the unexpected encounter of a potential alternative that actors were unable to anticipate—which could involve drawing on latent preferences (e.g., von Hippel & von Krogh, 2016). Thus, while serendipitous outcomes may be in itself uncertain actors operate in a world that is not. We still lack comprehensive understanding of the origins of truly novel choices and the search processes that lead to them. Quoting James March (2015):

> *"The sources of novelty are a great mystery [...]as you look at people trying to understand where novelty comes from, there are a number of people who are looking essentially for combinations of existing rules, or whatever it is. Some of that is very interesting research. [...] but I don't think that we've unlocked the key. I don't think we have anything comparable to Mendel. And until we get to something like that, we can handwave a good deal about combinations, but we don't understand them very well. So the sources of novelty are a domain that excites and concerns me."* (James G. March in: Liu, Maslach, Desai, & Madsen, 2015: 152)

Specifically, these fundamental questions remain: first, a basic question concerns a conceptual understanding of *what true novelty is?* The common view that novel solutions are more distant from existing ones seems intuitive at first (e.g., Gavetti, 2012), but the related argument that such distant locations reside on the same knowledge landscapes and getting to such distant locations requires the application of existing mental representations is not. In this view, actors search on existing and principally knowable landscapes, where the new solutions are just invisible for human actors. It renders the challenge of reaching more distant locations on these landscapes as one of computation, because cause-effect relationships and thus goals are assumed to exist (also see March, 1988). By answering the question *where goals come from,* we may understand what true novelty means and why it cannot be a result of search processes that rest on

the assumption of existing causal models of the world, which human actors just cannot fully comprehend. Investigating how actors create new causal models, we may understand how new goals can be formulated through which truly novel outcomes may be achieved. Thus, true novelty may result from creating a landscape (Alvarez, Barney, & Anderson, 2013) instead of finding means through which to reach more distant locations on an existing one. What is missing is a concept of a search that works under uncertainty and thus without the assumption of making inferences from premises (i.e., a clear goal or problem definition). Such a process can be imagined as preceding a problem-solving approach. So far, even *"problem-solving approaches for ill-structured problems have not been formalized"* (Macher, 2006: 829).

Second, building on such conceptual foundations, a related empirical question addresses the process of *how actors actually search?* In Simonian models, a question about agency over the search process itself is irrelevant. As I have elaborated, it only matters for the initial definition of the search space (i.e., problem-definition), leaving the subsequent screening of alternatives within this space a computational task (which could actually be operated by a machine). Thus, much of the search literature is concerned with the triggers as well as the outcomes of the search process (i.e., achieving a goal through a particular choice), leaving the actual search*ing* in-between a black box (e.g., Dahlander et al., 2016; Li, Maggitti, Smith, Tesluk, & Katila, 2013; Maggitti, Smith, & Katila, 2011; Posen et al., 2018). Interestingly, Cyert & March (1992: 19) already define *"an explicit emphasis on the actual process of decision making as [their] basic commitment,"* yet they do not really provide these insights and as Argote & Greve (2009) note in their reflection on 40 years of the Behavioral Theory of the Firm, much research is structure not process focused. This is a major limitation. Understanding how actors search matters under uncertainty, because the specific knowledge to establish structure prior to search is yet unavailable and generated through searching. While this does not affect the general assumption

of bounded rational actors and search as a means of finding appropriate outcomes it should affect *how* actors search. Yet, it remains unclear how.

Third, from extant theory we would expect that actors can infer cause-effect relationships and coordinate search efforts by specifying and allocating tasks toward achieving a common goal (Puranam, 2018). However, building on previous argument, under uncertainty searching may lead to the representation of goals. Thus, a critical question is *how to organize search based on emerging goals?* Uncertainty can be favorable for new ideas, especially when tapping into a diverse pool of knowledge. However, for any but trivial goals, interdependencies between equally potential alternatives should exist and commitments to some of them be necessary while searching to commence toward an outcome (e.g., Rittel, 1992). This raises questions about the coordination of search, the integration of efforts, and respective organization designs. Current theories on collaborative communities (Fjeldstad, Snow, Miles, & Lettl, 2012) or new forms of organizing (e.g., Foss, 2003), that come to mind, only highlight some general coordination mechanisms of how loosely connected actors share insights, while still relying on (widely) defined tasks for guidance of what to achieve. We lack explanations for organization designs that allow to simultaneously maintain the generative potential of uncertainty and continuously integrate various sources of knowledge toward realizing an emerging, organizational-level goal. Answering this question requires nuanced empirical insights to uncover how established and novel organization design principles may be applied.

In this dissertation, I address previous questions by studying how to embrace uncertainty. At the heart of this effort lies the notion that uncertainty can be a source of novelty for actors to leverage, instead of a threat to organizational survival that they need to avoid. Looking beyond coping mechanisms, I argue that this means to account for both assumptions related to uncertainty: the one about actors' ability to predict future consequences of choices *and* that about

their ability to predict future preferences (March, 1978). Thus, developing a concept of *embracing uncertainty* requires to extend the sole focus on human actors' cognitive limitations in computing choices toward the variability of preferences. Adding variable preferences, however, obstructs a computation of choices but it enables human agency in order to create choices. A focus on preferences means to move beyond what actors need to commit to prior to search and provides them with agency to consider preferences and choices simultaneously: this gives room for imagination (also see March 1988; Rittel, 1992; Shackle, 1979). Thereby, actors may leverage uncertain environments as a source of novelty. This agency of search requires judgment, which however, need not be irrational. As it has been persuasively argued by Grandori (2010), rationality refers to sound reasoning that leads to particular choices rather than accounting for the amount of choices considered.

Overall, I argue that this perception of uncertainty as a source of novelty requires a conceptual shift of our models of organizational search and structure. That is, search changes from a static computation based on inferences from premises (i.e., intentional rationality) to searching as an agentic process that rests on the consideration of reasonable and desirable preferences through which actors generate novel choices. Accordingly, the concept of structure shifts from something that exists prior to search, to something indeterminate (e.g., Buchanan, 1992) that emerges through searching. I will develop these arguments in the remainder of this thesis.

Overview

In three related studies (chapters 2, 3, 4) I examine how actors tackle truly novel, emergent goals and how this affects the design of the (organizational) structures that they create. I develop a set of closely connected concepts that can advance our understanding of how to effectively organize explorative search processes that can lead to novel outcomes. This thesis commences as follows.

In chapter 2, *Searching for true novelty*, I depart from the conceptual foundations of search, as described in chapter 1, to conceptualize a process of search that is capable of reaching beyond the computation or random encounter of choices. By drawing on abductive logic and the field of Design Studies, I reimagine how organizational search may generate novelty in the face of uncertainty. Instead of deductively moving from problem-definitions to solutions, I suggest that, triggered by doubt, organizational actors abductively create contextually plausible causal models to link potentially relevant problems and solutions. I elaborate the consequences of this conceptual shift and theorize abductive search activities that explain how actors may simultaniously search for problems, solutions, and links between them. The resulting framework builds on these insights to show how actors can sustain this generative search process or steer it toward closure—at which point search transitions to the process described in standard models of the Carnegie School. I contribute by providing a concept for an explorative search process and discuss implications of this model for theories of strategy, innovation, and entrepreneurship.

In chapter 3, *Thinking, doing, and the emergence of organizational structure*, I build on the insights from chapter 2 and empirically investigate the agency of organizational search, by studying how actors search in uncertain environments and how this shapes the new organizational structures they create. I inductively build theory from longitudinal case data that I collected by closely following the emergence of 35 new ventures over a core period of 2.5 years. I find two contrasting modes of how founders search to develop organizational structure. Both

originate from cognitive biases, either toward the future or the past, and affect the emergence of organizational structures: searching backward from future reference points allows founders to identify related strategies to create coherent organizational structures and achieve a stable development. In contrast, when searching forward from past reference points founders pursue opportunistic decisions to meet short-term performance goals, causing incoherent organizational structures and multi-directional development. By opening the black box of organizational search I depict the process as less mechanistic. Especially when triggered by foresight, it is largely influenced by idiosyncratic human agency. I highlight the power of mental representations to search more specifically in highly uncertain environments and to create more novel outcomes.

In chapter 4, *Designing organizations for abstract goals*, I answer the question how actors can deliberately design an organization capable of embracing uncertainty and leveraging endless slack resources. Together with colleagues, I empirically investigate this question by studying Hyperloop Transportation Technologies, a crowd-sourced organization with constantly joining contributors, who shape the development of a new, commercially functional technology ecosystem. Based on extensive field data, we find a form of organizing that builds on a non-modularization of tasks, constant exploration, and the ability to continuously redesign itself—which we label *catalyst organization*. Our insights shed light on organization designs for innovation activity that lie at the intersection of environmental uncertainty and unlimited knowledge supply—two characteristics that have been mainly considered independently. This paper is forthcoming in the Academy of Management Discoveries and appears in that exact version in the Appendix B.

I conclude this thesis in chapter 5, *Toward Marchian foolishness: theorizing exploration*, by discussing how to complement theories of search and organization originating in the Carnegie School with a theory of exploration. I suggest to look at organizational processes that lead to

novel outcomes through a lens of *embracing uncertainty* instead of retaining the one of uncertainty avoidance. This means accounting for how organizational actors are actually searching. It is central to this view to understand agency as rooted in cognition, search spaces as initially indeterminate, and organizational designs as loosely connected systems. This allows for a base assumption of organizational purpose that reaches beyond survival and novelty as a serendipitous outcome. I indicate how to build on these insights, linking to the literatures in strategy, innovation, and entrepreneurship. Practical implications address the question how human actors may continue to add value if they will be embedded in artificially intelligent systems.

2 Searching for true novelty

> *"The book does not pay much attention […] to the fact that links between problems and solutions […] may be constructed by organizational processes rather than being embedded in objective reality."*
> March and Simon (1993: 14-15), reflecting on their seminal contribution [1958].

Theories of organizational search offer a lens through which to understand strategy, innovation, and entrepreneurship. Grounded in the Behavioral Theory of the Firm (BTOF) (Cyert & March, 1963; March & Simon, 1958), this perspective rests on the premise that goals exist prior to search (March, 1972). Organizational actors can form such goals by drawing on *knowledge structures* that reflect prior preferences, such as organizational purpose, values, and objectives (March, 1988). These knowledge structures link relevant problems and solutions—with one another, and with the goal at large. For example, when actors receive negative performance feedback, they will be able to infer a goal to address this shortcoming, implying *what* needs to be done and *how* (Cyert & March, 1963; March, 1972). Thus, by defining a problem (Simon, 1973), actors will also set the solution space to search (Levinthal, 1997). In this view, search is synonymous to a deductive problem-solving process that unfolds mechanistically (Nickerson & Zenger, 2004) until bounded rational actors identify acceptable alternatives (Simon, 1955; 1956).

However, this view cannot, and was not developed to, explain *true novelty* which I define as organizations creating outcomes that originate from new problems, solutions, or links between them, for example novel strategies, radical product innovations, or new business ventures. True novelty requires new knowledge structures, which are inherently uncertain (Alvarez & Barney, 2005; Knight, 1921). Yet, current theories of search exclude uncertainty. They assume that actors draw on existing knowledge structures as if they were permanently in settings of risk (e.g., Gavetti et al., 2005, Nelson & Winter, 1982). This, however, would imply that they search for outcomes that are "*in some sense already known, rather than […] invent[ing] solutions yet*

unknown" (Buchanan, 1992: 19). My aim is to develop new theory on how organizational actors search under uncertainty to create novel links between problems and solutions and build new knowledge structures in order to produce truly novel outcomes.

My argument entails a conceptual shift from search as deductive problem-solving to an abductive design process (e.g., Roozenburg, 1993; Dorst, 2011) that allows for imagination, inspiration, and invention (Loasby, 2001; March, 1988; Peirce, 1878; Shackle, 1972). While the logics of abduction and design are so far largely prevelant in management and entrepreneurship practice (e.g., Dunne & Martin, 2006; Martin, 2009; Osterwalder & Pigneur, 2010; Ries, 2011), management scholars are also increasingly recognizing them as a promising route for theory building (e.g., Bamberger, 2018; Dougherty, 2016; Gruber, De Leon, George, & Thompson, 2015; Mantere & Ketokivi, 2013). I consider the design perspective as particularly suitable because it puts the uncertainty construct at center stage (e.g., Archer, 1964; Buchanan, 1992; Cross, 2007; Rittel & Webber, 1973) and allows us to treat new knowledge structures as artificial products of human agency (Simon, 1996)—as compared to choices from pre-existing options.

Building on this perspective, I argue that actors may search for true novelty by *embracing uncertainty.* In the abductive search process I develop, uncertainty will initially exists about the cause-effect relationships between problems and solutions that are potentially relevant to create new structure (e.g., Alvarez & Barney, 2007; Duncan, 1972; Tan, 2015). As a result, actors experience doubt about which problems and solutions matter and how to link them. I explain how actors may leverage and simultaneously reduce this doubt by hypothesizing plausible problem-solution links as "*causal model[s] of a situation*" (Grandori, 2010: 490; Peirce, 1878). Novel links may result from the generative potential of recursively oscillating between alternative problems and solutions. In turn, a new knowledge structure will emerge when actors converge on a unifying concept that allows them to integrate diverse problem-solution links.

Theories of Search in the Behavioral Theory of the Firm

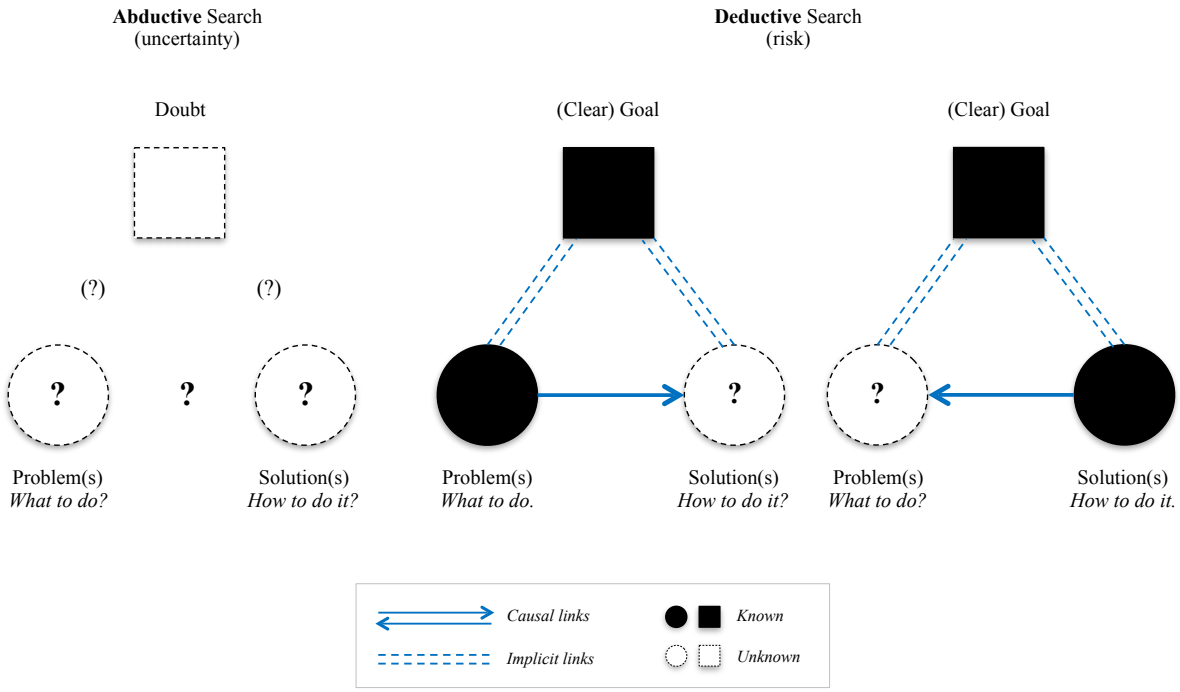

Figure 1. Knowledge Structures and the Logic of Search

Theories of search, grounded in the BTOF dominate our thinking of how organizations learn and adapt (Argote & Greve, 2007; Cyert & March, 1963; March & Simon, 1958). Generally, search describes a process through which organizational actors explore their environment for knowledge to enhance performance relative to an organizational goal (Greve, 2003). In this literature, it is a core assumption that goals exist prior to search (Cyert & March, 1963; Greve, 2003). Actors can define them based on performance feedback and their general understanding of organizational purpose, values, and objectives (March, 1972; 1988), from which they can infer *what* is relevant to do (i.e., problems to solve) and *how* it could be done (i.e., possible solutions) (see Figure 1, right). Jointly, these (implicit) causal links between problems and solutions represent actors' *knowledge structures*, which, similar to theories (Felin & Zenger, 2017), they can draw on to

achieve consistent behavior, order preferences, and direct action (March, 1988; March & Simon, 1958). They are, for example, reflected in actors' mental models (Gavetti & Levinthal, 2000), heuristics (Newell & Simon, 1972), interpretative schemata (Rerup & Feldman, 2011), operating procedures (March & Simon, 1958), and routines (Nelson & Winter, 1982).

When Existing Knowledge Structures Suffice: Search in Settings of Risk

When actors are aware of cause-effect relationships prior to search, they can infer performance dimensions along which to search for solutions (e.g., Newell & Simon, 1972; Simon, 1973) and compute probabilistic estimates for different search paths. Actors hence search deductively in settings characterized by risk. Given problem definition precedes the search for solutions (e.g., Baer et al., 2013; Leiblein & Macher, 2009; Nickerson & Zenger, 2004), the organizational ability to succeed at search will largely be determined by actors' problem representations, which they derive from their existing knowledge structures (Fernandez & Simon, 1999; Simon, 1973).

From the problem representation, actors will derive a landscape of solutions all of which are linked to the same problem and the same performance dimensions (Levinthal, 1997; Newell & Simon, 1972; Simon, 1973). While a landscape may vary in terms of the complexity of potential solutions, ultimately, it consists of a coherent (if unlimited) set of alternatives (e.g., Baumann & Siggelkow, 2012; Billinger et al., 2014; Gavetti & Levinthal, 2000; Rivkin & Siggelkow, 2003; Siggelkow & Levinthal, 2003; Winter, Cattani, & Dorsch, 2007). Even when actors seek alternative solutions in parallel they search for one unknown: which solution to select (e.g., Gruber, MacMillan, & Thompson, 2008; Nelson, 1961). Search is hence a mechanistic screening of choices limited by actors' cognition (Simon, 1955, 1956).

Existing Views on the Origins of Knowledge Structures: Coping with Uncertainty

Risk is distinct from uncertainty (Alvarez & Barney, 2005; Foss & Klein, 2012; Knight, 1921). Uncertainty results from highly complex and ill-structured conditions that cause a computational challenge (Fernandez & Simon, 1999; Macher, 2006; Simon, 1973). I define uncertainty as settings where actors' knowledge about cause-effect relationships of actions and their outcomes, including the value of said outcomes, is unclear or non-existent (Bhardwaj, Camillus, & Hounshell, 2006; Duncan, 1972; Grandori, 2010; March, 1994, Milliken, 1987).[10] This defies decision-making based on probabilistic estimates of possible outcomes (Knight, 1921).

Theories of search acknowledge the empirical ubiquity of uncertainty in organizational settings, but conceptually they exclude it. This is understandable, given the Carnegie Schools' aim of providing behaviorally plausible explanations of human agency (Gavetti & Rivkin, 2007; Levinthal, 2011; Simon, 1955). Uncertainty, first of all, poses a threat to organizational survival, thus prevalent search theory effectively tries to eliminate it (Gavetti et al., 2012; Cyert & March, 1963): to prevent failure bounded rational actors are primarily inclined to avoid uncertainty by setting up a negotiated environment in which to recall standard operating procedures (Cyert & March, 1963) and routines (Nelson & Winter, 1982) to instantly initiate local, feedback-based search processes designed to achieve solutions that are sufficient for organizational survival. Put differently, to cope with uncertainty, cognitively bounded actors rely on existing knowledge structures (Gavetti et al., 2005; Nickerson & Zenger, 2004). These structures allow them to simplify their search space by replacing unclear cause-effect relationships with familiar ones

[10] This definition encompasses March's definition of ambiguity, the "lack of clarity or consistency in reality, causality, or intentionality. Ambiguous situations are situations that cannot be coded precisely into mutually exhaustive and exclusive categories." (March, 1994: 178). While common to the literature (e.g., Davis et al., 2009; March & Olsen, 1976; Santos & Eisenhardt, 2009), unlike us, some authors have used the term ambiguity in the Knightian sense of risk (Ellsberg, 1961; Packard, Clark, & Klein, 2017).

(e.g., Csaszar & Levinthal, 2015; Levinthal, 2011; Simon, 1991). This approach maintains a deductive logic of search with at least subjectively probabilistic distributions of solutions (LeRoy & Singell, 1987; March, 2006).

Yet, in settings of risk, new knowledge structures implicitly already exist and are discovered (Alvarez & Barney, 2007). Hence, as I elaborate below, existing perspectives on search cannot convincingly explain how actors would purposively create new ones (March, 2006).

First, in evolutionary theories originating in the BTOF, the discovery of new structure is serendipitous (Nelson & Winter, 1982) and largely a product of action and luck, through exploration (March, 1991), slack search (Cyert & March, 1963), distant search (Levinthal, 1997), or pre-adaptation (Denrell et al., 2003). Work in this view explains novelty as serendipitous result of temporal availability of options (Cohen et al., 1972), such as contextual alertness (von Hippel & von Krogh, 2016). For example, von Hippel and von Krogh (2016) explain how individuals attending trade shows may, by looking at exhibits (i.e., solutions), recognize latent needs (i.e., problems) of which they were previously unaware. While, coincidence certainly provides an explanation for the discovery of novel structure, it cannot explain the process through which it is created originally, or, provide guidance for how such processes may be designed at the organizational level so that search can lead to outcomes that are complementary to existing knowledge stocks and the strategic orientation of the organization.

Second, cognitive approaches within the Carnegie School attribute the discovery of new structure to superior mental models, which allow actors to augment their otherwise myopic search (e.g., Gavetti & Levinthal, 2000; Simon, 1991). Cognition enables foresight and can provide a powerful way to imagine new structures that are distant and potentially invisible to others (Gavetti, 2012; Gavetti & Menon, 2016). However, cognitive approaches focus on heuristics that actors derive from their memory (e.g., Bingham & Eisenhardt, 2011; Gavetti et al.,

2005, Nickerson & Zenger, 2004). In particular, analogies serve as shortcuts to reach superior starting points for search and enable actors to draw cognitively distant positions on a solution landscape closer (Gary et al., 2012; Gavetti et al., 2005). But for any analogy to work, the yet unknown novel and the analogous context need to structurally correspond (Gick & Holyoak, 1980; Thagard, 2005). This ultimately biases actors to replicating familiar knowledge structures instead of generating new ones (Grandori, 2010). When pursuing new knowledge structures, any analogy should provide an equally (in)appropriate starting point for search, and no objective preference order will exist between them. Thus, while analogies may enable deliberate search under uncertainty, I maintain that it is unclear how that search should lead to true novelty.

Finally, recent research in the problem-solving view considers the identification of new structure as a result of actors' holistic understanding of a given setting. Actors may attain a comprehensive problem formulation to determine valuable solution spaces prior to search (Baer et al., 2013; Nickerson et al., 2007; Nickerson et al., 2012). To do so, actors seek exhaustive insights into observable symptoms and potential causes of a focal problem to increase the probability of isolating its "*root causes*" (Baer et al., 2013: 200). By avoiding biases that accelerate problem definition (e.g., existing mental models), actors grow their chances of thoroughly considering "*the entire problem space*" (Ibid: 204). But if root causes exist and may be discovered by tracing causes of observable symptoms, actors implicitly know cause-effect relationships. They are thus searching in settings of risk, seeking a probabilistically optimum problem definition. Despite reducing myopic search, this process remains deductive. Problem statements are independent and a prerequisite for the search and evaluation of solutions. Novelty exists and its identification remains ultimately a product of actors' bounded rationality.

In summary, theories of search in the tradition of the Carnegie School offer behaviorally plausible explanations for how (most) boundedly rational actors search. But they are constrained

to explaining organizational improvement based on existing knowledge structures. I argue that their original generation constitutes a different search processes that includes uncertainty and logically precedes the widely studied one. Below, I conceptualize such a process.

Toward an Abductive (Design-based) Theory of Search

Setting the Stage for New Knowledge Structures: Search in Settings of Uncertainty

I have argued that new knowledge structures are the foundation for any truly novel outcome (that is at least new to a focal organization). For example, prior research shows that when actors form new markets (Santos & Eisenhardt, 2009), commercialize novel technologies (Majchrzak, Griffith, Reetz, & Alexy, 2018), or build innovation ecosystems (Dattée, Alexy, & Autio, 2018), they need to constantly acquire insights to *create* the knowledge structures that underlie these novel outcomes. I define new knowledge structures as artificial (Arthur, 2007; Simon, 1996) and thus constructed instead of pre-existing (Alvarez & Barney, 2007; Dreyfus, 2007; Felin, Kauffman, Koppl, & Longo, 2014; Grandori, 2010; March, 2006). They emerge from organizational actors' insights of what may be relevant and how it may be done, through which they causally link problems and solutions.

Hence, when pursuing new knowledge structures, actors will initially lack clarity of such cause-effect relationships and thus need to grapple with uncertainty. In this context, bounded rationality should be one, but not the primary challenge actors will face. Satisficing heuristics (Simon, 1955; 1956) require some structure (i.e., parameters for when to stop searching) as a reference point, but exactly this structure is, by definition, initially absent and the product of the search process (Loasby, 2001, March, 1994). Thus, while the basic assumption of bounded rationality remains untouched, I propose that *how* actors search when they pursue new

knowledge structures changes. It should remain unclear or even unknown, which pieces of information (i.e., problems and solutions) that they hold may matter (Alvarez, Barney, McBride, & Wuebker, 2017; Grandori, 1984; March, 1978), which additional ones they may need (Faulkner, Feduzi, & Runde, 2017; Huang & Parce, 2015; Packard et al., 2017), and how these pieces of information may be connected (e.g., Bhardwaj et al., 2006; Duncan, 1972; March, 1988). Multiple, equally promising, potentially interdependent, and contradictory cause-effect relationships may exist. While alternatives are unlimited, without prior structure, actors will struggle to classify and evaluate pieces of information and how they may relate (e.g., Grandori, 2010; Knight, 1921; Langlois, 2007; Loasby, 2001; March, 1994; March & Olsen, 1975; Shackle, 1972).[11] These characteristics also defy decision-making based on probabilistic estimates of possible outcomes (Alvarez & Barney, 2005; Knight, 1921), because without prior links providing "*pre-existing purpose*" (March, 1988: 254) or "*values*" (Lindblom, 1959: 79), actors will struggle to establish mutually exclusive categories that can provide guidance for search. There is "*yet no 'problem' to solve*" (Schön, 1983: 41), but a puzzling setting to explore.[12]

[11] This does not mean that any single actor may not hold a clear classification system (e.g., Leroy and Singell, 1987)—we share and build on this assumption. But, our argument is about the existence of such concepts on the organizational level (Foss & Klein, 2012).

[12] Our conceptualization of uncertain settings resembles the one of *wicked problems*: social system problems, characterized by high complexity, uncertainty, and novelty (Churchman, 1967; Rittel & Webber, 1973). Wicked problems, like ill-structured problems (Simon, 1973; Fernandez & Simon, 1999), are inherently complex and comprise unclear interdependencies between potential problem definitions and solutions. Both, however, rest on fundamentally different assumptions of how they can be approached and thus, should not be conflated. For ill-structured problems, actors determine a representation prior to the search for a solution (Simon, 1973). Contrary, according to Rittel and Webber (1973), no ex-ante definition of wicked problems will exist. Instead, any attempt to define them requires the simultaneous generation of solutions. Thus, actors need to understand a wicked problem through searching. Wicked problems relate to creation processes where outcomes are uncertain prior to search. The criteria of what these outcomes should contain are unknown (or unknowable) and thus cannot be defined ex ante (Buchanan, 1992; Camillus, 2008; 2016; Dorst, 2011; Rittel, 1992). Given organizational actors may hold different values (Lindblom, 1959), every wicked problem can be treated as a symptom of a higher level problem (Rittel & Webber, 1973). The concept of wicked problems is central to the field of design (e.g., Buchanan, 1992; Huppatz,

For example, the new-to-the-world material graphene is a two-dimensional carbon molecule structure with extraordinary physical properties and the thinnest material known (Geim & Novoselov, 2007). Because of its versatile properties, it promises an abundance of commercial applications—from microprocessors to airplanes. But the material's properties, potential market applications, and preferences were initially unclear and generating ex-ante probabilistic estimates of how to operationalize any of these applications would have been impossible or unproductive.

Embracing Uncertainty: Abductively Searching for Two Unknowns

I suggest thinking about searching for new knowledge structures through an organizational process that *embraces the uncertainty* that exists over the causal links between potentially relevant problems and solutions. The absence of prior structure provides the necessary freedom to envision any new one (Knight, 1921; Loasby, 2001; Peirce, 1878; Shackle, 1972) and to construct it from scratch (Alvarez et al., 2013; Dougherty, 2016; Foss & Klein, 2012; McMullen & Dimov, 2013). Put differently, without prior structure, what constitutes a problem or solution should be independent and actors may think of both together (Dorst & Cross, 2001; Rittel & Webber, 1973). Hence, I posit that they may embrace uncertainty and achieve true novelty by simultaneously searching for *two* unknowns: problems *and* solutions.

To inform this conceptual shift of organizational search, I draw inspiration from the field of design, where tackling uncertainty to pursue novelty is common (e.g., Brown, 2009; Buchanan, 1992; Cross, 2007; Rittel & Webber, 1973). Design roots in pragmatism and rests on an abductive logic of inquiry (Dorst, 2011; Roozenburg, 1993). In turn, the logic of abduction, a

2015; Rittel, 1992) and becomes increasingly important for describing challenges in management (e.g., Camillus, 2008, 2016; Edmondson, 2016). For example grand challenges—complex global problems—share similar characteristics (e.g., Ferraro, Etzion, & Gehman, 2015; George, 2014; George, Howard-Grenville, Joshi, & Tihanyi, 2016; Grodal & O'Mahony, 2017).

process of forming initial hypotheses to explain a puzzling (i.e., uncertain) setting, provides a form of reasoning through which actors may introduce an inventive step (Hanson, 1958; Magnani, 2001; Mantere & Ketokivi, 2013; Niiniluoto, 1999; Peirce, 1878).

The starting point of abductive reasoning is doubt, which actors will experience in any puzzling setting (McMullen & Shepherd, 2006; Peirce, 1931-1958 5).[13] While doubt may be seen as an unsettling perception that actors may like to reduce, it can also provoke them to generate new and unexpected explanations, hence providing positive momentum for search (Locke, Golden-Biddle, & Feldman, 2008). Either way, and as a response to doubt, actors will seek explanations in the form of abductive hypothesis, to enhance their mental representation of the puzzling context (Burks, 1946; Dewey, 1915; Locke et al., 2008; Peirce, 1878). Contrary to logical consequences in deduction, abductive hypotheses merely represent conjectures of "something that may be" (Peirce 1931-1958 5: 171). They result from what actors consider as adequately explaining a specific puzzling setting by "account[ing] for the facts" (Burks, 1946: 303)—instead of what they can infer from existing knowledge structures (e.g., Bingham et al., 2010). I refer to abductive hypothesis as *plausible* causal statements (Grandori, 2010; Magnani, 2001). Plausibility in abduction replaces validity and certainty in deduction (Behfar & Okhuysen, 2018; Mantere & Ketokivi, 2013; Weick 1989).

I argue that actors can form plausible hypotheses by linking particular problems and solutions into pairs. This way, they connect aspects they consider relevant (what to do) with things to potentially implement (how to possibly do it) to form a causal model of a particular

[13] I merely assume that, because of intrinsic and / or extrinsic motivation, actors commit to a task or assignment that leads them to act in the face of uncertainty. I note that the specific question, why actors start searching in uncertain settings in the first place, is of particular importance and interest in entrepreneurship. However, it deserves specific attention and reaches beyond the scope of our theorizing.

uncertain setting.[14] I maintain that this is a conscious process that requires agency. Following abductive logic, I propose that actors may exert such agency through *judgment* (e.g., Grandori, 2010; Magnani, 2001; Rittel, 1984), a methodical and purposeful behavior under uncertainty through which actors strive for "*excellence in reasoning*" (Locke et al., 2008: 911; also: Mantere & Ketokivi, 2013). Reasoning matters when the freedom for conjecture is high—like under uncertainty—and actors may ponder endless possibilities through imagination (Felin & Zenger, 2009; Niiniluoto, 1999; Rittel, 1971; Shackle, 1979). It requires actors to produce logically consistent and contextually relevant causal models (Foss & Klein, 2012; Knight, 1921; Langlois, 2007; Loasby, 2001; Smith, 1980 [1795]). I cannot make assumptions how judgment may influence search outcomes (i.e., whether an abductive hypothesis holds), but that it provides an explanation for how actors evaluate the potential value of desired outcomes (Grandori, 2010). It is this agency through judgment that distinguishes abductive search from the mechanistic procedures of deductive search and can be a means for introducing novelty.

Conceptual Foundations of Abductive Search

Abstract goals. Following my argument, I suggest thinking about abductive search as originating from a puzzling setting, which I conceptualize as an *abstract goal.* Like any goal, I suggest that abstract goals represent desirable outcomes. But in contrast to clear goals in settings of risk, they will not provide specific guidance for where to start searching and for what. Accordingly, I define abstract goals as desired outcomes that cannot be pre-stated and thus foster doubt. This will enable actors to generate abductive hypotheses, directed toward the creation of

[14] Other scholars have emphasized the importance of such links (Cohen et al., 1972; Loasby, 2010; March, 1994), referring to what I label *problem* and *solution* as *context* and *form* (Alexander, 1964), *purpose* and *effect* (Arthur, 2007), *function* and *form* (e.g., Cross, 2007), *value* and *policy* (Lindblom, 1959), *means* and *effect* (Sarasvathy, 2001), or *need* and *solution* (von Hippel & von Krogh, 2016).

new knowledge structures that will form a representation of an abstract goal. Because abstract goals will be specified through an emergent knowledge structure, they are initially indeterminate (Buchanan, 1992; Rittel & Webber, 1973), *not* undetermined (Simon, 1973; 1996). In the case of graphene, commercialization is an abstract goal that provides an impetus for search, yet lacks guidance on the performance dimensions along which to search: it is unclear through which product, business model, and form of organization this abstract goal may be reached.

I situate abstract goals at the organizational level (i.e., more than one actor) where they can relate to (1) any organization or (2) specific organizations only. To the first point, abstract goals can constitute genuinely new to the world endeavors (e.g., creating a settlement on planet Mars), opportunities (e.g., building a Blockchain-based economy), or challenges (e.g., sealing the BP oil spill in the Gulf of Mexico) that are generally uncertain and any actor should perceive doubt about their nature. To the second point, abstract goals can represent idiosyncratic organizational objectives that are only uncertain for a focal group of actors. The goal of increasing revenues by 25% is abstract, if it implies that a firm should achieve this by a breakthrough outcome that requires the identification of new search domains (Adner & Levinthal, 2008; Bhardwaj et al., 2006; Kim & Mauborgne, 2005).[15] Otherwise it would be clear which knowledge structure to apply.

Because abstract goals are vague, they enable actors to influence cause-effect relationships and thus change the core structure of their search outcomes (e.g., Arthur, 2009; Paton & Dorst, 2011; Schön, 1984). A basic example from design education illustrates this idea. Actors assigned with the clearly stated goal of "devising a chair," may likely produce outcomes that exhibit the core features of existing chairs (i.e., a seat, four legs, and a backrest). Conversely, when

[15] Following my definition, for example, wicked problems (Rittel & Webber, 1973) and grand challenges (George et al., 2016) represent abstract goals (although the inverse need not be true).

abstracting the goal to "creating furniture to sit," they likely enhance the variety of still related alternatives that may remotely resemble the basic structure of a chair (e.g., a sitting ball).

However, such abstract goals may be difficult to determine, because actors often hold well-established mental models, which they may be inclined to apply (e.g., Bingham & Eisenhardt, 2011; LeRoy & Singell, 1987). These will direct search along established performance dimensions and—no matter how distant the search—toward familiar solutions (Chai, 2017; Felin et al., 2014). I suggest that actors can establish abstract goals by grappling with the uncertain "*subject matter*" (Buchanan, 1992: 5) of the focal setting (also: Loasby, 2001). For example, the design brief for the creation of the first carbon-neutral city[16]—presented to the engineering and design firm Arup (Wu, Davies, & Frederiksen, 2015)—could have been read as improving carbon-efficiency of familiar city concepts. But treated as an abstract goal of developing an "eco-city," it provided an opportunity to define a new market segment in urban development. No prior models existed for what an "eco-city" should be. It was unclear which of the current concepts of urban development, green technologies, and governance mechanisms could be combined, and which initially unknown alternatives for a groundbreaking result would exist. This required rethinking urban development and initiating a system-level change.

A triadic relationship. What further follows from my argument is that in an abductive logic of search, abstract goals, problems, and solutions are conceptually distinct (see Figure 1, left). This departs from prevalent thinking as related to settings of risk, where problems (or solutions) can essentially be treated as synonymous to goals (e.g., Simon, 1964), and one may refer to the goal as *the problem to solve* or *the solution to achieve.* The concepts of Simonian problems

[16] The *Dongtan* project was a large infrastructure development project initiated by the Shanghai Industrial and Investment Corporation. They aspired to build the world's first operational carbon-neutral city on an island in the Shanghai Delta.

(Simon, 1973), performance goals (e.g., Shinkle, 2012), and solution landscapes (e.g., Levinthal, 1997) rest on this assumption. However, by separating the three constructs, I emphasize their triadic relationship. This allows us to escape the prevalent thinking of pre-existing links between problems and solutions (March, 1972; 1988), to theorize how these relationships may initially be created. I propose that in such a triadic relationship, the abstract goal guides search, rather than a specific problem or solution, and actors can independently associate problems and solutions with it. Unlike parallel search, where actors explore multiple solutions to one problem (e.g., Nelson, 1961), I argue that actors can simultaneously search in both the problem *and* the solution space. While the abstract goal remains fixed, the problems and solutions representing it can vary.

This practice of independently and simultaneously searching the problem and solution space is common in the field of design. To generate an understanding of the problem space, actors can study the needs, requirements, and desires of people who are affected by the abstract goal (Krauch, 1999). At the same time, they may investigate the solution space by considering advancements in technology, science, and policy that relate to the abstract goal (Sommerlatte, 2009). For example, when pursuing the "eco-city," actors may generate relevant problems by studying the needs of future residents, investigating the objectives of different stakeholders, or defining basic practical requirements for this new development. At the same time, they may produce possible solutions by pondering technologies to reduce carbon emissions, research on future urban concepts, or governance forms for this new development.[17] Conceptually resting on the triadic structure, this individual and simultaneous association is central to my argument.

[17] Drawing on design practice, actors create a system of needs and a system of functions to get an idea of requirements and opportunities of a focal context. Krauch (1999: 80), for example, proposes the technique of "maieutic" to investigate hidden user needs (problems) and Sommerlatte (2009: 25) suggests the process of "unbundling technologies" to understand technological possibilities (solutions).

Abductive Search Dynamics and Activities

Building on this general logic of abductive search, I now turn to the dynamics of organization search I expect it to produce. I suggest that when organizational actors attempt to create new knowledge structures, triggered by an abstract goal, they will pursue multiple causal links between a problem and solution space to ultimately determine an area in either of them. This pursuit should be principally open-ended (e.g., March, 1994; Tan, 2015). Actors should be inclined to continuously generate additional plausible problem-solution pairs to potentially provide more plausible hypothesis for how to achieve the abstract goal. They inevitably stretch their bounded rationality and "*behave to the best of their possibilities*" (Grandori, 2010: 480). Thus, when abductively searching for new knowledge structures, actors should pursue maximum attainable results (which still need to be created)—*not* objective maxima (which would require existing knowledge structures). By forming new pairs—associating and linking problems and solutions, or, reconfiguring previously created pairs—actors sustain openness and control how, and if at all, they reach closure.

Following my argument, closure may be achieved through a reduction of actors' doubt. Within an abductive logic, they may reduce their doubt by producing an explanation of the focal uncertain setting that is most plausible with regard to alternative explanations (Harman, 1965). I suggest that this may be realized through a complementary set of plausible hypotheses, that actors can integrate into a coherent mental model (e.g., Bechky, 2003; Dorst, 2003; Harrison & Rouse, 2015; Langlois, 2007; Rittel, 1971). That is, connecting pairs or adding problems and solutions to them, forming the new knowledge structure as an outcome (e.g., Arthur, 2007; Bhardwaj et al., 2006; Rittel & Webber, 1973). To eliminate further doubt and stabilize this structure, actors may empirically evaluate its constituent problem-solution pairs, which will be

identical to testing deductive hypothesis. Both logics only differ, although notably, in terms of hypothesis generation, not testing (Chauviré, 2011; Grandori, 2010; Popper, 1963).

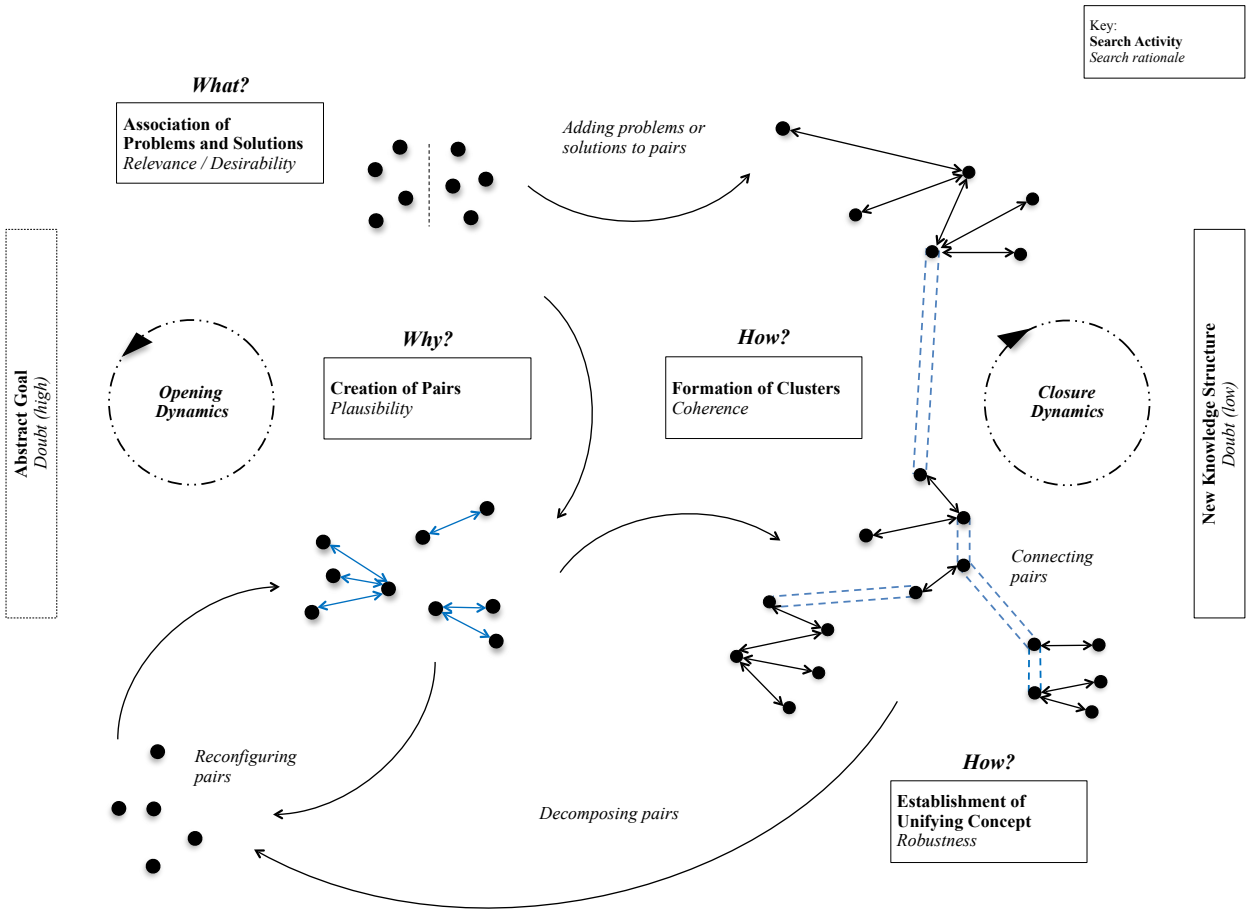

Figure 2. Abductive Search Dynamics and Activities

I now focus on the explicit search activities that underlie these dynamics (see Figure 2). Specifically, I illustrate how organizational actors may leverage their doubt about an abstract goal by associating problems and solutions to a focal context (i.e., *what* may be relevant) as well as creating pairs of them (i.e., *why* this may be plausible). These activities contribute to the divergence of potentially relevant problem-solution pairs—I refer to them jointly as *opening dynamics*. Activities that lead to connecting related pairs into clusters (i.e., *how* they may be combined), contribute to a reduction of doubt through the bottom-up formation of a joint set of

problem solution pairs: the new knowledge structure that represents the abstract goal. I refer to these activities that enable convergence as *closure dynamics*. Consistent with abductive logic, all search activities should be conceived of as highly interconnected and (largely) simultaneous (Behfar & Okhuysen, 2018; Mantere & Ketokivi, 2013). Thus, while discussing them consecutively below, I neither imply a stepwise nor prescriptive procedure.

Opening Dynamics

What? Association of problems and solutions. I argue that the intention of creating a representation of an abstract goal and the lack of specific guidance of how to achieve it requires actors' imagination (Loasby, 2001; Locke et al., 2008; Shackle, 1972). Although the abstract goal remains unclear for the organization, any single actor may associate specific problems and solutions with it (Lloyd & Scott, 1995; Schön, 1984; 1988)—even if, at the extreme, these associations entirely differ within the organization. What matters depends on how any single actor imagines the abstract goal (Knight, 1921; Shackle, 1972).

Although actors' associations represent conjectures, they are not arbitrary, but following abductive reasoning, context-related and aimed at providing a representation for the abstract goal (e.g., Bamberger, 2018; Behfar & Okhuysen, 2018; Magnani, 2011). Actors should start from an imagined future from which they refer back to currently available pieces of knowledge. This deliberate process of considering possibilities rests on the natural human capacity to consider relevant aspects (Felin & Zenger, 2009; Peirce, 1957).[18] For example, actors may imagine that an eco-city would ban combustion engines. They could investigate alternative transportation systems to associate future residents' needs, stakeholders' aspirations, and commuters' demands

[18] If some associations turn out as irrelevant, they will simply be left out when forming plausible hypothesis.

(problems). Separately they could study advancements in propulsion technologies, associating electric engines, autonomous vehicles, and hyperloops (solutions) as related to the abstract goal.

When imagining possibilities this way, feasibility is not of primary concern (cf., Baker & Nelson, 2005; Sarasvathy, 2001), but the freedom to playfully ponder desirable as well as potentially relevant aspects without instantly considering performance implications (e.g., Dodgson, Gann, & Salter, 2005; March, 1988; Shackle, 1972). As common in design, actors may immerse themselves in two separate realms, those of problems as well as solutions, and realize a broad understanding in each (Dorst, 2011; Krauch, 1999; Rittel, 1992; Sommerlatte, 2009). Actors generate diverse, independent, and context related conjectures, because any associated problem and solution may be potentially relevant. This search activity should not reduce actors' doubt about the abstract goal but maintain its generative potential (Locke et al., 2008).

Why? Creation of pairs. To move toward a reduction of doubt, I argue that actors can draw from this diverse pool of means and effects to create problem-solution pairs.[19] Only by linking particular problems and solution, they can justify why these are relevant to the focal context, thus making them plausible hypotheses that represent an aspect of the abstract goal (Cross & Cross, 1998; Dorst, 2001; Dorst & Cross, 2001; Grandori, 2010). To create such plausible problem-solution pairs, actors may (a) ponder the pattern of associated problems and solutions to propose a pairing (empirical abduction), or, (b) they may imagine a desirable aspects of the abstract goal first and select a corresponding pairing afterward (theoretical abduction) (Bamberger, 2018; Grandori, 2010). Either way, problem–solution pairs constitute closely connected units that are

[19] Actors may, of course, instantly form pairs. Our emphasis on the previous separate association is to improve the understanding of how abductive hypothesis are formed, that relate to a focal context, and to avoid conflation with those rooting in prior mental models.

context specific and non-generalizable (Behfar & Okhuysen, 2018). This requires actors' contextual awareness which may reduce random pairings.

Notably, plausibility in abduction is not to be confused with probability in settings of risk—it merely requires sound reasoning (Mantere & Ketokivi, 2013). For example, actors in the eco-city project could have identified an innovative power-storage system (potentially relevant solution). But aware that energy generation will be constantly feasible, they miss a problem that it may be linked to. To create a plausible hypothesis, actors may think of the summer months, when typhoons hit the tropical city and the constant energy generation through tidal stream generators, wind turbines, and solar panels (alternative solutions) may be interrupted. This raises the relevance of producing, storing, and even selling energy to neighboring suburbs. Linked to the innovative power-storage system, this problem-solution pair constitutes a plausible hypothesis.

In turn, creating such problem-solution pairs should enhance the clarity of the abstract goal for any single actor. When, however, they consider their pairs in the light of those of others, they may become aware of aspects they left unnoticed or were unaware of. This should restore their doubt about the abstract goal and prevent its premature fixation (Dattée et al., 2018; Yoo, Boland, & Lyytinen, 2006). In a design process, such ongoing openness is desirable (e.g., Cross, 2007; Jansson & Smith, 1991; Purcell & Gero, 1996), because it allows actors to ponder alternatives (e.g., Bazjanac, 1974; Rittel, 1992; Roozenburg, 1993; Schön, 1983), reconsider aspects they discarded as blind alleys (Harrison & Rouse, 2015; Locke et al., 2008), and reengage in search for more plausible and potentially truly novel hypothesis (e.g., Cross, 1997; Liu, 1996; Paton & Dorst, 2011; Schön, 1984). Because pairings are tentative, any associated problem and solution can be drawn on by others as a cognitive springboard from which to launch investigations in the respective other space (Bhardwaj et al., 2006; Cohen & Munshi, 2017; Felin & Zenger, 2009). As in design, actors search for plausible links between the problem and solution space by oscillating

between the two, constantly comparing insights (Cross & Roy, 1989; Dorst & Cross, 2001; Maher & Tang, 2003). These co-evolutionary[20] dynamics can lead to a simultaneous understanding of both spaces and sustain the generative potential of search (McKelvey, 1997).

The pool of problems and solutions generated this way may be diverse and enable actors to create truly novel pairs. Referring to the metaphor of search landscapes, this corresponds to links across landscapes (Adner & Levinthal, 2008; Felin et al., 2014). Importantly, in this process, these links are created from deliberately accumulated pieces of knowledge, not lucky discoveries.[21] For example, to commercialize graphene, actor A may raise the idea of focusing on the security industry (problem), leading actor *B* to think of vests and helmets (solution), which actor *C* in turn associates with cycling and proposes outdoor sporting contexts (problem). Drawing on this context, actor A may recall the initially abandoned electronic properties of graphene to suggest longer-lasting and faster-charging batteries based on its higher cell-level energy densities to propose applications in outdoor sports (solution). Likewise, launching from the possibility of fast-charging batteries through graphene (problem), actor *A* may analogize to pit stops in motorsports and notice possible applications for brake discs in cars by leveraging graphene's heat-conducting properties (solution). This solution may alert actor *B* to the constant challenge of heat reduction in micro-electronics (problem) and prompt associations of potential solutions for this market.

Following my argument, I suggest conceiving of problem–solution pairs as reaching beyond exclusive one-to-one links between a single problem and a single solution. Like any product in

[20] Following McKelvey (2002), I assume the these preconditions for co-evolutionary dynamics to apply: (1) actors must be heterogeneous; (2) actors must be adaptive; (3) actors must be able to interact with and influence each other; (4) there must exist higher-level constraints, which motivate a co-evolutionary process (in our case the abstract goal). As soon as one of these conditions is no longer met, co-evolutionary dynamics will come to a halt.

[21] This assumption relates to the design (and innovation) literature, that treats novel concepts as results of a constant accumulation of knowledge in an area of inquiry, instead of sudden encounters (e.g., Arthur, 2007; Cross, 2007).

design, they may include several problems and solutions that address a similar aspect of an abstract goal—representing more specific and thus potentially more plausible hypotheses. For example, when commercializing graphene, a new production technique (single solution) could solve construction constraints from an engineering perspective as well as financial restrictions of production costs (multiple problems). Likewise, convincing people to adopt the technology could be a key challenge (single problem) that could be addressed by attending industry fairs, cold-calling, and speaking at events (multiple solutions).

By linking problems and solutions, actors create a tentative and loosely connected set of hypotheses (Behfar & Okhuysen, 2018; Loasby, 2001). However, these problem-solution pairs neither provide criteria for why to stop searching, nor should they reduce their doubt over the abstract goal. They merely represent individually plausible (yet potentially novel) conjectures. Therefore, I turn to search activities that may lead to a reduction of doubt and toward closure.

Closure Dynamics

How? Formation of clusters. Building on the reflective practice of design (e.g., Cross, 2007; Dewey, 1915; Schön, 1983), actors may attempt to reduce doubt by making their mental model of the abstract goal explicit, thereby transferring the loose set of potentially plausible problem-solution pairs into clusters that coherently connect some of them. An explicit representation (e.g., through visualization or verbalization) will require actors to decide about interdependencies between pairs and, in turn, advance their cognitive representation (e.g., Brown, 2009; Cross & Cross, 1996; Klag & Langley, 2013; Rittel, 1992; Schön & Wiggins, 1992).

I suggest that this configuration of pairs into coherent clusters requires judgment about priority as well as complementarity (e.g., Arthur, 2007; 2009; Loasby, 2001). On one hand, actors may vertically integrate problem–solution pairs to elaborate a specific pair and increase the

depth of specific aspects of their representation. For example, in the eco-city project, actors may elaborate the problem–solution pair of achieving energy efficiency (problem) by appropriate design of building exteriors (solution), including new sub-problems, such as insulation or heat reflection, and applicable sub-solutions, such as greening rooftops or facades. On the other hand, they may horizontally add complementary problem–solution pairs to broaden their representations' scope. For example, the energy-efficient house may be extended by environmentally friendly power generation through energy-producing building materials. Even a concept that replaces transport by car with building-to-building micro pods would complement the energy-efficient house.

I suggest that when forming clusters of pairs, actors shift from causal conjectures (between problems and solutions) to structural conjectures (between problems-solution pairs) and from a judgment of plausibility to one of coherence. In turn, becoming explicit about their cognitive representation of the abstract goal should allow actors to suggest some structure around which further pairs may crystallize. This can break the momentum of oscillating search and initiate closure. However, any cluster of pairs that actors create rests on idiosyncratic assumptions (Newell & Simon, 1972) that may not be clearly distinguishable (Cross, 2007; Loasby, 2001) or directly comparable (e.g., Lindblom, 1959; Popper, 1963). Actors decide on the focus and comprehensiveness of any configuration of clusters in order to represent the abstract goal. Thus, any suggested cluster should (at least marginally) vary and reflect actors' preferences.

How? Establishing a unifying concept. Given this diversity of clusters and the lack of clear assessment criteria, the resolution of doubt, and thus closure, should require agreement among actors (Baer et al., 2013; Garud & Rappa, 1994; Lindblom, 1959; March, 1994; Rittel, 1992;

Rittel & Webber, 1973).[22] Building on abductive reasoning and design practice, I suggest that the logic of robustness (Ferraro et al., 2015; Padgett & Ansell, 1993) can provide a rationale for how actors may reach such agreement.

Robustness refers to the commitment on a strategy that keeps future options largely open (Dattée et al., 2018; Leifer, 1991). We may think of actors reaching agreement based on a higher-order unifying concept that allows for the integration of a variety of otherwise (partially) incomparable clusters, and which reaches beyond any actors' individual mental representation of the abstract goal. This notion relates to those of "*apposite proposals*" (Cross, 1997: 428), "*conceptual leaps*" (Klag & Langley, 2013: 150), or *"base principles"* (Arthur, 2007: 276), all of which are higher-order concepts that integrate heterogenous information. Following my argument, the unifying concept emerges through reflective practice and from the focal context (Schön, 1983), when actors recognize similarities across clusters. For example, to commercialize graphene, all actors may focus on the enormous physical strength of the material and driver security in motorsport. Although their ideas may vary from helmets to seat constructions as well as motorcycles to Formula 1, they may realize that all of them refer to some sort of "shielding idea" and protecting drivers from external impact and debris. Here, "shielding" is the unifying concept that allows for the integration of many of their previously largely incomparable ideas.

I argue that by realizing a unifying concept, actors may reduce their doubt about the abstract goal and achieve closure of the search process. I expect that any additional problem, solution, and

[22] While single actors may certainly satisfice with respect to their individual image of the abstract goal, this representation, as we are arguing, is still emerging within the organization. Also, this organizational process should not necessarily lead to an outcome over time, but this outcome should be produced within a political process (March, 1962; 1994; March & Olsen, 1976; Rittel & Webber, 1973) that involves negotiation and coalition formation (Cyert & March, 1963; Stevenson, Pearce, & Porter, 1985). However, a discussion of these dynamics reaches beyond the scope of this article and may be addressed in future work. We build on the basic assumption that, despite potential conflict, a general aspiration toward establishing a representation of the abstract goal exists within the organization.

pair that actors can create may gradually deviate from their unifying concept. Thus, even if plausible, actors will reject them as challenging this mental model (Lakatos, 1970). Likewise, actors may realize that additional problems, solutions, and pairs, become increasingly redundant, and even if plausible, they may not vertically or horizontally extend the alternatives that actors have produced so far (Grandori, 2010). As a result, actors' shared representation of the abstract goal should stabilize (Gavetti & Rivkin, 2007) and their search become increasingly myopic (Levinthal & March, 1993; Miller, 1993) and path-dependent (Arthur, 1994; Sydow, Schreyögg, & Koch, 2009). When searching in settings of uncertainty, these dynamics are positive, because they can lead to closure.

Given the lack of clear assessment criteria in uncertain settings, closure in abduction results from actors' judgment that further search would only create marginal change to this mental representation (Grandori, 1991; Pitts & Browne, 2004).[23] This is distinct from satisficing heuristics in a deductive logic (Simon, 1955; 1956), where actors choose a sufficient alternative based on a priori criteria (which may be adjusted). The difference lies in the assessment rationale, which in the first case rests on desirability (i.e., the value of creating additional hypothesis) as compared to a probability in the second case (i.e., the chance of discovering a better choice) (Grandori, 2010). I suggest that actors may only satisfice on an organizational level when they reach a shared representation of the abstract goal, from which they can derive assessment criteria.

The New Knowledge Structure

I refer to the joint set of problem-solution pairs at the point of closure, constituting actors' shared mental representation of the abstract goal, as the *new knowledge structure* (see Figure 3). Since it

[23] We note that this resembles the concept of theoretical saturation (Glaser & Strauss, 1967).

is the product of a bottom-up puzzling together of problem–solution pairs—through vertical and horizontal integration—we may conclude that this structure is hierarchical and nearly decomposable (Simon, 1962; 1996). This characteristic shares a similarity with Simon's (1973) complex and ill-structured problems. But instead of a means of *coping* with uncertainty, this hierarchical structure depicts the *result* of embracing it. It demarks the boundaries within the uncertain problem and solution space, linking specific areas of both (Cross, 1997; 2007). This new knowledge structure is the transition point of abductive (design-based) search to deductive (choice-based) search. Actors will have reached this point when they start substituting problems, solutions, and pairs, which implies a logic of improvement and deductive search. Searching by drawing on this new knowledge structure should then allow actors to find true novelty.

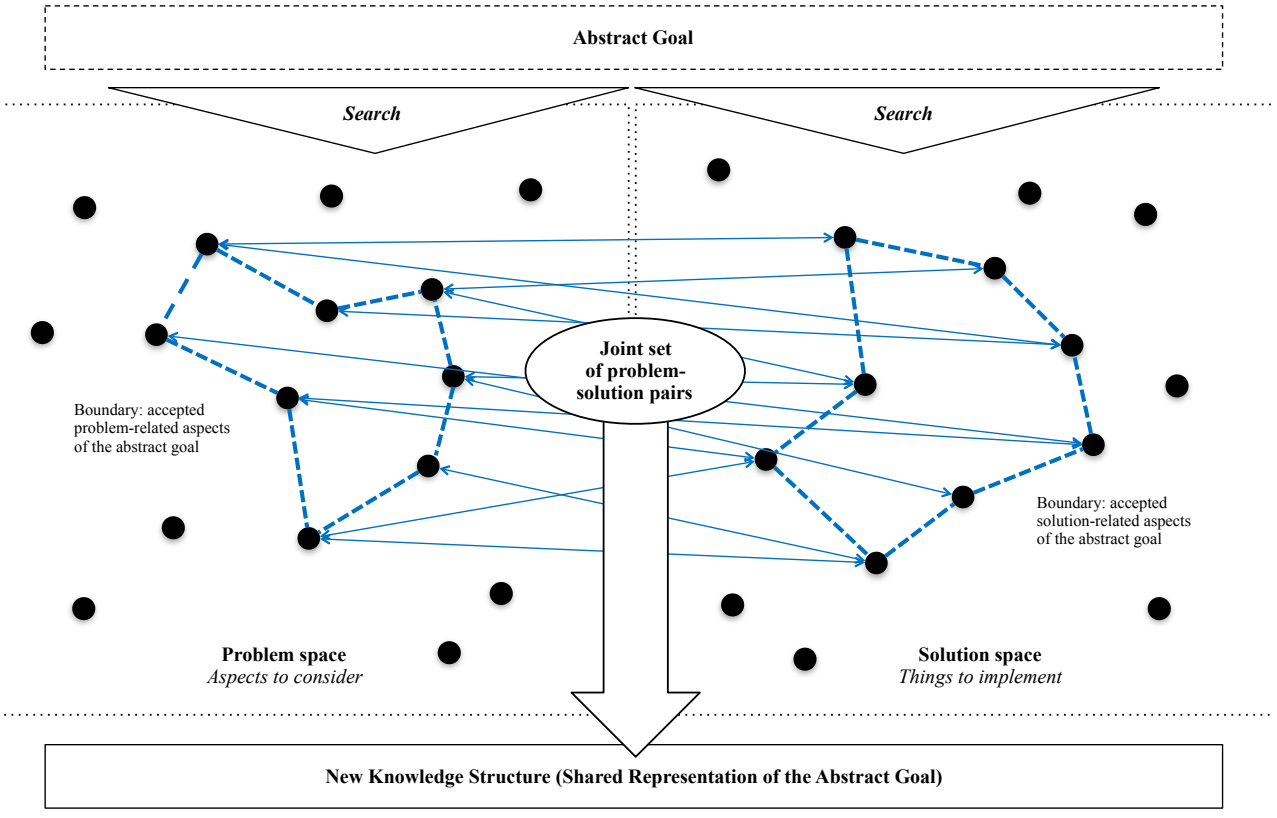

Figure 3. Closure of Abductive Search and Transition to Deductive Search

Discussion and Implications

In this study, I set out to extend existing theories of search originating in the BTOF. I highlight the boundary conditions of this perspective in explaining the origins of knowledge structures that underlie true novelty. By proposing an alternative theory of search that precedes problem-solving and *"take[s] uncertainty seriously" (*Alvarez, Afuah, & Gibson, 2018: 169), I show how actors may embrace uncertainty, instead of avoiding it, and, in doing so, establish new and potentially valuable causalities (e.g., March, 1988). I treat new knowledge structure as an artificial product of human agency that is designed and emergent as opposed to existing and discovered (Alvarez & Barney, 2007; Sarasvathy, 2003; Simon, 1996). Drawing inspiration from design studies (Buchanan, 1992; Cross, 2007; Rittel, 1971; Schön, 1983), I theorize an abductive process in which actors simultaniously search for problems, solutions, and links between them. From the perspective of creation theory in entrepreneurship, this may explain what is actually created (i.e., the "*unobservables*": Alvaraz & Barney, 2010: 570). I now elaborate key insights and link them to the strategy, innovation, and entrepreneurship literature.

Search and Novelty

First, I complement theories of organizational search originating in the BTOF by providing an explanation the emergence of true novelty. I address the current notion of search as an adaptation (e.g., Cyert & March, 1963; Levinthal, 1997) or problem-solving process (e.g., Baer et al. 2013; Nickerson et al., 2007; Simon, 1973), which assumes existing knowledge structures. I suggest that true novelty may result from "*non-optimizing strategies*" (Grandori, 1984: 192) that reach beyond feedback-based improvement (March, 1988; 2006). I argue that actors should search for what is plausible within a specific uncertain context and create novel structure through judgment

(Foss & Klein, 2012; Knight, 1921; Loasby, 2001; Venkateraman, Sarasvathy, Dew, & Forster, 2012). In doing so, I provide a conceptual framework for understanding how explorative types of search generate novelty that reaches—while not excluding it—beyond serendipitous discovery.

The notion of search as an improvement process results from "*the belief in a connection between action and feedback that matters rather than the actual causal link*" (Greve, 2013: 107). To explain true novelty, I conceptually break up this problem–solution dyad on which action and feedback rest. I treat problems and solutions as multiple aspects of an abstract goal. This shift matters, because aspects relevant for a novel knowledge structure may manifest as problems *or* solutions, which both constitute starting points for search. Actors may not prematurely focus on *one* problem or solution but oscillate between multiple alternatives, which can generate co-evolutionary dynamics and unlock substantial recombinant possibilities. I argue that this search for problem–solution pairs allows actors to create links between problems and solutions, which represent previously unknown performance dimensions. Values on which actors associate problems and solutions may differ: they can be located on different landscapes and actors may search along various vectors and across landscapes. We may thus conceive of abductive search in terms of connecting points across a three-dimensional space, instead of discovering peaks on a plane. True novelty should thus be thought of in terms of dimensionality instead of proximity (also see Adner & Levinthal, 2008; Felin, et al., 2014).

While most innovation originates from recombination (e.g., Salter & Alexy, 2014), I further stress that it matters *what* is recombined and on *which* basis: solutions based on a previously fixed problem definition or problems and solutions simultaneously based on an abstract goal. In the first case, actors achieve novel outcomes via problem formulation (Baer et al., 2013), while in the latter case, true novelty results from the construction of links between previously non-categorized problems and solutions. Following the latter approach, we may even expect that

problems and solutions not necessarily need to be new, but that it matters how these pieces of knowledge are combined to create knowledge structures (also see Baker & Nelson, 2005).

Search and Cognition

Second, I link to the conversation on cognition *(thinking)* and action *(doing)* for strategy formation in uncertain settings (Eisenhardt & Bingham, 2017; Gavetti & Rivkin, 2007; Ott et al., 2017). The prevalent view of action stresses local search and incremental progress as a response to uncertainty and is evident in evolutionary arguments in the BTOF (Cyert & March, 1963; Nelson & Winter, 1982) as well as entrepreneurship theory (Baker & Nelson, 2005; Welter, Mauer, & Wuebker, 2016; Sarasvathy, 2001) and practice (Blank & Dorf, 2012; Ries, 2011). Complementary to this work, my concept of abductive search, relates to the cognitive view that stresses mental models (Gavetti & Levinthal, 2000; Gavetti & Menon, 2016; Simon, 1991). I show why cognition and uncertainty matter for creating true novelty.

It underlies my argument that the way we see the world depends on the knowledge structures (e.g., theories) that we apply (March, 1988; 2006; Peirce, 1878; Popper, 1963). When these exist and remain stable, we can anticipate outcomes of our action (i.e., make causal inferences). I argue that uncertain settings can provide opportunities to create new knowledge structures, which I treat as, first of all, a cognitive process. My concept of abductive search resembles a theorizing process (Felin & Zenger, 2009; 2017; Weick, 1989), in which actors create new knowledge structures (i.e., a set of problem-solution pairs) that capture how actors conceive of an uncertain setting. I distinguish this view of cognition in terms of reasoning for plausible futures within a creation process, from cognition in terms of computing alternative choices in a discovery process

(Alvarez & Barney, 2007; Mantere & Ketokivi, 2013). This view of cognition as related to creation has been neglected.[24]

My view reaches beyond the functional discovery view of cognition, following which actors, even under uncertainty, should draw on familiar knowledge structures (e.g., analogies) to position themselves in favorable locations to begin searching (Gavetti et al., 2005; Gavetti & Menon, 2016). I suggest that by leaving existing knowledge structures, actors can shift from evaluating choices as *good* or *bad* to reasoning *what* choices matter and *why* as related to a focal context (Peirce, 1878; Rittel & Webber, 1973; Schön, 1983; 1988): "*When [actors] engage in reasoning, they do not just compute; they also cognize*" (Mantere & Ketokivi, 2013: 72). My concept of an abstract goal is central to this shift from problem-solving to forming causal conjectures. Instead of providing focus through cognitive shortcuts, abstract goals are deliberately vague and prevent instant simplified mental models of a search space. They lack clear categories for actors' existing pieces of knowledge, but provide a generative framing that allows to capture the views of many actors (e.g., March, 1994; Paton & Dorst, 2011; Schön, 1984; Zittrain, 1996). I argue that novelty should relate to the degree of goal abstraction: the higher it is, the easier it should be to create truly novel problem–solution pairs. For example, it may be this process of abstraction that explains how intermediaries like InnoCentive facilitate the creation of unforeseen products through the practice of broadcast search (Jeppesen & Lakhani, 2010).

I resonate with the cognitive view regarding broader concepts of actors' cognitive bounds. Yet, because the cognitive view rests on a discovery logic, it focuses on these bounds in terms of actors' understanding of search spaces (Felin & Zenger, 2009; Gavetti, 2012). In my creation

[24] While such a discussion is beyond the scope of this paper, I note that the differences in how I see cognition as opposite to the BTOF may be rooted in its positivist orientation, while my argument rests on pragmatism, a perspective which also resonates, for example, with the views of Popper (Phillips, 1975) and Kuhn (Mladenović, 2017).

logic, these bounds relate to actors' imagination. I concur with Gavetti & Rivkin (2007) that (bounded) *rationality* may increase over time when ever more is known of an existing search space, but suggest that (bounded) *imagination* will decrease with rising redundancies and incompatibilities of plausible conjectures of what a new knowledge structure should contain.

My argument further complements action-based logics like effectuation (Sarasvathy, 2001; 2008). Both rest on the idea of emergent structure, pragmatism, and the importance of taking uncertainty seriously (March, 1988; Sarasvathy, 2003; Sarasvathy & Dew, 2005). However, both differ in terms of the primary purpose of control (e.g., Grandori, 2010; March, 1978). I am concerned with actors' control of *desirable* outcomes and novelty as a potential result. Effectual logic focuses on actors' control of *possible* outcomes to ensure survival (or rapid failure and restart), but is less concerned with explaining novelty. I maintain that my view of cognition should be essential to explain viable outcomes, especially when reacting to contingencies of uncertain settings. Beyond general heuristics, as I have stressed, cognition is likely specific and idiosyncratic to the focal context. For example, my argument could help explain why actors employ resources in a certain way (Baker & Nelson, 2005) or why they choose a particular course of action (Sarasvathy, 2001). When actors select from available means and decide on particular effects, they link solutions with problems and conjecture causality. My separation of problems, solutions, and abstract goals may clarify the distinction of problems and goals that is implicit in this process (as, e.g., in Sarasvathy, 2001).

Search and Design

Third, I contribute to a science of the artificial in management (Romme, 2003; Sarasvathy, 2003; Simon, 1996; Venkateraman et al., 2012), highlighting the disconnect of the management and

design literature, and how to possibly reconnect both through the concept of organizational search.

Simon's (1996) view of design is prevalent in management. He conceives of it as a problem-solving process (i.e., a search for satisfactory solutions to pre-specified criteria) that he organizes according to scientific principles: analyzing complex tasks to produce better decisions.25 This information-processing view of design excludes judgment and ultimately enables artificial agents to design—leaving little room for true novelty. It suggests a mechanistic procedure that is still evident in the organizational and strategy literature, for example in writings on strategic problem formulation (Baer et al., 2013; Nickerson et al., 2007; Nickerson et al., 2012; Nickerson & Zenger, 2004). This perspective resonates with Simon's (1973; 1996) idea of achieving superior solutions (and even novelty) through a thorough analysis of problems prior to search. It implies that structure pre-exists and search constitutes a computational challenge even when dealing with complex and ill-structured settings. Problems are always thought to have root causes which actors may find by tracing back observable effects (Baer et al., 2013). Thus, they can determine existing cause-effect relationships, which indicates settings of risk and deductive search. However, although Baer et al. (2013) draw on Rittel & Webber's (1973) concept of wicked problems to highlight potentially competing views and unknowable aspects of problems in highly complex and ill-structured settings, their idea of root causes is antithetical to Rittel & Webber's argument: for wicked problems, problem formulations evolve through the generation of solutions as in the process I described, and any attempt to prior structure should be arbitrary.

Indeed, the alternative view of design that I build on originates from the concept of wicked problems (Rittel & Webber, 1973), that is, indeterminate contexts in which actors first need to

[25] I acknowledge that in his later work Simon (1996) points at social settings for a possible exception. But to our knowledge he neither develops this argument nor was this part of his agenda.

create the "*subject matter*" (Buchanan, 1992: 16) and thus cannot decompose it a priori. This process is context-specific and cannot follow a deductive scientific approach (Schön, 1983). In this view of design, agency is central and exerted through judgment (Huppatz, 2015; Rittel, 1984; 1992) that manifests by actors creating particular cause-effect relationships. This judgment is detached from a projection whether such outcomes will actually be achieved, but it refers to potential values that could be created (Grandori, 2010). Specifically, actors' consideration of which outcomes would be desirable (if true) with regard to the focal context. This view is distinct from judgment that relates to the probability of outcomes based on prior assumptions (Knight, 1921). Under uncertainty, probability assessments should be impossible (or based on luck). Also, feedback from any action may be simply ambiguous and thus prevent actors from assessing if their judgment was correct (Alvarez et al., 2017; Greve & Gaba, 2017; March & Olsen, 1976). When, however, treating judgment in terms of value potentials, I emphasize how it relates to something that actors can control: the abductive hypotheses they can produce and the comparisons among alternative ones as more or less desirable as well as plausible.

This view of search is far from mechanistic—a characteristic of current theories of search that has recently been recognized as a limitation, because it leaves out explanations for what actors *do* when searching (Greve & Gaba, 2017; Posen et al., 2018). Such models, so I argue, should be particularly relevant when thinking about explorative types of search. If not random (as in, e.g., Cohen et al., 1972; Puranam & Swamy, 2016; von Hippel & von Krogh, 2016), exploration should involve agency to explain how value is created (Arthur, 2007; Felin & Zenger, 2016; 2017). Related to March's (1988; 2006) writings on a technology of foolishness, we could hence also conceive of value creation as a process of linking problems and solutions in novel ways. I suggest that our thinking of search in terms of exploring value potentials through abductive search may be a promising avenue for future work studying novel, dynamic, and

hypercompetitive markets (D'Aveni, 1994; Eisenhardt, 1989a), the commercialization of innovative technologies (e.g., Majchrzak et al., 2018), or the resolution of grand challenges (Ferraro et al., 2015; George et al., 2016; Grodal & O'Mahony, 2017).

Limitations, Future Directions, and Conclusions

Of course, my theorizing is not without limitations. While I maintain that the search framework that I develop opens new avenues for research, in itself, it represents an abductive hypothesis: my best explanation for how to include the uncertainty construct into existing theories of organizational search in order to be able to reason how actors may search for true novelty. Thus, empirical effort is needed to better understand the conditions that enable abductive search; when this (likely) more resource-intensive search process is applied and by whom; as well as the actual activities through which actors create truly novel outcomes and ultimately value from a new knowledge structure. Doing so will allow us to establish boundary conditions for the applicability and effectiveness of abductive search under uncertainty. In this regard, I consider the following areas for future research as particularly relevant to further develop my framework.

First, in line with the BTOF, I conceive of abductive search as an organizational process, however, I am not specifying a form of organizing. It is important to investigate which organizational designs facilitate or inhibit such a process. Following my argument, I would expect that hierarchical structures obstruct abductive search, because they require pre-established goals based on which actors will search deductively (Puranam, 2018). I therefore point to fluid (Faraj, Jarvenpaa, & Majchrzak, 2011) or open-ended organizations (Tan, 2015), with low (to no) hierarchy (Foss, 2003)—such as virtual organizational forms (Boudreau & Lakhani, 2009) or meta-organizational designs (Gulati, Puranam, & Tushman, 2012)—as potentially suited to tackling abstract goals, as these organizational forms should be more tolerant of abstract goals

and the doubt it creates. Furthermore, important questions remain concerning the nature of abstract goals and how they will actually trigger search. Where do they come from? If, as we can imagine, they will be stated, it remains unclear if actors will start searching because of how they are presented, or whether it requires specific organizational design features to facilitate search for abstract goals. Likewise, an important question concerns how such features will influence the kind of knowledge structures that can be created as well as how they help to maintain the generative potential of doubt (Locke et al., 2008).

Second, while clear goals allow for an allocation of tasks and thus a distribution of power before search (March & Simon, 1958), dealing with abstract goals implies that power will be up for grabs and may be contested throughout the search process (Kaplan, 2008; Lukes, 2005). Consistent with the logic of abduction, actors will need to (constantly) act so that their power remains "something that may be" (Locke et al., 2008: 907, emphasis in original). We may conceive of abductive search as a political process where actors gain power from integrating plausible hypothesis into an emergent knowledge structure. It would be interesting to investigate empirically how they navigate such a process, to understand the role of strategy in shaping organizational search. How, when, and why do they introduce a particular hypothesis? When do actors compete or collaborate? For example, while competition can drive constant exploration, collaboration, negotiation, and coalition formation may be crucial for better understanding closure of abductive search. In sum, I see clear links to political dimensions of organizations (March, 1962; 1994; March & Olsen, 1976; Rittel & Webber, 1973) as well as recent calls for more research (Gaba & Joseph, 2017; 2018) on the central but neglected constructs of the BTOF, such as the dominant coalition (Cyert & March, 1963; Stevenson et al., 1985).

Potential shortcomings aside, I have presented a comprehensive framework that allows us to think of search more broadly as a deliberate behavior that is directed toward an outcome, even if

it is unclear and needs to be created. Like Simon (1996), I am concerned with design and its importance in a management context. In my view, however, actors who seek a truly novel product, strategy, or organization, will search abductively for previously unnoticed or even unknown causal links between problems-solutions. Thus, the search for true novelty is first of all a cognitive process (Arthur, 2009; Rittel, 1971; Visser, 2006). Or, as Yoo, Boland, and Lytinnen (2006: 228) argued: "*The future of our economy is dependent on creating products and services that never existed before. It requires imagining a new world, designing artifacts to put into it, and inspiring others to follow."*

3 Thinking, doing, and the emergence of organizational structure

"I ride in a city—the rest can be found."
(Clint Eastwood)

Organizational search is central to behavioral and evolutionary approaches to the firm (Cyert & March, 1963; March & Simon, 1958). Existing theory describes search as a mechanistic process in which organizational actors explore their environment for new ways of operating (e.g., strategies, policies, governance structures) to maintain or enhance organizational performance relative to an organizational goal (or aspiration level, used synonymously) (Cyert & March, 1963; Greve, 2003; March & Simon, 1958). Accordingly, this goal provides direction of where to search and guidance for selecting among alternatives (Knudsen & Levinthal, 2007). Goals further enable actors to infer appropriate organizational design choices to govern search activities (e.g., He & Wong, 2004; Lavie & Rosenkopf, 2006; Lavie et al., 2011).

It is a central premise of this theory that actors hold reliable information about their goals, which allow them to search for alternative solutions. Cognitively bounded actors search locally until they achieve their goals or by adjusting them to performance feedback (Greve, 2003). In this view of search, organizational structure—a clear goal and organizational design—is of main interest. They explain how actors identify solutions to restore or improve organizational performance. With this focus on outcomes, insights into how organizational search processes actually unfold are of little importance and, hence, have been largely neglected. Research in this tradition focuses on the structures through which actors can achieve their goals, but it is silent about how these structures emerge in the first place.

My aim is to study this process. Existing search theory originates in the idea that actors hold the knowledge to establish structure prior to search (i.e., define a goal and organizational design).

I maintain that when organizations encounter highly uncertain environments, understanding the search process becomes important. Prior research shows that competing in nascent markets (Ozcan & Santos, 2015; Rindova & Kotha, 2001; Santos & Eisenhardt, 2009), creating alliances (Ozcan & Eisenhardt, 2009), initiating innovation ecosystems (Dattée et al., 2018) or starting new ventures to commercialize novel technologies (Andries et al., 2013; Majchrzak et al., 2018) constitute organizational settings of high environmental uncertainty where organizational structure is emerging as the knowledge to reliably define goals and effective organizational design grows over time.

Specifically, environments of high uncertainty possess two main characteristics. First, actors lack the information to infer cause-effect relationships (Duncan, 1972) and thus the ability to predict the results of their actions. When environmental uncertainty is high, multiple, equally probable sub-goals without clear preference order and unknown interdependencies can exist (Gifford, Bobbitt, & Slocum, 1979; Grandori, 2010). Thus, actors are often simply unaware of their lack of important knowledge and cannot possibly search for it (Knight, 1921). Then, conclusions that actors can draw from their existing knowledge become ambiguous and discriminating relevant from irrelevant alternatives will, at the extreme, be impossible (Reetz & MacAulay, 2017). As a result, defining the knowledge to specify goals and assess alternatives (i.e., what to search for) becomes increasingly difficult (Dunne & Dougherty, 2016). Second, without a specific goal and information about what to search for, actors cannot make appropriate organizational design choices for how to search (i.e., division of labor: Puranam et al., 2014). Interestingly, prior research shows how these two characteristics of uncertain environments are independent from the agency of search. For example, Huang and Pearce (2015) demonstrate through field studies and experiments, that—beyond founders—also business angels who could select to invest across multiple early stage ventures could not pre-define appropriate structures to

guide their evaluation process. Even in established settings (e.g., mature markets), we may conceive of actors as experiencing uncertainty similarly, if they lack vital structural knowledge of the environment to clearly define goals (Henderson & Clark, 1990).

In environments of high uncertainty, I suggest to treat organizational goals as emergent instead of pre-defined. This acknowledges that multiple, equally promising goal definitions can exist—which may even contradict. Knowledge to specify emergent goals, largely lies in the future, hence only reveals when time unfolds. The inability to establish structure ex ante therefore results from the unavailability of relevant knowledge, instead of actors' cognitive limitations to acquiring it (bounded rationality assumption; Simon, 1955). This distinction does not affect the general assumption of bounded rational actors and search as a means to find appropriate solutions, but it should affect *how* they search. Actors may discover relevant knowledge over time. Then, organizational structure—goal definition and organizational design—becomes the joint outcome of the search process. Yet, it remains unclear how.

This notion leads to the broad and largely open question that frames this inductive study: how do organizational actors search in uncertain settings and through this process influence the emergence of new organizational structure? I closely examine organizational search processes in uncertain settings, by following entrepreneurs in their pursuit of implementing business ideas through building new ventures. For these founders, knowledge is ambiguous, organizational structure absent, and search the dominant activity. I find two contrasting modes—*integrating* and *leaping*, of how these founders search that originate from their cognitive biases, either toward the future or toward the past. I start with drawing on the literatures that informed my inductive inquiry to then explain how founders create organizational structures through search, contrasting three search processes for each of the two modes that I find.

Creating Organizational Structure Through Search

Bounded rational actors search for satisfactory solutions to reach an organizational goal (Simon, 1956). When directed to a goal and triggered by decreasing organizational performance, search is considered problemistic (Cyert & March, 1963). This describes the mechanism of how organizational actors explore their environment for distributed new knowledge (e.g., Afuah & Tucci, 2012; Winter et al., 2007), strategies (e.g., Siggelkow & Levinthal, 2003), or organizational forms (Levinthal, 1997; Rivkin & Siggelkow, 2003) to sustain or enhance organizational performance. Actors start searching locally to their current knowledge base and gradually increase this distance until they achieve their goal (Greve, 2003).

Much of what we know about search, is measuring outcomes of this process (e.g., Katila & Ahuja, 2002; Rosenkopf & Nerkar, 2001; Salter, Ter Wal, Criscuolo & Alexy, 2015), what neglects that essentially human actors engage in this process (Dahlander et al., 2016; Li et al., 2013). Paucity of work investigates the process of how actors truly search in organizational settings (Posen et al., 2018). For example, MacAulay, Steen, & Kastelle (2017) focus on how actors search to compete in their intraorganizational context, while Nigham, Huising, & Golden (2016) look at how they search to select particular organizational routines for change. The literature that focuses on the search process more closely, looks at established organizations, and hence it is concerned with the improvement of pre-existing structures (e.g., Levinthal, 1997; Siggelkow & Levinthal, 2003; Rivkin & Siggelkow, 2003). Yet, we lack insights into their emergence. In fact, our limited knowledge about the origins of organizational structure may coincide with the sparse understanding of actual search processes—thus looking at both could be relevant.

Existing theory depicts the knowledge actors hold as allowing them to decompose and structure goals (Simon, 1973). Based on these organizational goals, actors make organizational design choices to execute search processes (March & Simon, 1958; Puranam et al., 2014). Drawing on these goals further directs them to promising search spaces (Newell & Simon, 1972). In this view, search is a mechanistic process, with the focus on outcomes and how they enable actors to improve existing organization designs, refine goals, and ultimately enhance organizational performance (Cyert & March, 1963). But when actors set out to create new organizations, uncertainty can be high, and knowledge on which to reliable structure goals emergent. Without such reliable upfront structure, the search process itself and how it unfolds can provide insights into the emergence of new organizational structure. So far, how to search when goals are emergent remains a largely open question. [26]

Searching for Emergent Goals

If structure is impossible to define ex ante, prior literature suggests two ways to think about search. One literature rests on the view, that actors may operate with almost no structure and merely generic goals (i.e., creating new ventures) (Sarasvathy, 2001; Sarasvathy & Dew, 2005).

[26] The search for emergent goals can be viewed as problemistic. That is, the idea of building a new organization based on a business idea clearly represents a goal and because building new organizations means that performance is absent, increasing it is vital and constitutes a stark trigger for search. When uncertainty is high, these goals can become increasingly ambiguous and actors' assessment of potential solutions for reaching these goals ever more difficult. In that sense, founders may perceive even their local search as distant, i.e., the knowledge they gain as new instead of familiar (Adner & Levinthal, 2008). This creates a problem, because initially, actors main concern should be their short-term survival, which is commonly associated with searching locally to exploit familiar knowledge. From existing theory, it is unclear how founders may resolve this issue. Distinguishing search in new organizations in terms of distance to existing knowledge may thus constitute an inappropriate choice. Alternatively, we may also conceive of emergent goals as relating to slack search, because they allow actors to explore relevant knowledge without deliberately pursuing specific outcomes. But slack search rests on the assumption that actors can spend excess time to explore ways of enhancing established firm practices. New organizations, however, are notoriously resource constraint and actors seek a viable form of organizing fast (Penrose, 1959).

Here, actors focus on making sense of available resources (Baker & Nelson, 2005) or instantly reacting to arising opportunities (Miner et al., 2001) to build organizational structure. While these are useful approaches in uncertain environments, they result in stark reliance on environmental contingencies. By focusing on the exploitation of serendipities, actors relinquish potential control over how their organizational structure emerges. This view focuses on search as an endless process but excludes the intention to find a particular organizational structure.

Contrary, other literature suggests that it can be preferable to establish at least some structure upfront, based on which to search for improvements (Clement & Puranam, 2017; Sine, Mitsuhashi, & Kirsch, 2006), and rather err in terms of too much structure (Davis et al., 2009). That is, any structure may provide a common reference point for actors to relate new knowledge to, hence creating some internal focus and control. Generally, organization design theory suggests that balancing the degree of structure is vital in uncertain or fast changing settings. Actors can adapt to altering environmental contingencies, to maintain performance or ensure survival (Burns & Stalker, 1961; Galbraith, 1973; Lawrence & Lorsch, 1967; Thompson, 1967). How to search when goals are emergent may hence benefit from some structure. When ambiguity about present knowledge is high, prior research suggests that actors may generate such structure (1) by drawing on what they learned in the past or (2) by conducting thought experiments of how the future will be (Gavetti & Levinthal, 2000).

Possible Origins of Organizational Structure in Uncertain Environments

First, theories of search—and problemistic search in particular—rest on the assumption that actors access knowledge generated through learning. This experience is stored in standard operating procedures or routines and allows for specific responses to changing contexts (Levitt & March, 1988; March & Simon, 1958; Nelson & Winter, 1982). Recent literature reemphasizes

that actors may benefit from applying heuristics (Bingham & Eisenhardt, 2011; Eisenhardt & Sull, 2012)—holistic mental maps that provide crude cognitive short-cuts (Newell & Simon, 1972) and promise better starting points for search (Gavetti et al., 2005). Actors may draw on these past reference points to initiate local search (e.g., trail-and-error).

However, in initial phases of organizational development, they have little past to refer to (March, Sproull, & Tamuz, 1991), and even if existent, knowledge from prior action may provide ineffective guidance in uncertain environments (Greve, 2003). The value of any past reference point—routine or heuristic alike—depends on how well it fits the context it is applied in (Holyoak & Thagart, 1996). In uncertain contexts, the advantage of past reference points to achieve this fit remains ambiguous. Local search based on experience is only effective, if actors can select promising search spaces—in uncertain settings, they lack exactly this knowledge.

Second, while theories of organizational search build on cognition, they generally exclude foresight. But recent advances in this literature suggest that bounded rational actors may generate cognitive representations of the future to identify better strategies (Gavetti, 2012; Gavetti & Menon, 2016). For example, these may be contained in visions (Dattée et al., 2018), blueprints (Ozcan & Eisenhardt, 2009), or desired futures (Pitsis, Clegg, Marosszeky, & Runa-Polley, 2003), all of which enable actors to share their ideas (Felin & Zenger, 2009). Emphasizing this cognitive dimension of search advances the overly mechanistic picture of experience-based search (Posen et al., 2018). This is interesting, because when drawing on future reference points, actors inevitably make assumptions and engage in abductive reasoning (Dougherty, 2016; Peirce, 1878)—as opposed to inductive or deductive reasoning when leveraging past experience. They may thus reach beyond what they have learned and create novel outcomes, despite their limited cognitive capacity. Actors may draw on future reference points to test even crude assumptions or wild guesses, and initiate distant search through experimentation (e.g., Brown & Eisenhardt,

1997; Thomke, 2003). For example, running several experiments in parallel, may allow them to find superior business models, opportunities, or technologies (Andries et al., 2013; Gruber et al., 2013; Nelson, 1961).

Summarizing, these two approaches suggests that actors may navigate their search to resolve emergent goals by drawing on either past and future reference points. With our limited knowledge of search in uncertain settings (Greve, 2003), there are still basic questions related to both approaches. With regard to the past reference points that means, understanding when and how actors may effectively apply their idiosyncratic knowledge. For future reference points, it is important to investigate, why actors may draw on some ideas to enforce certain probability states in the present, while omitting others. That is, initially and under uncertainty, multiple potential alternative futures constantly exist, all of which are largely subjective and mendable (Lord, Dinh, & Hoffman, 2015). Thus, mental representations of the future can only provide ambiguous recommendations for the present. Only a few studies address search in terms of learning and foresight simultaneously (Gavetti & Levinthal, 2000; Gavetti & Rivkin, 2007; Gavetti & Menon, 2016). While, this dual nature of search seems important for strategy formation in new organizational settings, we still lack a detailed understanding of why and how actors actually apply both approaches (Ott et al., 2017).

One way of empirically studying how actors search for emergent goals may be through focusing on their limited cognitive capacity. This remains central to any search process and becomes visible in what actors pay attention to (March, 1994; March & Simon, 1958; Simon, 1947). Attention can vary in terms of target and prevalence in actors' minds indicating where they search (Li et al., 2013; Ocasio, 2011). From existing literature we would expect that, in more certain settings, actors will direct their attention to prioritized sub-goals, which they obtained via decomposing a general goal (Cyert & March, 1963). When uncertainty increases, they may focus

on balancing attention between past and future reference points to find reliable structure for search. How actors search may thus shift from sequential attention, to simultaneously considering multiple potentially important interdependencies of an emergent goal (Baumann & Siggelkow, 2012).

While it remains unclear how actors may actually search this way, it can explain why they commit resources to some fix activities—incrementally define tasks and assign responsibilities. This structure is an outcome of search rather than an ex ante goal. Organizational structure—the determination of a goal and a related organization design—may thus initially emerge together. It is important to understand how organizational actors search when uncertainty is high and how initial organizational structures may enable or constrain future action (Leonard-Barton, 1992; Sydow et al., 2009). Although prior studies acknowledge the link between search and organizational structure (e.g., Gavetti & Rivkin, 2007) they were not designed to investigate actual search processes and how they affect the grow of new organizational structures. To provide these insights, inductive theory-building is appropriate (Denzin & Lincoln, 1998; Edmondson & McManus, 2007).

Methods

In my exploratory inductive study, I closely followed the founders of 35 new ventures[27] in German and British start-up hubs over a core period of 2.5 years. This longitudinal design was appropriate to capture how founders search and its effect on organizational emergence (Langley, 1999).

[27] I excluded one additional venture after the second interview due to concerns about the founders' commitment.

Empirical Setting

Early stage entrepreneurial ventures constitute notoriously uncertain endeavors (e.g., Alvarez & Barney, 2005). Founders can be expected to search and explore opportunities that relate to their business ideas to reduce this uncertainty. It is through this agency that organizational structures may be created. New ventures also develop at high speed (e.g., Gersick, 1994), which allows to observe the emergence of organizational structure (almost) in real time. The initially low complexity further means that it is likely to capture much of this development. Also, who is searching and how this may influence organizational emergence should be largely transparent.

Following recommendations for purposeful sampling (Lincoln & Guba, 1985), my selection of early stage entrepreneurial ventures aimed at meaningful comparisons to ensure better theory development (Glaser & Strauss, 1967). I sampled cases from a multi-industry setting to account for potential differences in how founders may search as well as varying uncertainty (see Table 1). With regard to flexibility and speed of search, I considered whether firms were producing hardware (artifacts) or software products, and for each the technological complexity. I included ventures in two-sided markets to account for potential interdependencies of search. Further, cases varied in the maturity of their industry to reflect the potential existence of dominant strategies. Finally, I distinguished between different sources of funding and if founders had prior start-up experience. Selecting ventures across these categories allowed me to firmer ground my theory and enhance its generalizability (Yin, 2009).

Table 1. Firm Characteristics and Data Sources (at the end of the 2.5 year core period)

Firm Characteristics and Data Sources

Case	Industry sector	Business focus	Founder	Firm Size[1]	Founding Experience	Acquired Funding	Interview rounds	Internal documents[2]	External documents[3]	Additional accounts
1	Online marketplace	Automotive	2	12	Yes	Business Angel	6	P	B / S / PR	Chats / Email
2	High-tech	Machine learning	1	4	Yes	Self funded	5	n/a	B / S / PR	Email
3	High-tech	Computer accessories	2	5	No	Crowd Funding	5	P	B / S / PR	Chats / Diary
4	Low-tech	Beverages	2	7	No	Business Angel	6	B / P	B / S / PR	Chats / Email
5	Service	Consulting	1	1	No	Self funded	2 (failed)	B / P	n/a	n/a
6	Online marketplace	Dating	2	5	No	Self funded	5	B / P	B / S / PR	Chats / Diary
7	Software	Advertising	4	11	Yes	Bus. Angel / V. Capital	5	P	B / S	Email / Diary
8	Online marketplace	Bespoke jewellery	2	13	Yes	Bus. Angel / C. Funding	5	B / P	B / S / PR	Email
9	Software	Data management	2	5	No	Self funded	5	P	B / S	n/a
10	Online marketplace	Product testing	2	15	Yes	Business Angel	5	B / P	B / S / PR	n/a
11	Online marketplace	Social media app	4	7	No	Business Angel	6	B / P	BP	Chats / Diary
12	High-tech	Smart lock technology	2	8	No	Business Angel	5	P	B / S / PR	Email
13	High-tech	Medical products	4	5	No	Self funded	4	No access	PR	Email
14	Software	Online security	2	75	No	Bus. Angel / V. Capital	5	P	B/ S / PR	Email
15	Online marketplace	Education	1	8	No	Business Angel	1 (failed)	n/a	B / S / PR	n/a
16	High-tech	Sensor systems	3	31	No	Bus. Angel / V. Capital	6	B / P	B / S / PR	All
17	High-tech	Robotic toys	3	11	No	Bus. Angel / V. Capital	5	B / P	B / S / PR	Observation
18	High-tech	Video technology	3	8	Yes	Business Angel	5	B / P	B / S / PR	Chats / Email
19	Online marketplace	Social media app	3	12	Yes	Venture Capital	4 (failed)	n/a	B / S / PR	Email / Chats
20	Online marketplace	Music	2	2	Yes	Business Angel	5	P	B / S / PR	n/a
21	Online marketplace	Legal	3	6	Yes	Business Angel	5	P	B / S / PR	Chats / Email
22	Online marketplace	Fashion	2	3	No	Governmental Grant	5	P	n/a	Email
23	Online marketplace	Jobs	4	12	Yes	Bus. Angel / V. Capital	5	P	B / S / PR	Observation
24	Service	Traveling	2	3	No	Self funded	4 (failed)	B / P	B / S	n/a
25	Low-tech	Gastronomy equipment	4	3	No	Self funded	4 (failed)	B / P	n/a	Observation
26	Low-tech	Food	2	15	No	Crowd Funding	5	B / P	B / S / PR	Email / Chats
27	High-tech	Big data	4	4	No	Governmental Grant	5	No access	PR	Email
28	Low-tech	Education	2	15	Yes	Venture Capital	5	No access	B / S / PR	n/a
29	High-tech	Carbon composites	3	5	No	Governmental Grant	5	n/a	B / S / PR	Chats
30	Low-tech	Food	3	3	No	Governmental Grant	3 (failed)	B /P	PR	Email
31	Service	Pharma	1	2	No	Self funded	5	B / P	PR	Email
32	High-tech	Aerodynamics	3	6	No	Governmental Grant	5	P	PR	Observation
33	Low-tech	Food	2	4	No	Self funded	5	B / P	B / S / PR	Email
34	High-tech	Medical products	2	4	No	Governmental Grant	5	P	B / S / PR	Observation
35	Low-tech	Fashion	2	2	No	Business Angel	5	B / P	B / S / PR	Chats

[1] full time team members [2] BP: business plan; P: presentation [3] B: blog; S: social media; PR: press

Initially, I asked founders I knew and who fit these criteria. In a snowballing process (Biernacki & Waldorf, 1981), these founders then introduced me to further suitable individuals. I excluded ventures that would likely follow predefined procedures (e.g., those affiliated to venture builders). Because I could not predict a priori which theoretically interesting patterns I would find, where they would emerge, or, how long start-ups would survive, I collected evidence from a larger set of cases (e.g., Baker & Nelson, 2005; Nigam, et al., 2016). This also allowed me to corroborate emerging theory and to test its boundaries (Campbell, 1975).

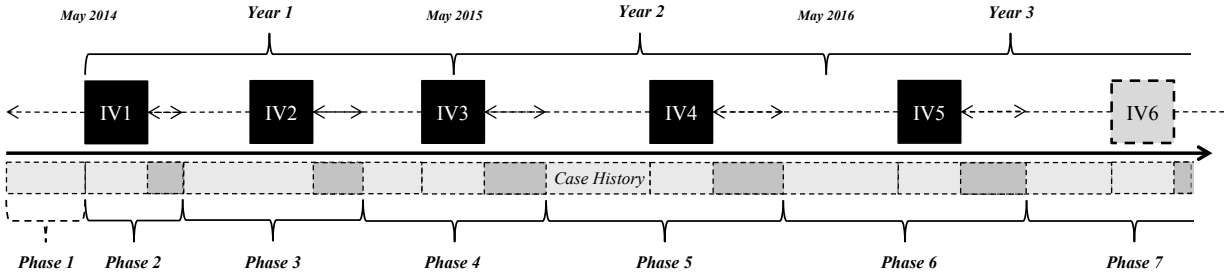

Figure 4. Data Collection Procedure

Much of what I learned came from my direct interactions with founders, from reflecting right after meetings, or when preparing for them. In my full-time commitment between spring 2014 and the end of 2016, I conducted five waves of on-site interviews with founders[28] (see Figure 4). The interviews lasted 90 minutes on average but ranged between 45 minutes and three hours. I taped and transcribed all 231 interviews, which lead to approximately 6,000 pages of verbatim transcript corrected for grammar and spelling. Face-to-face interviews allowed me to establish personal rapport with the founders. Running them at the start-ups' sites facilitated informal chats to other team members and provided an understanding for the actual

[28] I followed any venture until it was either sold or the founders declared that it failed. After failing, founders of all but two firms agreed on a final meeting. I still interview founders of more than ten existing ventures in larger intervals.

organizational setting.[29] These contextual insights were invaluable when analyzing interview data.

Interviews. My aim of the data collection was to understand how founders search. Therefore, interviews were open conversations, allowing founders to reflect on developments that were critical to them and thus relevant to understand this process (e.g., Isabella, 1990; Tulving, 2002). Some founders referred to this setting as "counselling session," because I only provided a clue of our last meeting, asking them to elaborate on how events unfolded,[30] saying *"It's August now, tell me what happened since we last met in early May when you started to negotiate funding."* When describing events, I prompted founders to add illustrative details and specific descriptions, to learn why they mattered to them and to create more accurate accounts. With this procedure, open-ended questioning can enhance the reliability of retrospective data (Miller, Cardinal, & Glick, 1997). Normally, informants spent most time elaborating and evaluating current activities or pondering future ideas and anticipated challenges. Combining retrospective and real-time data like this, generates comprehensive longitudinal accounts (Leonard-Barton, 1990). While founders determined the actual content, my role was to ask for clarification, probe statements, and ensure general focus. I relied on individual case histories and some common questions for guidance. As typical in inductive research, both accounts evolved with my growing insights (e.g., Pratt, 2009).

My main reference were individual case histories (e.g., Gersick, 1994) based on organizational topics raised by the founders (e.g., relating to the business model, product

[29] I only used *Skype* or *FaceTime* to conduct the interview, if a meeting in person was impossible and further postponing would have meant to miss interesting developments. I only decided for this option after meeting the founder before and when I felt confident that this would not negatively affect the conversation.

[30] In the first interview, I asked for a comprehensive account of events and actions from the moment they had the business idea to the point in time of the interview. I also granted anonymity, confidentiality, and emphasized that there were no right or wrong answers but only the informants' opinion.

development, or funding). I treated all topics as equally important and only paid closer attention when founders repeated themes. From these accounts, I created mind-maps for each case, which I memorized when preparing for interviews. This allowed me to track how existing organizational themes evolved, if new ones emerged, and to prevent loose ends (e.g., *"What happened to [the thing] you were telling me about last time?"*). I constantly probed how reliable I could predict founders' responses and thus how valid my assumptions about their behavior were. If flawed, I might say *"This is surprising to me. From what you said so far, I wouldn't have expected [this]."* My second reference were common questions (e.g., recent priorities, pending decisions, and team structure) that I asked any founder and which were most relevant in the first conversations. These questions were broad to ensure that respondents would talk about topics significant to them (e.g., Isabella, 1990). At the end of interviews, I always captured organizational activities through a standardized tool (i.e., the Business Model Canvas: Osterwalder & Pigneur, 2011), encouraged founders to assess their ventures' performance[31], and asked for an exact count of employees, (paying) customers, market entries, and acquired funding.

I used additional sources to enhance the accuracy of my interview data (Jick, 1979). I relied on firm documents (i.e., business plans and presentations) and the firms' digital presence (i.e., log of: firm blogs, social media profiles, company websites). For some cases, I obtained unique accounts in form of founder diaries and observatory evidence. When I noticed potential changes in strategy, informal chats with founders provided clarification between interviews. To gain information about firm achievements (e.g., prize, funding, product launch), external data like press articles and videos provided valuable sources (see Table 1).

[31] I used a 5 point Likert scale (1 = low; 5 = high). I also asked founders to evaluate their personal motivation on this scale, because I noticed that this often triggered particularly secretive interviewees to talk extensively about their current situation.

Data Analysis

I analyzed my data according to recommendations for inductive theory-building research (Denzin & Lincoln, 1998) and constant comparison techniques (Glaser & Strauss, 1967) in two main phases. The first occurred naturally during data collection, when I leveraged the richness of my contextual understanding (Lincoln & Guba, 1985). I reflected after interviews when ideas where vividly present, when transcribing them, or when preparing for a new one. For each case, I captured salient patterns through illustrative sketches and hand-written memos (Hesse-Biber & Leavy, 2010), and elaborated recurring themes (Denzin & Lincoln, 1998). It was through these simple descriptions that I first noticed how founders broadly differed in their approach to venture development. That is, some founders seemed to act, based on a variable, yet ultimately clear idea of what their organization should become—like meticulously carving a sculpture. Conversely, other founders' actions appeared computational—like programming an algorithm—accepting any input in order to generate pre-defined outputs. In my continued data collection, I paid particular attention to aspects that might relate to this notion.

The second phase of analysis started after the fifth interview wave, when my accounts of founder behavior stabilized. To capture the phenomenon of interest, I holistically assessed my data, openly coding search cognition (thinking) as well as search action (doing) (Gavetti & Levinthal, 2000; Gavetti & Rivkin, 2007; Ott et al., 2017). I aggregated this evidence in vignettes describing salient patterns, strongly relying on in vivo codes and verbatim citations. I then analyzed the individual case histories to identify salient patterns in organizational development (i.e., organizational goals and division of labor). Finally, I investigated the link between how actors search and the emergence of their organizational structure over time (Langley, 1999), ensuring that my findings were grounded in the case evidence.

I then examined cases comparatively, focusing on how founders searched and how their ventures emerged (Eisenhardt, 1989b; Miles & Huberman, 1994). This analysis allowed me to make a revelatory discovery. I realized that the temporal reference points founders directed their attention to were central to the differences I observed in how they searched. This reinforced my notion of two search modes, each of which seemed to impact a more or less stable development of the venture. In the first mode, search was mainly directed by flexible long-term concepts of the future (e.g., vision, idealized future). Past reference points, such as performance feedback, only seemed to provide input to refine the ventures' future concepts. Conversely, in the second mode, past reference points were central to define fix short-term goals. In both modes, the ultimate future reference point was exiting the business. To explain these regularities and provide tentative theoretical explanations I wrote short working papers (Denzin & Lincoln, 1998).

With these insights, I thoroughly consulted the literature. This process made me realize that (1) how founders searched, (2) where they searched, and (3) how they updated their search were broad themes that could help to structure the observed regularities. Together with a second coder who was new to the project, I used these themes as "sensitizing concepts" for further analysis (Reinecke & Ansari, 2015: 624). Building on the initial vignettes of search cognition and action (i.e., first order concepts), we identified distinct *search activities* for each theme (i.e., second order themes), which we label: (1) *puzzling and hustling,* (2) *upgrading and adapting*, and (3) *controlling and reacting*. We then linked each search activity to salient patterns of organizational development to connected *search processes* (i.e., aggregate dimensions). These explain (1) how different mental representations guide search and inform resource allocation decisions, (2) how these mental representations affect the proximity of actors' search to build organizational structure, and, (3) how different mental representations influence search directions and impact

the trajectories of organizational development. Finally, we aggregated related search processes across themes to coherent *search modes*: cumulative patterns of search and organizational emergence. We find two modes: *integrating* and *leaping*.

We constantly challenged conclusions through thought experiments (Miles & Huberman, 1994). By cycling between data, findings, and existing theory (Mantere & Ketokivi, 2013), our understanding of two search modes and their influence on organizational emergence stabilized.

Two Modes of Search and New Venture Development

The two search modes *integrating* and *leaping* that we find, result from how founders balance their attention (Ocasio, 1997; 2011) between past and future reference points. *Integrating* means translating a desired, relative future (e.g., vision) by seeking representations of it in the present, thus searching backward. By gaining understanding of potential representations of the future, founders pursue informed decisions that fit their desired and evolving future picture of the organization. The present organizational configuration is hence dragged in one consistent direction and develops on a linear trajectory. Contrary, *leaping,* means transforming a present state to match an absolute future (i.e., performance goals), thus focusing search forward. By seeking results of a fixed and clearly articulated near future, founders pursue opportunistic decisions that allow them to reach these aspired outcomes as quickly as possible. The present organizational configuration is hence pushed in multiple altering directions (Figure 5a and 5b; see also Appendix A).

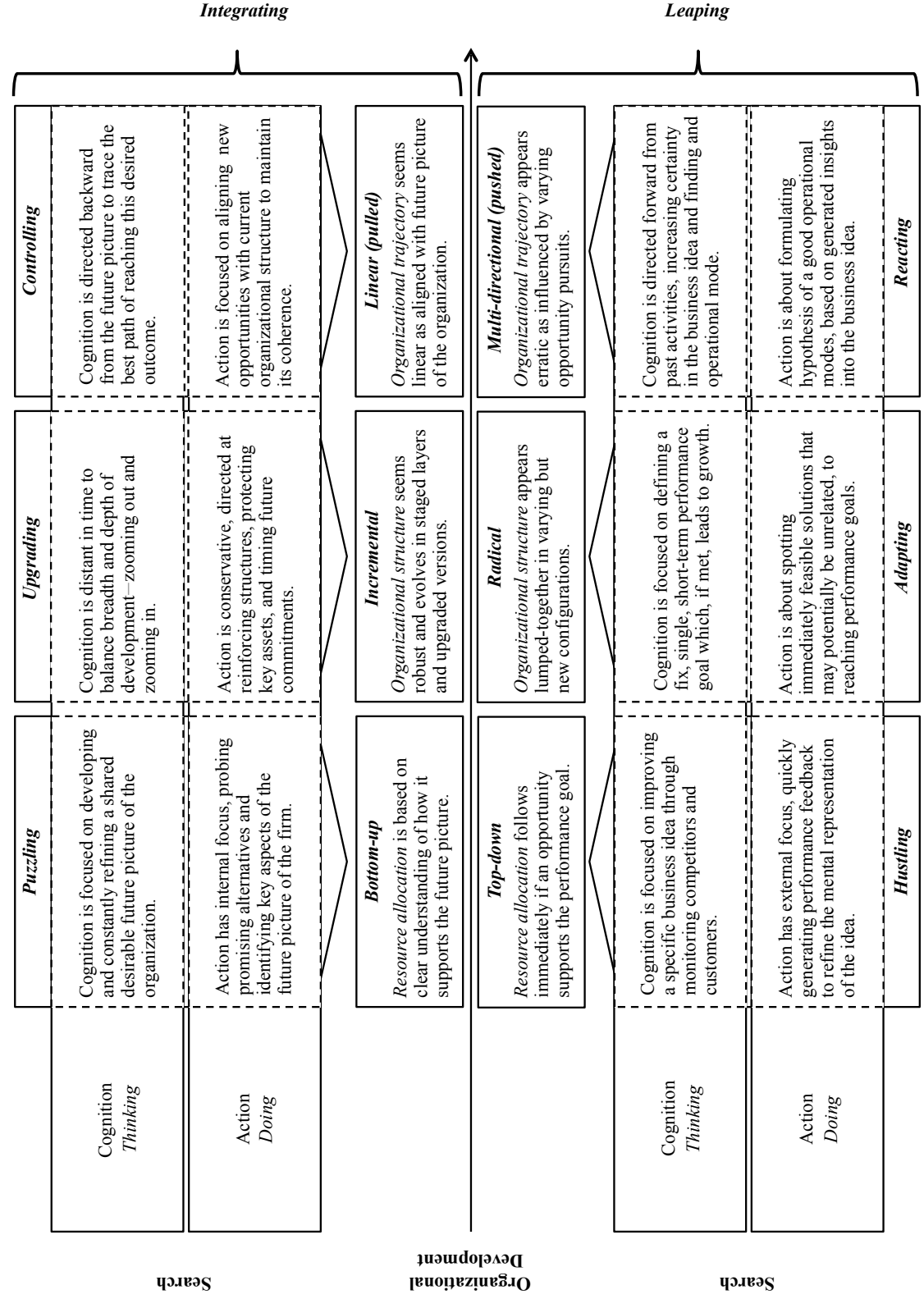

Table 2. Data Structure

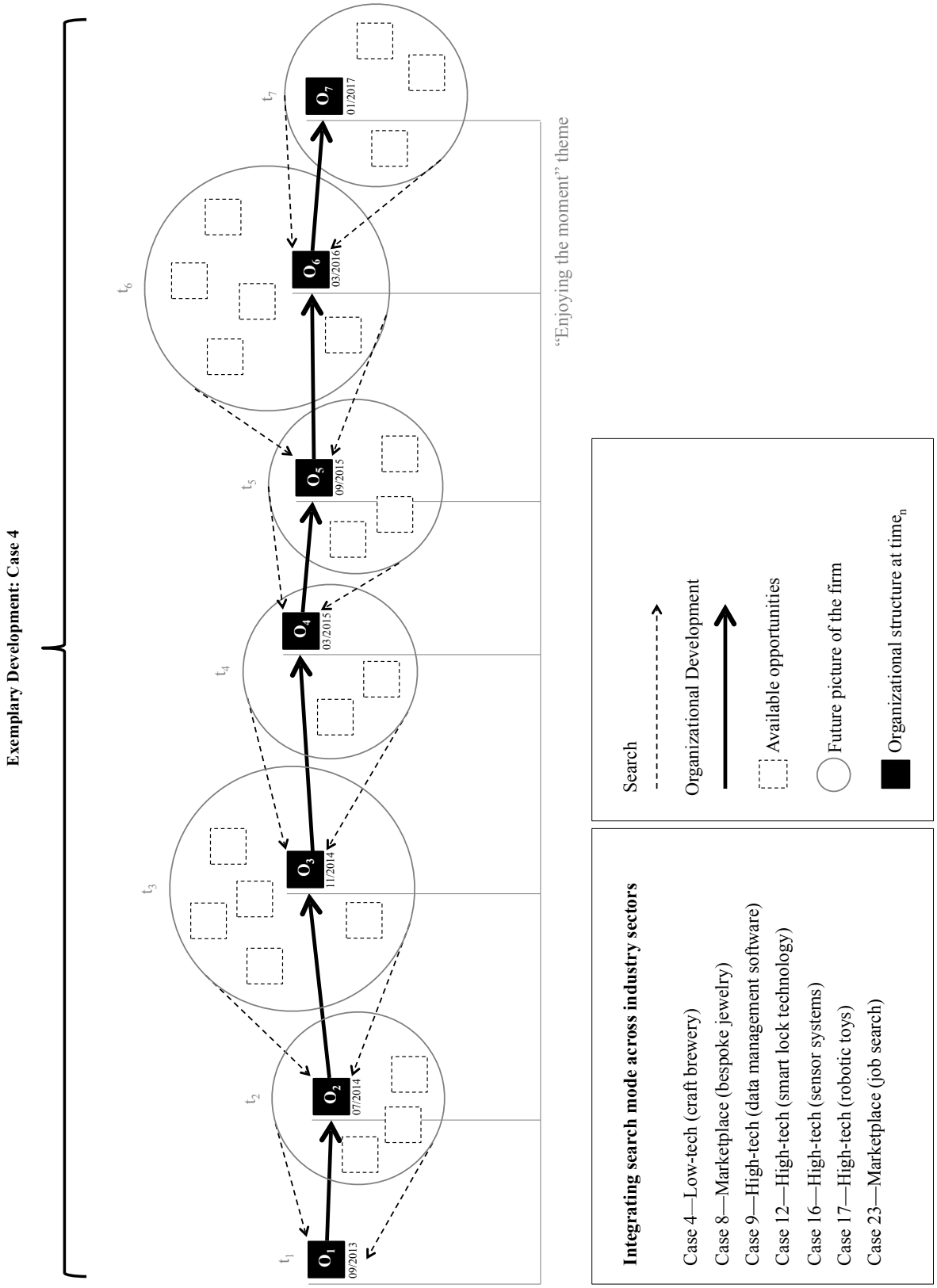

Figure 5a: Integrating Mode and Organizational Development

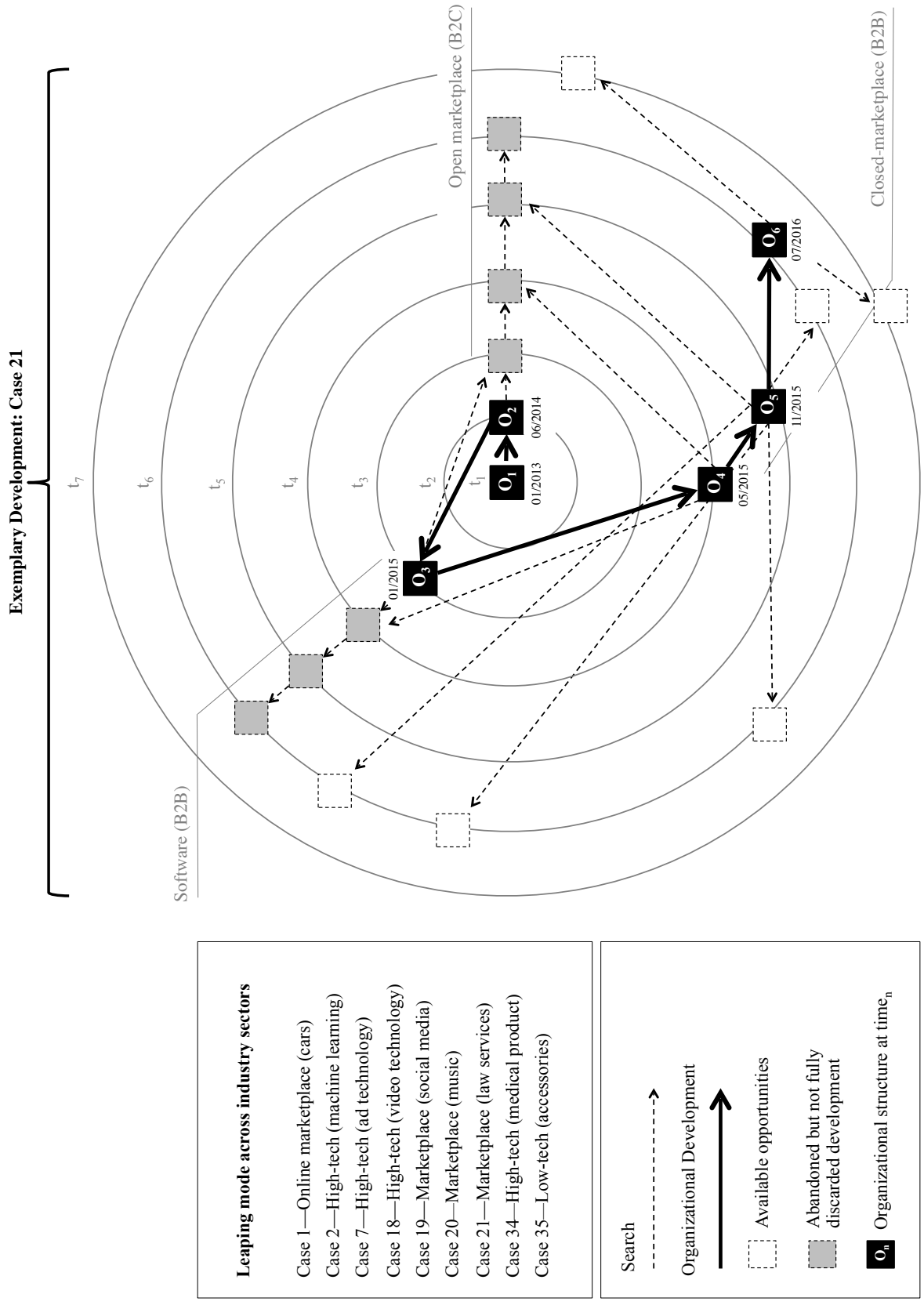

Figure 5b: Leaping Mode and Organizational Development

I will present my findings by comparing founders in both search modes, drawing primarily on one case each. For conceptual clarity, I will present theoretical dimensions and contributions upfront, although they emerged from my data (Suddaby, 2006).

Mental Representations and Resource Allocation

How do actors navigate their search? Prior research suggests they will draw on mental representations that will lie in the past, when resulting from a learning process, as opposed to the future, when based on cognition and foresight (Gavetti & Levinthal, 2000). Founders in all cases embarked on a learning process of developing their venture. Some of them mainly relied on the past mental representations this process produced, while others strongly focused on the future. While the distinction of past and future reference points for search is not new, I show how a bias for either of them triggers two distinct search processes and resource allocation patterns.

Puzzling–cognition. When *integrating,* I observe that founders' main attention is on a broad, vague, and relative picture of the future, which they hold about their idea. Will and Harry (case 4) are good example of this. They started to sell home brewed beer at student house parties and set out to create a craft brewery after graduating. Despite the current trend, this is still an old industry with limited potential for innovation. However, their idea was to *"creating a company that is 99% different to anything that's out there […] take [this] idea in our head and build it in the real world."* As Will describes it.

> *"We think there is room for innovation, there is room for change, there is room to really push for what we want to do. And that's the philosophy of us doing our business, really. We want to push it and take risk and if it does not work out we have taken the risk and that is it. But we want to take the risk and go for it to see how far we can push it."* (case 4)

Their product is a young person beer that combines the fizziness lager and the taste of ale, communicates the purpose and motivation of their business.

> *"We believe that beer is all about sitting around with friends and having a good time and enjoying the moment […] That sort of vibe where it's like you want to have a cool easy drink, you enjoy it, it's refreshing and it sort of goes with the vibe of what you like and it sort of basically makes itself cool. And that leads all the things we do as a company."* (case 4)

They set out to start a firm that could translate this perception of enjoying time with friends into an offer for customers. Because this idea rests on individual perception, rather than objective description based on market research, it is largely abstract. Will and Harry also do not compare it to existing solutions (e.g., competitors), on which they could improve. Their idea is original and the way they capture it, is in a vague future picture. This applies to other ventures too. Tim, Tom, and Terry (case 17) started their firm based on realizing a fantasy they had as kids: building their own robot or *"dream machine."* Their venture for seamless, modular robotic toys rests on a future picture of capturing this idea. Or Nik and Dave (case 8). They run a diamond trading business when they helped a friend to realize a bespoke engagement ring. The emotional story of his overwhelmed fiancée created a great demand. Their new venture for bespoke jewelry is based on the future picture that captures the essence of this story.

All founders constantly advance their future picture. Will and Harry refer to this as a process of *"creating and continuously refining maps"* of what this desirable future could be. For example, they question if their future picture of enabling people to have a great time with friends would be represented by just producing and selling beer or if it would mean to create the experience of drinking beer too. Will describes this. *"[Should we be] moving more outside of the beer and becoming more of an experience rather than just a beer. So not just focusing on the product—we create a great product—but making it more valuable by creating a great experience around it."* Building their own chain of bars would be one option to control this experience.

> *"Our tagline is: 'Enjoy the moment.' So we can be the bottle in someone's hand, then we can be that thing in a bar, that's all very well, and people can drink beer and enjoy the moment that way. […] Our thing is about being this young person's ale, that has to be lived out […] take this sort of brand and make it more than just a bottle or more than just a badge on a beer tap and more than just a beer, but an experience […] really live it out, live out the brand message live*

> *out the ethos and make it a tangible reality? And that would be done through creating a space."* (case 4)

Although this future picture is constantly evolving and added to, its core is fix. For Will and Harry, *"[…] it's still staying the same. I think that we want to be a company that's producing the go-to beer for people like ourselves. We want people to sit in a beer garden saying: 'I could murder for a pint of [your beer] right now.'"* Founders also use metaphors, analogies, and comparisons to make the picture more tangible. Will and Harry refer to *"that sort of Innocent Smoothie type team where everyone's there because they're sort of really on board […] building the A Team up, a really strongly knit team […] become[ing] a Premier League sort of company."* Hence, the future picture they hold is not constrained to the product, but also comprises the organization itself. For Will and Harry, it is the idea of a non-traditional company. Both explain that they have to think differently about a brewery. *"What is a brewery in the 21st century? You get your phone out, press a button, and get a beer."* They also describe their roles in this scenario as *"sitting in an office pressing buttons and composing the next solution from [their] desk, rather than standing in a production facility […], "build a company that is about tech not labor."* Harry provides a rich illustration of what this means.

> *"[…] You know the way we see it […] it's a fun quirky place to work, it is basically not a brewery anymore, it's more like almost say a technology company in the way we think and the way we work and the way the office would look and the way the people would react to it. A small company with the brains in-house but everything else, all the production and all that stuff is out of house. […] The way the company would look from the outside, you'd mistake us for a technology company. It would more likely be a really cool office with people on laptops making things happen rather than what a lot of breweries would with the actual HQ inside the brewery: a big lab, loud production house. I don't think we'd be that way, […] I think our brand and the whole culture of our company reflects on that really. I'm really excited about doing and creating this squad of people. It wouldn't be a hierarchical company, it would be flat as a pancake. It would be almost like a football team with me and [Harry] as the captain rather than any sort of boss. That's kind of the way we do anything."* (case 4)

Like Will and Harry, other founders who are *integrating,* show a similarly strong reliance on such future pictures, that vividly, yet vaguely capture their ideas of their business, and guide search, while paying minor attention to past reference points—information gained through

market feedback of their offer. For example, Nik and Dave's (case 8) picture rests on the of theme of bespoke jewelry for a mass-market, for Arthur and Victor (case 16) it is about shaping the emerging IoT sector, and for Tim, Tom, and Ted (case 17) it is about enabling kids to construct their own robots. They all draw on future reference points to create firms that change industry sectors—irrespective of size or maturity—instead of providing an improved solution.

Puzzling–action. Throughout my study, I notice that all founders with stark attention to future reference points were convinced that their future picture of the venture was principally right. As such, these founders perceived to generally know something (i.e., the right direction to go), although objectively, their endeavor was equally ambiguous to the execution of any other novel idea. I argue that this notion is central to understanding how they searched. For them, search was about understanding aspects of their future picture—they, figuratively speaking, thought that they had to find the dots, rather than connecting them. Hence, the future picture represents a rough structure with the connections for which they had to find the elements (i.e., specific solutions). As Will describes it. *"We've got this sort of vision ahead of us, it's out there to be won, we'll get there eventually, but […] we're always refining these very small, negligible details to get it."* Founders, when *integrating*, utilized their future picture to generate and learn about multiple strategic options that related to the structure it provided.

To address their future picture, Will and Harry investigate strategies of how to create the experience of drinking beer—reaching beyond their product. For them, this should be done through their own physical space, in which they could create and control an experience. They built a pop-up bar which they set up at different venues to probe that experience and engage with customers. This prototyping approach enabled them to test if they could create the experience they sought this way and to thoroughly understand how it would be to run their own bars.

> *"It's basically a test bed for the kind of vibe we want to go for. So, essentially, we are popping up our bar […] we can play with different sort of styles, we can play with types we are seeing. Really work out what a bar would be like, when it would get permanent and what kind of feel it would have to it – whether it would be quite rustic or, you know […]. All we learn, we'll take some of that and are able to get another bar further down the line that sort of permanent one."* (case 4)

Similarly, Nik and Dave (case 8), look into how to balance online and offline elements of their business model. While they are an online business, offering solutions to design and try on bespoke jewelry online, they are certain that this type of product would need an offline element too, because customers would want to be looked after and led through the whole process. They tested a strategy for a physical presence through a temporal collaboration.

> *"In fact, we deliberately did it as almost like a mini-start-up within our start-up. In the sense that we separated it and we didn't get everyone involved in the early stages."* (case 8)

By probing promising alternatives, founders consciously install learning processes to gain understanding about their future picture. As Will and Harry describe *it: "We're always dipping our toe in certain ways of doing things."* Interestingly, founders do not simply probe if a new idea is feasible, but they apply it to any area of their business to find solutions that met their own high requirements. For Will and Harry, the quality of their special beer blend is an essential element of their future picture—enabling young customers to have good time with their friends—instead of a standard beer they could sell through good marketing. Although they were reliant on the brewery, they decided to end this collaboration when quality issues arose, accepted a decline of sales, and found a better arrangement.

> *"Basically the bottles that came in were, not rubbish, but below standard and we weren't happy with them. So we had a bit of an argument with the brewer about, you know: 'This is not up to standard, what has been going wrong?' Their reaction was: 'That's brewing mate, deal with it.' […] So from that it was that we thought: 'We don't particularly want to work with someone with that attitude.' We asked for more focus from them, but that's not good enough."* (case 4)

This ambition to find the best representation of their future picture also means that founders do not stick to the first solution that seems good enough, as Nik and Dave describe.

> *"There's a huge testing culture in our company so that's why there's nothing fixed, because saying that something is fixed means that you can't come up with any further ideas of testing and that's just a lack of creativity."* (case 8)

However, probing alternatives is not just about continuous improvement to match an ideal future picture. When *integrating*, all founders were aware of the key aspect of their venture and strict about finding a reliable solution for it. For Will and Harry this aspect was the beer production, which they outsourced. *"It's just a constant risk hanging over us. If the brewing goes badly wrong, we could go from everything to nothing in one month."* But they did not have the skills, capital, or time to internalize mass-production. To ensure the fundamental quality control, they put major effort into finding an arrangement, in which they worked collaboratively and closely with two experienced brewers. Likewise, Nik and Dave were determined to find an outstanding sales person from the industry to generate trust for customers. This was vital, irrespective of their eventual strategy of balancing online and offline. Also, Tim, Tom, and Ted (case 17) put major effort in designing a tiny electronic connector that was essential to enable the seamless connection of the robotic toolkit modules, which was core to their idea. This work was independent of the parallel configuration of the toolkit modules.

These findings illustrate, how, when *integrating,* founders engage in search process of probing alternatives of the future picture and solving key issues to maintain current development, balancing search breadth and depth (Katila & Ahuja, 2002). Here, the founders' future picture of their venture, informs this learning process to form mental representations of the past. Importantly, because the input for this process originates from their future picture, founders only integrate external feedback to specify a strategy or gauge how it is generally perceived (i.e., 'define the dots'). Despite collaborating, founders ultimately stay in control of the general strategy that results from their future picture (i.e., 'the connection of the dots'). For example, while Will and Harry are well embedded in their local community of customers and network of

partners, they only pay attention to responses from this network to assess their general direction of development. They refuse to change their future picture or how they generally think about their business as a result from this learning process. *"That's not the focus of the company, but it's still good to hear the general feedback. It's still good to hear other people's opinions."*

Puzzling–bottom-up resource allocation. When *integrating*, founders' key rationale for search is gaining understanding of how the future picture of their venture may be realized. I find that they commit resources to probe multiple alternative representations of their future picture, thus they keeping these commitments temporal. As Will says. *"I think we are quite flexible […] we can very easily jump from one side to the other […] at the moment, we're very free to move on."* However, while resources are flexible, founders are cognitively constrained in how they are prepared to allocate them. They only accept solutions if they match with their future picture and, hence, these alternatives are internally consistent. They evaluate each alternative by its incremental contribution to this desired future. For example, Tim, Tom, and Ted (case 17) spent a long time to develop their product, almost causing an irreversible delay that would have put the survival of their venture under major threat. They negotiated every detail of their solution so that it would fit with how they originally imagined a *"dream-machine."* Similarly, Jane and John (case 9), who develop a data management software, were very selective in the corporate partners they accepted for a co-creation process. This form of product development was central to their idea, but finding the desired partner caused delays too. Additionally, the flexibility founders are able to maintain when *integrating* is constrained by their determination to solve key issues of their venture. Will and Harry, for example, invested both, substantial time and financial capital to build a reliable production process. Thus, while keeping resource commitments for probing new strategies low, founders permanently allocate resources to activities they identify as core to their

business. Fixation of resources is bottom-up, piece-by-piece.

Hustling–cognition. When *leaping,* founders search differently. Instead of a vague future picture, their focus is on a specific idea. This idea, is usually a better solution to an existing problem—a product, based on a new piece of technology or new business model. Sam and Joe (case 21) are good example of this. They launched a marketplace for legal services to increase price transparency and offer better deals.

> *"We are the first marketplace for legal services. We connect specialist lawyers and clients. Our focus is on offering the best deal, usability, and design. Something like does not exist online. Then we said: we digitalize it and be very specific. There are no offers as specific like this on the market […]. Nobody does in [our country], here we are completely 'stand-alone', nobody thought about this before."* (case 21)

This pattern applies to other ventures too. Jim (case 2) applies the AI algorithm he developed in his Ph.D. to design multiple new software applications that improve data management. Leo and his three co-founders' (case 7) own a technology that allows them to realize new advertising formats on mobile devices. And Jan and Lisa (case 35) offer DIY kits for female accessories. Because their ideas are specific, founders can compare them to those of competitors. Indeed, when *leaping*, this is a central process. For example, Sam and Joe are very conscious about major players. *"Always closely monitor, for sure. […] We have always looked: who is doing what?"* When founders compare themselves they draw on their competitors for inspiration.

> *"There exist big role models. They are [competitor 1], [competitor 2], [competitor 3], they also do a model like this and they are doing fine. They do it right. […] and I told him [out investor] that [competitor 1], our role model from [the other county] do it exactly like that."* (case 21)

Although none of them started with the intention of copying an existing business their improvements are largely incremental.

> *"We really do look a lot like their [competitor 1] landing page. That's interesting, because we never started to become a copycat, but certainly you monitor what your competition is doing. We are not 100% copycat, but we are a bit of [competitor 1], a bit of [competitor 2], and a bit like [competitor 3] with how we manage documents. We are a marketplace, and the difference to our competitors is that clients can choose their lawyer. I think that's higher value for them. We have these role models [competitor 1-3]—they only offer a marketplace."* (case 21)

Founders' mental representation of their ventures' future are generic and also strongly oriented toward their competition.

> *"The big vision is to generally become like [competitor 1] for [our country]. We really want to handle these smaller cases, offer additional services, and make the cheapest offer. So far, that's the big vision. In principle, what we do now, just a little bit more professional." [...] The vision is really to target companies [instead of private clients], because that's where the money is. And then we want to grow in this sector."* (case 21)

Instead, of a vivid picture of their venture, founders continuously collect ideas for incremental product extensions to offer better products to new customer groups. As Sam and Joe describe. *"[…] there is always this backlog. That's where we dump all these unspecified ideas, where we say: 'Write it down, maybe we will look into this at some point."* To decide, which idea to pursue, they rely on external feedback, they gain from launching versions of their product.

> *"You shouldn't disconnect development from the market. Don't build something only internally and then you get out and say: 'Hello, here we are.' And the people say: 'I don't need it. It already exists and it's impossible for us to integrate it into our workflow.' And that's why we said: 'Ok, it really makes sense to gather and evaluate user feedback.' We want to see how people react […] and we will run this for longer."* (case 21)

Despite their specific idea, founders, when *leaping*, are flexible in how to implement it. At the extreme, their ideas are just starting points of learning processes that transform their ideas. For example, Sam and Joe describe this. *"We are totally flexible, we just have to wait and see what works."* Thus, the influence of customers on the configuration of the founders' idea is stark. *They [our customers] found it interesting and that's why we also find it interesting. [...] we always listened to our customers, that's how we do it."* A good illustration of how Sam and Joe's customers influenced their decisions is their change from a marketplace with B2C focus to a B2B office management software for lawyers—and back.

> ***Change to software.*** *"Many lawyers said: 'I don't need new clients, but I like the idea of moving my clients to your service. I like the fact that they can pay directly on your platform and that we can use all these tools, like video chats.' Then we thought: 'Why don't we focus on that.' Again, we listened closely to our customers."*
>
> ***Change back to marketplace.*** *"Through market research we found out that from the outside world we are perceived as: we help clients to find a lawyer. Nobody gets the idea that we offer an office management software. Sure, we have a nice dashboard, but we wouldn't claim to be a*

software provider anymore." (case 21)

Other founders, when *leaping*, also engage with customers on social media to understand how they use his products and to devise new ones (cases 2, 7, 35). When *leaping*, founders attend to past reference points that they generate by learning about their offer. These reference points provide objective guidance for improving their product and to increase performance.

Hustling–action. Throughout my study I notice that, interestingly, all founders with stark attention to past reference points felt truly uncertain about their specific idea. Although they were convinced that it improved existing offers, they perceived to know very little about its general value. As Sam describes it. *"We honestly didn't know who our target group is, because you never know."* I argue that this notion is essential for how they searched. For them, it was about understanding how to configure their specific idea so that it would appeal to a group of customers—while they perceived to know the dots, they did not know how to connect them.

Founders' launch multiple configurations with alternative features of their idea and test them in parallel (e.g., Nelson, 1961, Gruber et al., 2013). This procedure applies to founders of online and offline ventures alike. For example, Sam and Joe test three core configurations of their legal service: an open marketplace, a closed marketplace, or an office management software. Similarly, Ella, Mike, and Steve (case 18) experiment with three alternatives to apply their video production technology: sell the software, embed it in a proprietary hardware product, or offer a full-service solution. Given their uncertainty, founders treat each strategy independently and a priori, as equally valid. Thus, search speed is vital to identify a good strategy before their competitors, or to reduce uncertainty before running out of resources. *"It's always a question of speed."* (case 21)

> *"Running a start-up is like Formula 1. You always have to go full throttle, you always have to be the first. […] If you look back, then you just get third or fourth." [...] It's also about speed with respect to competitors. New ones pop up here and there and you have to ensure that you're faster. […] You have to realize quickly if something is working or not. Don't lose yourself in product details, just get the product out and see if it works—if not, try something else."* (case 21)

These findings illustrate that, when *leaping*, founders' engage in trial-and-error learning (Argyris & Schön, 1978; Greve, 2003) to generate past reference points, based on which they can refine their mental representation of the future. While this is typical in new ventures (e.g., Ries, 2011) it illustrates, why, when *leaping*, founders depend on the information from this process (i.e., to connect the dots). Their mental representation of their venture's future consists of an array of alternatives, which they need to contextualize based on external information. They are uncertain about the right strategy. Thus, *"[…] it's always good to talk to the external world, because, in the case of doubt, they know it a little better."* (case 21)

Hustling–top-down resource allocation. When *leaping*, founders' key rationale for search is gaining understanding of how to improve the current strategy of implementing their specific idea—ultimately finding one that is sustainable. They commit resources broadly to various trials.

> *"Say, you loosen the purse strings and you get more sales. Then you pull the plug and you get less. You quickly realize what is working. We are still playing around a lot. We commit money to one idea and then nothing happens."* (case 21)

However, once a trial is successful—that is, it increases performance—founders bundle resources top-down to this one strategy, reinforcing development speed. Drawing on past reference points provides them with the certainty to make these right or wrong assessments. Ray (case 19) illustrates this action vividly.

> *"I always think of it this way. You have a pile of rice or soil. Then you pour water over it. You may already expect it to run down the left side of the pile, but you don't know. You just have to pour the water and somehow it will find its way. Once a little river emerges, you have to pour vast amounts of water in this stream, to make it continuously stronger."* (case 19)

Proximity of Search and Organizational Structure

Where do actors search? The distinction of local and distant search and its implications on firm performance is central to theories of organizational search (March, 1991). More recent work has linked these two forms of search to organizational structure (Gavetti & Rivkin, 2007). Then local search corresponds to incremental developments and distant search to more radical changes. By making the notion of time explicit in this paper—local search relates to a nearer future than distant search—I find a contrary pattern. Founders purposively draw on distant search to guide incremental improvements and local search to foster radical change.

Upgrading–cognition. I have argued that, when *integrating*, founders balance breadth and depth of search (Katila & Ahuja, 2002)—probing alternative strategies to realize their original idea while ensuring reliable strategies for core activities of their business. I observe how the founders' future picture of their venture—distant in time—enable them to do so. What I find is, that the founders' future picture provides them with a reference point, drawing on which they can cognitively distance themselves from the present (zooming out) or, conversely, to cognitively approach the present (zooming in).

When zooming out of the present, founders cognitively switch from looking at strategic alternatives independently, as they encounter them in the present, to holistically, with their distant future picture of the venture in mind. Thus, distant search means searching broadly to integrate new knowledge. For example, at one point, Will and Harry (case 4) had to decide between three equally valid options of realizing their idea of a space to control the customer experience: a party series with upcoming musicians, a joint venture for a chain of bars, or, their own bar. To assess these alternatives, they distanced themselves from the objective present reality these options presented—zooming out—and pondered them in the light of their subjective

future picture. They finally decided intuitively for the party series, instead of the more lucrative bar chain. This procedure seems random and irrational. However, with regard to reaching their future picture it was not. While not the most lucrative strategy at the time, it ensured the consistency of development. Will refers to this routine as *"surveying the scene."*

> *"When we have a hard decision to do, […] we just survey the scene essentially, survey the context, survey the actual problem and then from that, once we've surveyed a problem […] It goes on a bit more gut feeling and the decision is made in our head by surveying the problem and you come out with an answer. There's no sort of calculating the risk. You've just got to understand it and then think: 'Oh, it's easy to come up with an answer.' I think that's still the way we do it."* (case 4)

Arthur's (case 16) action is another example for the notion of zooming out. He, regularly, physically distanced himself from the present office context of his venture. Unlike Will and Harry, his aim was not decision-making. He took stock of present resource allocations and strategic alternatives. His attention to future reference points gave him an external view on present opportunities, challenges, and activities of his daily routine. This external view ensured that the venture's strategy would be focused on becoming a leading provider of industrial data-analysis solutions in the emerging IoT sector, instead of selecting any emerging development path in this new industry. Arthur describes his action of detaching himself from the present.

> *"There are many things you don't see when you're stuck in the daily business. I am getting blind when I am sitting [in the office]. It doesn't work. What I do now is that I work from somewhere else for two days a week—for example my own kitchen—to get an external view on our business. That allows me to give feedback, to improve things. Otherwise, you are part of the system. But you shouldn't be part of it. […] You must be the pedal that drives that system."* (case 16)

Besides enhancing the breadth of search by zooming out—contextualizing strategic alternatives—founders refer to their future picture to increase the depth of search by zooming in—reinforcing core activities.

Upgrading–action. Founders also draw on their future picture to zoom in the present and enhance the depth of search. That is, they actively develop core aspects of their ventures'

strategy that they perceive as vital to their original idea. Ed (case 14) refers to them as *"must-win battles to eventually win the war*." While all founders in my study mentioned such aspects, those *integrating* were specific about them and provided a rationale of how they linked to their future picture. They articulated the necessity to develop robust organizational structures to address these core aspects throughout the study, and, importantly, persistently searched for a realistic and satisfactory solution. These solutions comprise a tight integration of strategy, people, and product. They enable the founders to reduce risk in core areas and to protect their key assets.

For example, for Will and Harry product quality is key. This seems true to any business. However, for them it is the basis on which to create experiences with their beer—essential to their original idea. To not becoming a traditional brewery and be stuck in the operations, they had to manage the outsourcing well, because *"[…] have[ing] a big, bad batch of beer, […] would be a nightmare […] You can't just ditch an entire batch of bad beer—that would be brutal."* They abandoned initial collaborations and created a more reliable arrangement.

> *"We now have this triangle. […] what we have done is, we've moved all our brewing. And now we have this sort of almost like a triangle of people involved. It's me and [Harry], it's the [new] brewery, and it's the brewing consultant and we're all now working together in very close tandem. And the brewing consultant and the brewer, know each other very well so it's a quite close sort of triangle of sharing knowledge and stuff […] really building on the knowledge we have got and the knowledge of those two to create recipes that are sort of watertight and there is no more space for any mistakes."* (case 4)

Similarly, Tim, Tom, and Ted's (case 17) idea rested on the premise, that their toy robots would be seamless. This goal was difficult to achieve. They decided to acquire new knowledge to develop innovative solutions for micro-electronic parts of their toolkit internally. They could have applied more conventional solutions, but would likely have missed their original idea.

To execute these strategies, founders search for people and abide to rules. First, given their resource constraints, this often means convincing people of their idea rather than hiring them. Will and Harry induced the former development head of a major beer brand into working for

them almost for free. Arthur and Victor, built ties to high-profile individuals in politics and business, they leveraged to publicly reinforce their claim of becoming a major industry player. Also, Nik searches for people. *"Without a doubt, I think I'm now surrounding myself more with people who are helping to guide that journey."* Second, founders rely on sets of rules. Like any rule, they provide clear guidance for action.[32] For example, Will and Harry refused innovations on their product, but in strategies that would lead to the experience they wanted to create.

> *"What we're trying to do is to is a specific type of beer, which is this mixture between larger and ale—do it really well. But the beer is a sort of lubricant for the experience really. And, you know, we want our beers to be very good quality and they have to do a certain job for us and so, you know, our beers rank well. But we're not going to do weird stuff."* (case 4)

More generic rules ensure that growth rests on a solid foundation. As, Nik (case 8) explains.

> *"In the early days, [Dave] and I were going, we'd rather you know we'd rather like not have our books done, but have a growing business. That was the kind of arrogant argument that we made. I realized that statement is false."* (case 8)

Harry (case 4) supports this rule. *"Sales always follows production […] that's how it works."* Thus, founders also deliberately time their implementation of new strategies for business development. Will, *"[we make] slow but right decisions."*

> *"None of these decisions are going to be made as snap decisions they're always going to be quite based on a lot of thought […] very reflective, not rushing into anything. […] We're slow and sort of steady at making sure we've assessed the situation properly before we start really making a quick decision so that's how we're dealing with it."* (case 4)

Upgrading–building organizational structure incrementally. When *integrating*, founders balance breadth and depth of search (Katila & Ahuja, 2002). While this is an established strategy to ensure firm performance and survival (Tushman & O'Reilly, 1996), my findings indicate how it affects the formation of a firm.

[32] These rules differ from 'simple rules' (e.g., Bingham & Eisenhardt, 2011) in that they inform actors about *what* to do, rather than *how* to do it. Here, rules are related to values founders' hold to make specific decision, instead of providing general strategic guidance.

When building organizational structure, founders increase the depth of search to realize core aspects of their ventures' strategy (e.g., brand values, quality standards, product features). This activity resides in the practical dimension of search. Conversely, when enhancing the breadth of search, founders select strategic options for further development. This process exists in the cognitive dimension of search. Nik provided the analogy of (case 8) *"scuba diving"* and *"snorkeling"* to illustrate search depth and breadth. *"I am at the top of the water, looking down, and then I've got a team that is deep diving."* This analogy illustrates another aspect. When founders draw on future reference points to balance depth and breadth of search, they discriminate between action and cognition, and manage both independently. Gian (case 3) explains how he is managing the duality of action and cognition for organizational development.

> *"You want to a certain point not executing on small things yet and you want the big picture. But sometimes it is good to bounce back and understand the details as well. I think because of this the best thing to do is, look at the big picture, jump into the small detail for a short amount of time and then straight back, jump back to the big picture. Don't be in the middle, because you get lost in the middle."* (case 3)

Interestingly, I find that when founders engage in distant search, they build organizational structure incrementally, instead of leveraging future alternatives to change it (Gavetti & Rivkin, 2007). Drawing on their future picture, this mental representation always guides their search (breadth and depth), allowing them to construct their organizational structure piece-by-piece—like putting together a jigsaw puzzle. Founders develop this holistic configuration by adding to core aspects of their venture. At any time, these configurations represent distinct and internally consistent versions of the vague future picture the founders have of their venture. They improve these versions in stages to produce better representations. Will and Harry, although operating in a different industry, compare this upgrading process to the development of technology products.

> *"A way we think about it is: you have a tech company [that] releases a product and they have version 1, version 2, version—we have that sort of thing. […] It's the same with say, iOS software. […] Everything we do, I think it's like we step it forward and do one version […] it all goes and it comes like version 2, version 3 and it's like iteration and sort of, yes, that's how it is,*

> *it's versions […] you improve in steps really."* (case 4)

Adapting–cognition. I have argued that, when *leaping*, founders rely on rapid trial-and-error learning (Argyris & Schön, 1978; Greve, 2003) to improve aspects of their business idea and test new strategies that may enhance short-term performance. Therefore, they funnel all activities on this fix and clearly measurable outcome (Cyert & March, 1963). It is non-negotiable and consistently represented throughout the organization. As Sam explains.

> *"You really have to generate KPIs. That means the first revenues, the first customers, to generate KPIs to present to your next investors. So that they say: 'Ok, they got that amount of money, they managed to achieve this, that's where they can be in three years' time.' […] You really have to prove [it], KPIs, KPIs, for weeks, for months."* (case 21)

While this action is not new, it shows how the founders' perceived uncertainty about their business idea draws them in a search loop—interpreting external information, adjusting their offer, and interpreting new information. Here, valid knowledge comes from outside the organization, informing strategy changes to achieve near future performance. Growth is the only measure to decrease founders' uncertainty and means to acquire new resources to find even better strategies. It highlights the constraints of founders' agency (Emirbayer & Mische, 1998).

For example, Adam and Fred (case 1) run a marketplace for automotive services. With their algorithm, they can instantly quote any car repair job and offer the cheapest mechanic for it. They focus on strict growth targets—more customers, more transactions, more mechanics—through improving on their current strategy and developing their website based on feedback. But they do not break out of this routine to test other growth strategies, unless externally triggered. In comparison, founders in *integrating* mode, have a general certainty about their idea. They probe alternative strategies and reinforce existing ones drawing on their internal cognitive map of their venture in the future. This makes them proactive in developing their business. Thus, compared to Adam and Fred, Nik and Dave (case 8) seek growth of their marketplace by probing specific alternatives of their future picture of selling bespoke jewelry. While they ponder external

feedback on these alternatives, they do not use it to introduce new ones.

Adapting–action. When search is directed to near future performance goals it is local in time. While these goals are absolute, they are unspecific in how they will be met—multiple, even unrelated strategies are equally valid. Thus, founders search for any solution that might address their focal goal and accept any (and often the first) alternative to meet it. Kurt (case 19) explains. *"It's really opportunity spotting. Evaluating: what works, what is easy."* This notion also relates to the necessity of finding good strategies first. As Sam states. *"It's survival of the fittest."*

> *"I mean, to be honest, segmentation is important, I completely get it, but when you are just starting out and you are going for growth quite often you are just like: 'f***, just give me the orders from anywhere.'"* (case 1)

Kurt and his co-founders' (case 19) are a good example of this action. Starting with the idea of connecting newcomers in urban areas through a social media app, they switch between three different, and potentially better use cases for their service, each time rebranding their product. Also, Ella, Mike and Steve (case 18), set out to sell a video production software, but commit to strategically different projects. At the extremes, these range from becoming an agency when managing an entire video production, to becoming a hardware provider, when assembling their own camera systems. Likewise, Andy and Fred (case 1) constantly react to new investment offers that require major attention although they could focus on long-term projects, because they generate constant growth. But they and impede such projects. All these founders' behavior is in contrast to those in *integrating* mode. The latter refuse growth opportunities if they conflict with their internal ideas of what their venture should become.

Adapting–building organizational structure radically. I argued that, when *integrating*, founders separate the cognitive and practical dimension of search, and, as a result generate stable

organizational structures. However, when *leaping*, I find that this is not the case. Here, founders search locally—cognition and action are joined activities (Miner et al., 2001). That is, founders' interpretation of feedback and their search for incrementally better strategies are in a loop. Their attention is to short-term goals that reside in the near future—this future is changing in each circle. As such, founders are cognitively inhibited from zooming out to contextualize feedback, but also from zooming in to reinforce core activities when new feedback restarts the loop. This prevents them from a constant improvement of their organizational structure. Instead, when founders search locally, their organizational structures change radically. To reach performance goals, their whole organization needs to adapt to a new strategy—as compared to changing within the constraints of a future picture (when *integrating*). One example is Sam and Joe's venture. Although they started with the idea of a marketplace for legal services, they changed to becoming a software provider, before, half a year later, they changed back into a different marketplace model.

> ***Start.*** *"We are a marketplace for legal services."*
> ***Change 1.*** *"We will change into providing an office management software."*
> ***Change 2.*** *"Forget about the software, we don't do that anymore."* (case 21)

In their pursuit of short-term goals, founders organize people to execute a new strategy ad-hoc. The frequent adaptation to short-term goals means that their organizational structure appears lumped together in varying yet new configurations. For example, Sam and Joe (case 21) maintain flexibility by keeping employment temporal.

> *"[Luc] the CTO is a key figure in our company construct [...] the only permanent employee, the rest are all freelancer. [...] now that the page is up, we fired a few employees—I mean we did not fire them, because they are all freelancer. You just say: 'Ok, you are out, because we don't need you at all.' [...] We are very agile, because we just work with freelancers. If worse comes to worst, we can switch off this company in a week."* (case 21)

While this structure is efficient, it obstructs founders from establishing an organization that reaches beyond the specific goals they organize around. This applies to older ventures too. Steve

(case 10) throughout the study mentions his uncertainty about the sustainability of their venture – despite managing stable revenues. He maintains short-term goals and temporal employment to execute specific tasks. As a result, these ventures in *leaping* mode are more hierarchical than those in *integrating* mode. In the latter, flatter structures allow for everyone to collaboratively find the best way of translating the future picture of the venture into a present solution.

Search Direction and Trajectories of Organizational Emergence

How do actors update their search? A core assumption in the search literature is that actors have a backward-focus when they engage in experience-based learning and a forward-orientation when they draw on their mental maps (Gavetti & Levinthal, 2000). That is, they look back to the past and forward into the future. They search in *two* directions—this is intuitive. However, my data indicate a contrary pattern: founders look forward from the past into the present or backward in the past from the future—this is counterintuitive (Dattée et al., 2018; Lord et al. 2015). I argue, that this inverse pattern results from the empirical context I study. While prior literature on search looks at incumbent firms, I studied new ventures. I argue that this new setting, changes the certainty actors can have in their strategic options. Actors in established firms have little uncertainty about their current strategy—they can relate it to their past performance and assess future strategies relative to their current ones (e.g., Greve, 2003). Thus, actors are cognitively located in the present when pondering how to move on. But before firms are established, actors should experience ambiguity or even uncertainty about their present position. Hence, cognitively locating themselves either in the future or in the past should provide them with a more reliable position from which to assess strategic options. My data indicate this. Drawing on their envisioned and agreed upon future picture, when *integrating,* founders search backward from the future toward the present (and past). But with their main attention on

performance feedback, when *leaping,* founders search forward from the past into the present (and future). In both modes, they search in *one* direction. I observe that this direction of search, affects trajectories of organizational development. When searching backward, these are linear, while they are multi-directional when searching forward.

Controlling–cognition. When *integrating,* founders hold a vivid future picture of their venture that increases their certainty about their position in the present. Thus, they cognitively locate themselves in the future and rather perceive of their venture as what it will be, than what it is now. However, their future picture does not provide founders with information about which specific strategy to select (Porter, 1985), but it also constrains them from selecting strategies opportunistically. That is, founders are certain about their general strategy but open to its execution. They are aware of vital areas of development and can be opportunistic about selecting available strategies in the present within these boundaries (cf., Sarasvathy, 2001). As Will and Harry described it. *"You need to know where you are going […] have a feeling and understanding of the quest [you] are entering. […] then you figure out the rest on the fly."*

> *"It's like, say in Lord of the Rings, where you're trying to get to Mordor. You don't just start off straight away. You have to know the terrain somehow before you start the quest, you don't just set off. […] We kind of know the general gist. We know that: 'We don't want to go in that direction but we want to go in this direction.' And now it's the case of executing and sort of passing the obstacles to get to that place. On the fly, you are moving along rather than trying to plan for them […]. We know which way we're going, so let's just go in that direction and work it out as we're going along."* (case 4)

Controlling–action. Within the cognitive boundaries of their future picture, founders search backward *"[…] start[ing] with the vision and sort of work downward from there" (case 4),* seeking present strategies that match their future picture. Initially, selected strategies are crude, because founders probe multiple of them and only invest limited resources in each. At this point, their future picture is crude too. But founders succinctly reduce the crudeness of both, eventually

aligning them. Thus, although the founders' future picture triggers their search, is not fix, but influenced by what is feasible. Nik describes this dynamic process of aligning future and present.

> *"You just got to be real about things and understand that you have a double vision. You need to be able to see the business both in the eyes of the future and in the eyes of where it really is now."* (case 8)

A good example of this process are Will and Harry's brewing venture that rests on the premise of controlling the experience of drinking beer with friends. Starting from this vague future picture, they searched backward to identify ever better strategies to execute their idea. They incrementally moved from a crude pop-up bar (future and present are distant) to a party series with local musicians in unique urban locations, that captured what their idea (future and present are the same) *"the vision ahead has become reality."* Also, Arthur and Victor (case 16) or Nik and Dave (case 8) searched backward from their idea of an IoT firm or online marketplace respectively, to succinctly align present strategic options with their future picture.

In this process, founders only accept new strategies, if they align with their future picture, but they reject them if not. In general, founders, when *integrating*, resist the temptation of following market trends as this could harm their novel outcome. Will and Harry describe this. *"We are trying to make sure to hold our ground and not be tempted to just jump on a bandwagon and then compete with people on these sorts of grounds. That's not who we are, that's not what we're about."* They also rejected a lucrative opportunity for a joint venture for a chain of bars with an experienced partner, but accepted the one for the party format.

> ***Reject:*** *"[The bar] is a very promising proposal, that can make a lot of money, potentially. But it does not fit with the general theme [of our business]. They basically become two strategies, which just diverge and diverge more and more."*
>
> ***Accept:*** *"[The party format:] it's both. That's the reason why we kind of like this strategy. It's obviously about making money and revenue and it is a strategy that is not just done because it's revenue there to be made. It's not like selling our beer to a big supermarket chain, but it works. We are aligned with our mission and the two quite fit together."*
> (case 4)

Controlling–linear organizational trajectories. Despite starting from a broad, vague, and relative future picture of their venture*,* founders, when *integrating,* achieve linear organizational development. Indeed, assessing strategic alternatives in the present based on a notion of the future, allows them to select internally consistent strategies—at the expense of rapid growth.

> *"It's really about going through the stages of growth and we are making sure that we get every stage right […] You know, if you're pushing hard growth you push too hard, you end up with something not being right. […] It really has to be done in a balance without rushing into it and getting too carried away. […] Just be methodological with it I think."* (case 4)

When searching backward from the future, founders literally pull the organizational structure toward their anticipated future state. Thereby, they control the direction of organizational development and progress is linear (e.g., "time-paced change" Brown & Eisenhardt, 1997: 25). Searching top-down—future picture to implementation of real strategy—founders *"conduct"* (Rob, case 23) a collaborative development process. Will describes this notion. *"Mine and [Harry's] roles fall to just orchestrating a band, really. You know, just being a conductor […] ensuring the symphony is coming along nicely."*

Reacting–cognition. Conversely, when *leaping*, founders draw on past learning, to enhance the certainty about their position in the present. Hence, they cognitively locate themselves in the in the past and look at their venture as what it is now and thus may become in the future. Their past performance provides founders with a clear starting point, from which to search forward toward a short-term future goal (e.g., Cyert & March, 1963). They linearly extend the past to the future (i.e., improving what they did)—any future strategy that increases performance is acceptable (e.g., Levinthal, 1997). To escape this procedure, founders ultimately search for a rationale that allows them to increase performance reliably. Throughout my study, Michael (case 20) referred to this aim as *"finding the formula."*

> *"We're just trying to get more bookings and get some kind of growth rate established, so we can say, 'Look, here's the formula. Here's what we know is growing. That's why we think it can be a big business.' […] We can copy-and-paste that model into other cities."* (case 20)

This rationale eventually provides founders with the certainty of what their business is. In contrast, founders, when *integrating*, are always certain about this outcome—though it is fuzzy.

Reacting–action. When *leaping*, the founders' business ideas are starting points for a sequential search process for the best strategy to execute it (Newell & Simon, 1972). Therefore, they constantly improve their original configuration of the product. As Sam noted. *"The product is fix, but of course, it should improve."* Compared to *integrating,* founders do not need to align future and present. Instead, they instantly create this match in form of a specific hypothesis about a good operational mode for their idea. They test multiple of these hypothesis, forwardly, each formulated from information of the last trial.

> *"You just have to constantly optimize. It's really like optimizing a car—testing the dampers, testing a new seat, testing new seat belts, and so on. Then one of the seat belts breaks and someone goes through the window and you think: 'Damit, these seat belts are terrible, let's try new ones. It really is optimization. It's like a machine that is running and you have to figure out: where do I optimize? […] At the beginning, you may just have the wheels, dampers, and steering wheel and in the end you have a car. There are a thousand little pieces you have to optimize."* (case 21)

This optimization process contains two implicit assumptions about knowledge. First, founders assume that their initial product is a good point to launch a local search process from (March & Simon, 1958)—although objectively, this is still ambiguous. Second, in contrast to *integrating*, where founders' knowledge to realize their vague future picture can be assumed as mainly tacit, relevant information about executing clear short-term goals are largely explicit when *leaping*. Here, founders can specify and manage the tasks to execute new strategies. I find that therefore—mainly the CEOs—occupy a more central and dominant role, as in the collaborative approaches when *integrating*. Sam refers to this role as *"drill-sergeant."*

> *"As CEO, you have to push your people. I am still too nice and say: 'How are things?' You have to say: 'This is done by the end of the week or you're fired.' Or along these lines. You have to be more drill-sergeant so that they understand. Because they take too much time. […] I am always the execution power and I think that, in the end, it is the CEO who has to execute. […] "I am sick of everyone butting in. I just say: 'That's how do it—end of discussion.'"* (case 21)

Reacting–multi-directional organizational trajectories. When *leaping,* founders start from fix reference points (past performance) and aim at clear goals, however, they generate erratic organizational development. While their goals provide some guidance—informing what to achieve—they do not offer specific direction in how. New strategies to reach these goals pop up in unforeseen ways, and in order to generate a performance boost, founders accept any and often the first alternative. Given their clear short-term goals, founders of online and offline ventures alike, exclusively accept new strategies based on quantitative measurement (e.g., sales, retention of customers). As Ray (case 19) states *"conversion, always, conversion."* While this ensures improvement, it does not provide information about (the right) direction of development.

> [Founder is talking about increased conversion rates.] *[Interviewer: "So would you say that there is a threshold above which you would know that you're going in the right direction? Or how do you ensure that it is going in the right direction?"] "Well, to know that it is going in the right direction, well, that's a bit the problem."* (case 21)

When *leaping*, founders literally push their organization forward from the past toward the next better short-term future state. As a result of this bottom-up search, they exclusively link their previous and current strategy—connecting dots—instead of linking strategies to one holistic framework. In this process, founders only control their venture's sprint to the next short-term goal, but they struggle to steer its overall development. Both, technology (e.g., case 2, 7, 18) and online service ventures (e.g., cases 1, 20, 21), shift between various (unrelated) applications and offers. Thus, drawing on past reference points enables founders to achieve grow, but at the expense of internal consistency ("event-paced change" Brown & Eisenhardt, 1997: 25).

Transitioning Between Search Modes and its Effect on Firm Performance

I also observe transitions between modes: from *integrating* to *leaping* and vice versa. These changes occur permanently and as a reaction to how perceived uncertainty in their venture.

Founders perceive higher uncertainty when their resources (funds, time, cognitive capacity)

diminish, product complexity remains high, and external feedback is limited or ambiguous. These conditions typically led founders to transition from *integrating* to *leaping* (e.g., case 6). Thus, they gradually abandon their desired holistic mental representation of the future and funnel their action on one fixed goal. Allocating resources to this single purpose reduces strategic alignment of present actions and established organizational structures may be broken up. Contrary, when resources availability increases and external feedback is positive, founders perceive less uncertainty, which may lead them to transition from *leaping* to *integrating* (e.g., case 14). They start to devise mental representations of the future to initiate a more holistic organization development, in which previously unspecific resources take a dedicated function.

> *"Then we said: Hang on, we just got a lot of cash from our investors. If they give us one million, they certainly want to have 10, 20, 30 million back at some point. We won't generate big revenues with a simple [product] like this. So, we thought: Ok, what is our core competence? And then we started building a vision around that—the one we now have. Ideally, you want to start from the vision, and work backward from there, but we just started and then realized: s***, we need a vision, quickly, because our investors provided a lot of cash. Then we started: Ok, we are a data security company, and we will build a comprehensive product suite that protects all your devices and allows multiple additional services. We will be the company that you trust and that makes all your devices safe."* (case 14)

My data also indicate that relying on *integrating* or *leaping* affects organizational performance. *Integrating* positively affects long-term results, while *leaping* causes inconsistent performance outcomes that may be positive in the short-term. Both search modes depict contrary strategies and founders who clearly operate in one mode show higher performance, while choosing approaches simultaneously combining the two lowers organizational performance. However, given the constant uncertainty that affects new venture development, founders benefit from transitions between these modes when their organizational performance decreases. Transitioning between search modes allows them to compensate for encountered drawbacks of each strategy.

Discussion

My aim is to uncover how search under uncertainty affects the emergence of new organizational structure. I have argued that, when uncertainty is high, organizational structure may be treated as emergent instead of existing—as prevalent search theory would suggest. Then, how organizational actors search, determines the emergence of such structures and reduces uncertainties. I found that, without ex ante structure, founders of new ventures demonstrate cognitive biases to reference points in the future or the past to navigate their search in these uncertain settings. When founders draw on a distant future picture of what they aspire, they look backward in time and only apply learning from the past to adjust their representation of the future. Conversely, they look forward in time when they primarily apply what they have learned in the past to produce near future goals for generic guidance. Both biases impact on how organizational structures emerge.

This study makes three contributions. First, by showing how actors actually search, I highlight the importance of time to conceptualize search and provide evidence that this behavioral process should be conceived as less mechanistic (Posen et al., 2018). Instead, when based on beliefs about multiple desirable future states, it is dynamic and results from idiosyncratic human agency. Second, this study underlines the importance of bounded rational actors' cognition to overcome incremental progress and potentially achieve novel outcomes (Gavetti, 2012). Third, with regard to open systems theories more generally (e.g., Thompson, 1967), these findings indicate that actors' perception of their knowledge determines if they consider environments as uncertain.

The Search Process, Cognitive Biases, and Emerging Organizational Structures

The concept of time is central to theories of organizations (Ancona, Goodman, Lawrence, &

Tushman, 2001; Barkema, Baum, & Mannix, 2002; Mitchell & James, 2001) and search in particular (e.g., Gavetti & Rivkin, 2007; Katila, 2002). Yet, it is merely implicit in existing theories that largely focus on search outcomes instead of looking at search processes (Dahlander et al., 2016; Li et al., 2013). By studying organizational emergence, I emphasize the temporal nature of a search process. My insights offer a more detailed picture of search and time, suggesting that founders draw on both, past and future temporal reference points, instead of focusing on only one (Brown & Eisenhardt, 1997). But how they balance their attention varies, which defines their cognitive biases. These biases affect (1) the coherence of organizational structures that founders build, as well as (2) the trajectories of how these structure develop.

(1) With regard to coherence, my findings suggest to inverse the expected pattern of local and distant search and associated organizational development (Gavetti & Rivkin, 2007). That is distant search relates to organizational plasticity (Porter, 1985) and local search to incremental organizational development (Nelson & Winter, 1982). I observe the inverse relationship: cognitive breadth favors specific and incremental organizational development, while cognitive constraints often cause divers and radical organizational progress. By drawing on future reference points, actors seek holistic understanding of how to specify the vague mental representation of their venture. Prior research shows that searching holistically in the beginning may foster the coherence of complex structures (Baumann & Siggelkow, 2012). My findings illustrate how, when searching within broad cognitive boundaries of a relative future, actors have the flexibility to consider diverse but still related strategies and select those that align with their emerging organizational structure. Hence, when searching distant in time they can exploit more. Thus, by incrementally committing resources to related strategies, actors create coherent organizational structures. Conversely, by relying on performance feedback (Greve, 2003), actors target clear improvements of their current strategy, testing one alternative at a time. My findings illustrate how searching this

way creates cognitive constraints. Actors search locally in time and accept any strategy to achieve their aspired, absolute, and near future goal. This strategy may significantly deviate from their emerging organizational structure and, hence, organizational plasticity enables actors to execute radical change. To achieve this change, they reallocate essential resources but cause an inconsistent development of organizational structures.

(2) Instead of searching in two directions (Gavetti & Levinthal, 2000)—forward into the future and backward into the past—I argue that because of their cognitive bias, actors primarily search in one. Similar to Simon's (1996) distinction of stimulus and goal driven systems, I find that actors search forward from past reference points generated from feedback to reach fix near future goals and backward when drawing on distant future reference points that result from foresight. My findings imply that this direction of search affects actors' ability to control the trajectories of how organizational structures emerge and, interestingly, this is rather achieved through searching backward than forward. Control results from the integration of future reference points and the present search process, while past reference points are detached from it. That is, by simultaneously comparing multiple present and future states actors seek matches between them—this integration is absent when actors sequentially refer one present state to one continuously updated future state. Control positively affects linear organizational development, whereas the lack of it results in multi-directional trajectories. In this view, mental representations of the future provide actors with a set of yet not enacted options—multiple unspecified but still probable paths—which they may reinforce when identifying appropriate present solutions. This suggests a potential value of conceptualizing organizational goals as residing in multiple probability states that actors may simultaneously reinforce, instead of one projected state in time (Lord et al., 2015). For future research, this view accounts for goal diversity as a result of environmental uncertainty as well as goal diversity within organizations due to coalition dynamics (Cyert & March, 1963).

Overall, prior arguments suggest that despite high uncertainty—or rather because of it—coherence and control of organizational development may result from human agency. This insight matters because the extensive body of literature on problemistic search renders this process as largely mechanistic (Posen et al., 2018) and hence, actors as overly passive. But with high uncertainty performance feedback is likely ambiguous (March & Olsen, 1976) and thus requires interpretation instead of automatic reactions. Likewise, the practitioner literature recommends rapid trial and error learning to master new venture creation in uncertain settings (Ries, 2011). However, the success of such local search likely depends on the deliberate choice or creation of the search space not merely the recourses to repeating a mechanistic search process. This argument emphasizes human agency and its temporal embeddedness (Emirbayer & Mische, 1998).

Cognition, Foresight, and Semi-structures

Prior arguments stress the importance of human cognition for strategy making (Gavetti et al., 2007; Posen et al., 2018). At the same time, the biases that I find reflect the limits of actors' cognitive capacity, which renders my theorizing behavioral and may be quintessential to understanding search processes in uncertain settings.

I argue that an important middle ground for strategy exists, that resides between approaches that emphasize the need for planning (e.g., Porter, 1980, Brandenburger & Stuart, 1996) and those recommending means-driven action to achieve control (e.g., Sarasvathy, 2001; Sarasvathy, Dew, Read, & Wiltbank, 2008; Wiltbank, Dew, Read, & Sarasvathy, 2006). Especially theories of entrepreneurship question such foresight in new organizational settings, but argue that actors should leverage present resources instead (Baker & Nelson, 2005; Sarasvathy, 2001; Sarasvathy & Dew, 2005). This stream of research, however, is still unspecific about the extent and accuracy to which means-driven actors envision the future and hence how, if at all, they may influence

organizational growth beyond their capabilities of reacting to serendipities. Thus, by integrating cognition to action within the search process, I address critical limitations in the effectuation framework (Arend, Sarooghi, & Burkemper, 2015). While I focus on cognition as the main driver of search, future research may closely study the inverse effect to improve our understanding of thinking and doing in strategy formation (Ott et al., 2017). This notion of a middle ground links to recent advancements in the strategy literature. These are concerned with extending the tenet of incremental progress in behavioral theories rooted in the Carnegie School (e.g., Levinthal & March, 1981; 1993), by moving beyond organizational experience and integrating foresight through cognition (Gavetti, 2012; Gavetti & Menon, 2016; Posen et al., 2018).

Addressing these advancements, my findings indicate that, although uncertainty is high and effective structures should be difficult or impossible to establish ex ante, mental representations of the future provide guidance for search. I argue that they serve as semi-structures, enabling actors to balance clear direction and openness of organizational development (Brown & Eisenhardt, 1997). Typically, we conceive of semi-structures as decision making heuristics generated from past experiences and learning (Bingham & Eisenhardt, 2011; Eisenhardt & Sull, 2012). They offer generic strategic guidance of *what* to do and thus prevent actors from pursuing false developmental routes. The mental representations of the future that I find, complement these prior concepts of semi-structures. They direct actors in *how* to make specific decisions that match the values of their desired outcomes, by informing them about internally consistent choices. We may thus treat cognition as more than "off-line" search that unfolds in parallel or in advance of experience-based search action (Gavetti & Levinthal, 2000: 115). Instead, applying mental representations of the future can enable actors to control their actions in the present and inform organizational development "online" (Ibid).

Drawing on this extended view of semi-structures, can inform our thinking of how to achieve

novel outcomes. Generally, we assume that bounded rational actors produce mental representations of their environment to reduce its complexity (Simon, 1947; Levinthal, 2011). While the accuracy of these mental representations improves decision making (Gary et al., 2012), it gradually favors myopic search and inhibits novelty (Levinthal & March, 1993). However, I find that some actors generate broad mental representations of the future (i.e., future reference points) that are unique and cannot be replicated solely based on objective information of the environment but rest on vision. By drawing on these mental representations, actors can avoid myopia, but act in ways that are impossible or unimaginable to others (Gavetti, 2012). My findings suggest that, to leverage uncertainty by generating novel outcomes, it may be indispensable that actors' mental representations are deliberately vague. Moving beyond my data I can speculate how.

When uncertainty is high, heuristics constitute mental representations that allow actors to simplify decision-making (Eisenhardt & Sull, 2012). That is, actors need less information to quickly identify acceptable solutions in complex environments (Bingham & Eisenhardt, 2011). This focus on the *simplicity* of heuristics is distinct from the *vagueness* that I find in mental representations of the future. Arguably, both concepts provide actors with general structures for search, while excluding information for specific outcomes. But simplistic and vague mental representations have distinct properties that may affect search outcomes. I argue that simplification facilitates average results, while vagueness enhances the likelihood of novel outputs. I suggest that this distinction roots in the origin of the information that form each mental representation: one is (1) past- and one is (2) future-based.

(1) Typically, the literature conceptualizes heuristics as learned through experience (Newell & Simon, 1972). Actors perceive of the knowledge that forms such heuristics as valid and thus as providing reliable decision rules. Once they execute particular heuristics, they run a deductive

problem-solving process within established boundaries (Simon, 1973). Acceptable decisions are likely structurally similar to previously successful ones (i.e., 'do what we did last time to solve a similar challenge'). For example, when expanding beyond one country, actors replicate the pattern of former positive markets entries (Bingham & Eisenhardt, 2011). Hence, heuristics are generic and favor conservative action (i.e., local search) while constraining the exploration of novel alternatives. They constitute coping mechanisms to select good enough alternatives that ensure survival in the face of uncertainty (Grandori, 2010). For example, within the effectuation framework, actors apply decision-making heuristics that focus on available means to ensure control over organizational development (Sarasvathy, 2001). While this procedure may provide ventures from failure, the theory is quiet about how to create innovative businesses that are potentially novel.

(2) In contrast, mental representations of the future constitute desired outcomes that lack the certainty of experience-based heuristics. Actors draw on hunches and ideas that are vague. These mental representations are unspecific and allow for variance of potential outcomes, but they are still specific enough to support strategic decisions. Contrary to heuristics, however, vagueness means that these mental representations likely contain "inaccurate perceptions" (Sutcliffe, 1994: 1374), which can trigger actors' doubt about which solution actually represents their desired outcome. The resolution of this doubt may be a powerful trigger for search and explain how actors can overcome myopia to generate novelty.

To alleviate doubt, actors may articulate guesses through hypothesis and validate them. These hypothesis capture their assumptions of how current opportunities relate to alternative futures and thus represent satisfactory search outcomes. In this view, future exists in multiple probability states in the actors minds, which they can enforce by linking them to present opportunities (Lord et al., 2015). The vagueness of their mental representations reflects in the

variance of goal definitions that offer new perspectives for evaluating opportunities (Adner & Levinthal, 2008). Instead of offering generic guidance through simplification (i.e., heuristics) these goal definitions are generative (Locke et al., 2008; Zittrain, 2006). Because present opportunities and desired outcomes are both flexible, actors can create diverse links (i.e., hypothesis) between them and establish new value dimensions. Therefore, this abductive process (Peirce, 1878; Dougherty; 2016) can lead to structurally novel outcomes. It is contrary to searching with a fixed mental representation (i.e., a specific goal or generic heuristic), where actors always evaluate opportunities to the same value dimensions—outcomes only vary along these established dimensions.

Further, alleviating doubt potentially requires actors to generate, test, and compare various alternative hypothesis. This may be a lengthier process than finding a satisfactory solution that structurally resembles previous ones. Spending more time on this search process may generate hypothesis along multiple value dimensions that are not easy to compare. This could delay satisficing behavior when assessing confirmed hypothesis and favor potentially better outcomes.

Current literature presents analogies as particularly powerful heuristics (Gavetti et al., 2005; Gavetti & Menon, 2016). In this view, they still constitute coping mechanisms that provide approved search frameworks. My findings, however, allow for a complementary view that underlines the generative potential of analogies for search. I suggest that when actors draw on analogies that illustrate desirable futures, instead of resting past experience, they may trigger their imagination and association. They enable an associative process in which actors generate and test hypothesis of how to actually represent these analogies. Beyond my sample, a related example form the fine dining industry illustrates this argument. The three-stared celebrity chef Heston Blumenthal and his team famously create their highly innovative dishes—featuring unique ingredients and science-based production techniques—by starting from Blumenthal's childhood

memories (BBC, 2017). These memories serve as analogies to be captured in the aspired dishes. Alike, Steve Jobs utilized his admiration for calligraphy as one guiding heuristic in the development of Apple computers, which clearly set them apart from its competitors.

To summarize, by mirroring uncertain environments through vague mental representations actors embrace uncertainty. This seems favorable for generating novel outcomes which result from linking aspects of a desired but vague future state with present representations of it. This view of search is less mechanistic than traditional models where future states are clear and fixed, but it requires agency through which particular present solutions are constantly aligned with aspects of an emergent future goal. Following this argument, our current view of satisficing behavior as central to classic search processes (i.e., actors accepting an alternative solutions if it meets a pre-determined goal) may be too static (e.g., Gavetti, 2012). This view focuses on actors cognitive limitations of screening choices but it neglects that actors may (need to) stretch their cognitive bounds when creating novel outcomes.

Perception, Beliefs, and Uncertainty

Finally, the cognitive biases I find represent actors' beliefs (March & Olsen, 1976) and ontological assumptions about knowledge. That is, despite uncertainty, founders' perception of what they know varies between search modes and hence determines the knowledge they seek. When biased toward the future, founders belief to know something ex ante and search to find related knowledge. Contrary, when biased toward the past, founders belief to know nothing ex ante—ultimately any knowledge could be relevant. What founders belief to know affects their perception of uncertainty. Interestingly, founders who rely on vague future pictures seem to perceive less uncertainty than those who intend to improve existing offers. This reverses the prevalent notion of temporal organizational structures (Orlikowski & Yates, 2002; Reinecke & Ansari, 2015),

indicating that we may associate relative concepts of time with an enhanced perception of certainty and control, instead of linking it to absolute concepts.

Actors with any of the cognitive biases benefit from their temporal reference points to navigate their search and evaluate knowledge of their search space (Newell & Simon, 1972). Although any temporal reference point still provides largely unspecific guidance, future reference points seem to offer more direction. They enable actors to investigate a smaller search space in depth, instead of extensively searching a broader one. That is, actors rely on a set of explicit but qualitative measures as opposed to generic quantitative ones. Thus, while under uncertainty some structure should be better than none (Clement & Puranam, 2017; Davis et al., 2009), its utility may differ. Until uncertainty decreases, actors may benefit from cognitive structures that significantly reduce their search span (Gavetti & Levinthal, 2000), and conversely should avoid those, that provide multiple promising starting points for search.

Further, these insights complement core assumptions about the objective properties of uncertain environments in open system theories (e.g., Thompson, 1967). My findings suggest that actors' perceptions of such settings are important too, because objectivity may be difficult to attain. It is widely acknowledged that environmental clues may be ambiguous and thus require interpretation (March & Olsen, 1976; Posen & Levinthal, 2012), and that subjective perceptions of uncertain environments may constitute a sound basis for decision making (Puranam & Swamy, 2016)—even for generally objective actors. Yet, this duality of environments as objective and perceived has largely been neglected. When uncertainty is high, actors may achieve (bounded) rational decisions (Grandori, 2010) rather by following what they perceive, to create internal consistent decisions, instead of relying on potentially defective objectivity. Thus, relaxing the notion of objective environmental properties extends our understanding of bounded rational decision making (Simon, 1956). That is, variation in actors' search outcomes may not just result

from the environmental properties that they attend to, but also from their diverse perceptions of even identical ones.

4 Designing organizations for abstract goals

The study forming this chapter was accepted for publication in the Academy of Management Discoveries. To respect the copyrights of the journal, I will only provide an abstract of the paper here. Please find the original manuscript attached in the Appendix B (p. 142).

Majchrzak, A., Griffith, T. L., Reetz, D. K., & Alexy, O. 2018.
*Catalyst Organizations as a New Organization Design for Innovation: The Case of Hyperloop Transportation Technologies. **Academy of Management Discoveries**. 4(4):472-496.*
https://doi.org/10.5465/amd.2017.0041.

"Some problems are so complex that you have to be highly intelligent and well-informed just to be undecided about them."
(Laurence J. Peter)

Abstract

Common goals are central for organizing actors. They allow to specify and allocate tasks to ensure directed efforts. However, as I have illustrated in previous chapters, under uncertainty we can conceive of organizational goals as emergent and determined through the organizational search process. Thus, a critical question remains how actors can organize search processes based on goals that are initially abstract and hence deliberately design an organization capable of embracing uncertainty? In a collaborative effort, I empirically investigate this question by studying Hyperloop Transportation Technologies (HTT), a crowd-sourced organization with constantly joining contributors, who shape the development of a new, commercially viable technology ecosystem. Based on extensive field data, we find a form of organizing that builds on a non-modularization of tasks and constant exploration, which allows for a continuous redesign. We label this organization design a *catalyst organization*. Our insights shed light on organization designs for innovation activity that lie at the intersection of environmental uncertainty and an unlimited supply of external knowledge. We contribute by explaining how these two contingencies for organization design, that have been mainly considered independently before, can be fruitfully integrated.

5 Toward *Marchian* foolishness: theorizing exploration

> *"The ability to forget, or overlook, is also useful. If I do not know what I did yesterday or what other people in the organization are doing today, I can act within the system of reason and still do things that are foolish."*
> (March, 1988: 263)

Theories of search in the tradition of the Carnegie School are concerned with how most organizational actors behave. They focus on human actors cognitive limitations that prevent rational decisions, and, by conceptually creating a small and comprehensible 'world,' maintain an inferential logic (i.e., deduction: *what must be*) such that bounded rational decisions remain possible (e.g., Cyert & March, 1963; March & Simon, 1958; Simon, 1947). These theories are fundamental to the field of management. They emphasize organizational goals as central to collaborative and purposive action in order to achieve improvement and exploitation within existing structures. However, this perspective leaves the inventive side of human actors and how they explore a principally endless 'world' to creating new structures largely unnoticed. As such, current theories of search are limited in fully accounting for those actors who generate truly novel outcomes.

In this thesis, I am concerned with theory that explains how this (presumably smaller) group behaves, which however can be considered responsible for initiating radical innovations or business ventures that in turn may lead to the formation of new industries or markets; resulting in a disproportional creation of value. Drawing on my findings of previous chapters I suggest—and will develop below—to build such theory on a logic of *what might be* (i.e., abduction: Peirce, 1878) and 'foolishness' as a form of organizational intelligence (March, 1988; 2006).[33] Further, I

[33] My argument echoes concerns about management practice in the popular practitioner literature (Kim & Mauborgne, 2005; 2017). I am not questioning the importance of balancing explorative with exploitative modes of search (March, 1991) or I imply to abandon the latter.

integrate concepts from design (e.g., Buchanan, 1992; Cross, 2007; Dorst, 2006), political science (Rittel & Webber, 1973); and economics (e.g., Langlois, 2007; Loasby, 2001; Shackle, 1979).

Both perspectives are complementary. While they rest on behaviorally plausible behavior of human actors, the first can be conceived of as effective in environments that are largely stable and continuously evolving as compared to the second, which I argue, is necessary in uncertain, ambiguous, and emerging environments (e.g., Dattée et al., 2018; Santos & Eisenhardt, 2009). This means to *"take uncertainty seriously"* (Alvarez et al., 2018: 169). It requires an understanding of how organizational actors may embrace uncertainty instead of coping with it and a major shift in theories of organizational search and structure in the tradition of the Carnegie School, which fundamentally build on uncertainty avoidance. It demands treating uncertainty beyond exclusively related to search outcomes, like when building on an inferential logic, but it means to account for uncertainty as the contextual characteristics that actors have to deal with initially.

My focus in this thesis is on the inclusion of the uncertainty construct into theories of organizational search and structure. First, this allows to advance our understanding of explorative types of search, in particular, to conceptually account for more than organizational survival and novelty as a serendipitous outcome. Second, I suggest to view exploration per default as search under uncertainty, instead of through a 'problemistic lens.' Further, I argue that studying how actors embrace uncertainty allows us to understand how they are actually search*ing.* This largely remains a black box in extant search theory (e.g., Dahlander et al., 2016; Li et al., 2013; Maggitti, et al., 2011) and it is of major interest to this literature (Posen et al., 2018). But, as I have discussed throughout this thesis, this literature assumes that actors effectively operate in a world in which uncertainty is absent: search is problem-driven (i.e., problem-solving), which means that goals can be quantified, decisions can be made through inference (e.g., exploitation), and their

achievement can be measured. Without uncertainty, however, computation seems an appropriate and sufficient conceptual description of search*ing*. Human behavior is constraint to defining the necessary inputs (i.e, a search space or starting point on it) to initiate a computational procedure as well as assessing the output of this process. Recent calls for a richer cognitive model of such problemistic search models (Posen et al., 2018) suggest that through cognition, actors could augment this process (i.e., the inputs) in order to discover novel solutions (i.e., which are more distant: Gavetti, 2012). Reaching beyond such views, I argue that understanding how actors actually search is only interesting, when it is related to variability in (searching) behavior, which means conceptually leaving a computation of choices as the main explanation. While this, as I will elaborate below, involves cognition it first of all requires uncertainty as a precondition to escape a logic of reason. Thus, I will refer to the concept of *embracing uncertainty* in terms of exploration (search).

Embracing Uncertainty as a Concept of Exploration

I have suggested that embracing uncertainty requires to conceptually account for both assumptions about uncertainty: the common one about the inability of predicting future consequences of choices *and* the often neglected one about predicting future preferences (March, 1978). Including variable preferences (values) into a theory of search—such that actors can consider preferences and choices independently and simultaneously—allows to extend the narrow focus on human actors' cognitive limitations in computing alternative choices (based on fixed preferences; as defined in models of the Carnegie School), toward their ability to pursue novel goals. While the search literature acknowledges that actors may search for mental representations of new value dimensions that are distinct from dominant ones, it maintains that simultaneously considering such representations and alternative choices is irreconcilable (Csaszar

& Levinthal, 2015). A longstanding question remains how to search for truly novel goals without assuming some already existing higher-level goals to guide this process, which in turn would object the very idea of novelty (March, 1988). I have proposed a conceptual shift in common models of organizational search and structure to resolve these issues.

First, this requires a shift in the view of structure: from something that exists prior to search to something that emerges through searching. In this altered view, structure is an artificial product that actors create in a design process (Simon, 1996); such as when elaborating a new strategy, developing a new technology, or building a new organization. Building on the design literature, I suggest to treat the uncertain contexts in which these inventive processes take place as *indeterminate* (e.g., Buchanan, 1992; Rittel & Webber, 1973). Indeterminacy is distinct from undetermined (Buchanan, 1992). Undetermined refers to the established assumption that definite conditions exists to describe any structure, which means that with sufficient computational power they can be analyzed and defined. This is evident throughout Simon's work (also that related to design). For example, the idea of root causes in the problem-solving literature rests on this assumption (e.g., Baer et al., 2013; Simon, 1973). In comparison, indeterminacy relates to what Rittel (e.g., 1992) calls 'wicked problems,' which have no subject matter in itself except from what actors involved in 'solving' them conceive it to be. This is not to imply that nothing can be known about an indeterminate context, but rather that what needs to be known cannot be analyzed independent from simultaneously determining the subject matter through linking specific preferences and choices (i.e., representing many valid root causes) and thereby creating structure (Buchanan, 1992; Rittel & Webber, 1973). This view of organizational structure as emerging from indeterminate contexts provides the conceptual foundation for the shift of how actors can search beyond a sequential computation of choices.

Second, I have hence suggested that when actors embrace uncertainty, preferences are variable and searching means to simultaneously consider reasonable or desirable preferences and related choices together. For example, actors can search for two unknowns when conceiving of causal links between problems (i.e., preferences) and solutions (i.e., choices) (see chapter 2), or between a mental representations of a desired future and current opportunities when building a new start-up (see chapter 3). Thus, searching changes from a deductive computation of alternative choices to an abductive process in which actors associatively generate causal models of a specific indeterminate context. Rather than based on environmental contingencies (e.g., Cohen et al., 1972; von Hippel & von Krogh, 2016) these causal models constitute deliberately formulated hypothesis. It has been argued with regard to economic decision making that constructing explanations based on currently held knowledge are more likely to yield valid results for a novel and uncertain context than if treating such a context as representing a known problem and applying an already constructed solution (Grandori, 2010).

By moving from a deductive to an abductive process and thus fixed to flexible preferences, I explain variability in searching behavior, which I argue is essential for conceptualizing exploration. While fixed preferences are needed for (bounded) rational decision-making, considering preferences initially cannot be a rational procedure. As March (1988; 2006) has persuasively argued, it is not rational to act so when it is in fact impossible (i.e., under uncertainty). Instead, organizational intelligence can result from accepting the temporal relaxation of an inferential logic of decision-making (based on fixed preferences) to enable foolishness and play (March, 1988): human actors are fairly good at making the most of what they can conceive through imagination (Shackle, 1979; March, 1995). As I have discussed in chapters 2 and 3, through imagination they can explore preferences independently but also linked to possible solutions (existing or new). Thus, through variable preferences actors can create new

choices like in a puzzle. While the established view in innovation is that novelty results from (re)combination (e.g., Salter & Alexy, 2014), I argue that it matters what is (re)combined and hence, what is variable: choices only or choices and preferences. I argue that true novelty (e.g., radical innovation) is the product of previously non-existent preference-choice links that result from the latter (e.g., new technologies linked to unnoticed human needs). Such links can be considered as truly novel because they cannot be realized through (even distant) landscape search (Felin et al., 2014), but rather constitute previously unnoticed dimensions of a landscape (Adner & Levinthal, 2008).

However, while actors may continuously imagine new preference-choices, imagination is constraint by their knowledge and what they can possibly conceive, as well as what they will consider as reasonable in a given uncertain context (Shackle, 1961; 1983; 1986). Thus, while imagination is not (bounded) rational, it is not purely fictional or even random either (March, 1988). I have elaborated that this assumption spares the existence of meta goals to provide guidance for direction or selection of alternatives (Ibid). Because the subject matter of an uncertain contexts is yet to be determined, actors cannot share anything apart from the doubt about the search outcome. In turn, I have argued that this doubt triggers their idiosyncratic imagination and thus the generation of multiple preference-choice pairings. These pairings can be complementary and address different but potentially valid cause-effect relationships. The task is one of integrating values toward a resolution. For example, this is evident in both empirical findings presented in chapters 3 and 4: the founders who seek to implement diverse but vague mental representations of their venture or the organization of HTT in terms of diverse but relevant aspects to develop their technology. The design literature provides a conceptual foundation for a search process through which actors can link discourses and integrate values (e.g., Buchanan, 1992; Cross, 2007; Dorst, 2006). A related literature on team creativity also

supports the argument that integrating instead of selecting among alternatives is conducive for achieving novel results (Harvey, 2014; Harvey & Kou, 2013).

Following my argument, I suggest to think of search*ing* as an inventive activity through which actors generate instead of analyze knowledge. This is not about making present choices based on assumptions about future consequences or preferences (March, 1978; 1988). But searching constitutes a purposive exploration of possible causalities. It relates to present preference-choices and whether they are desirable to be realized, instead of considering whether future consequences or preferences will occur. The latter is an inappropriate concern, given that the future will be created through search for a structure that does not yet exist.

In sum, focusing on choices only is a view that is logical for exploitation, but it is not so for exploration. Instead of alternative choices only, I suggest to conceptualize exploration with regard to alternative preferences also. This argument links to the practitioner literature in terms of how to escape established and competitive markets and instead create new ones (Kim & Mauborgne, 2005; 2017), as well as the benefits of applying design thinking (Martin, 2009).

Exploration as an Inherently Agentic Process

The concept of embracing uncertainty provides explanations for an explorative search process through which actors generate novel outcomes, beyond relying on serendipity and luck.[34] It is not the question if novel outcomes, in fact, can be planned or future outcomes guessed correctly: judgments about future outcomes in the presence of uncertainty are inevitably shaped by luck (Knight, 1921). Even when knowing outcomes, these can often be ambiguous (Alvarez et al., 2017).

[34] I do not exclude serendipity in general, but I also do not rely on it to explain how actors acquire novel outcomes.

However, the inability to assign probabilities to outcomes does not mean that conjectures need to be generated at random. While acknowledging that the outcomes remain uncertain, I argue that it remains useful to theorize how searching for them unfolds through the systematic construction of conjectures. Thus, judgment under uncertainty is central to the reasoning process that underlies the formulation of abductive hypothesis (e.g., Magnani, 2001): the linkages of specific preferences and choices that might lead to achieving a certain outcome. This is not about actors guessing outcomes correctly, but about actors explaining why a particular hypothesis constitutes a plausible conjecture in a setting of uncertainty (what the design literature labels a specific puzzling incidence (e.g., Schön, 1983)). The role of hypotheses in abduction, which underlies my theorizing, is different to deduction, which I have extensively argued current theorizing in the tradition of the BTOF builds on. This difference relates to what Peirce (1931-1958) refers to as a reasoning process that one makes *from* a hypothesis (deduction) as compared to one that is directed *to* a hypothesis (abduction). In deduction, the main interest is in whether to accept a hypothesis (i.e., is it supported or not): deduction looks at probability judgments in settings of risk and is concerned with future outcomes being true or not (Grandori, 2010). In abduction, the interest is in why a particular hypothesis matters in the first place and the process through which (and why) it is suggested: abduction looks at value judgments (in settings of uncertainty) and is solely concerned with how plausible (and desirable) a certain outcome may be (Ibid). In abduction, the assumption is that a hypothesis does not simply follow from what is known, which provides room for novelty. This pragmatist view of judgment allows to distinguish between the *"concrete ends that actors pursue in their action from the results of these actions"* (Dittrich & Seidl, 2018: 114).

Linking to chapter 2, an example of this logic is, in fact, me writing this very thesis: given my intention (i.e., abstract goal) to develop novel theory, I am facing uncertainty of what this

theory would be. Initially, I did not know if the argument that I was pursuing would receive a positive evaluation. Still, I tried to construct it in a way that it linked to existing knowledge in the search literature (i.e., solutions) and to relevant questions still open in that literature (i.e., problems), so that the emerging theory (i.e., new knowledge structure) I was heading toward would consist of interesting arguments (i.e., problem- solution pairs; plausible hypotheses) that were internally consistent (i.e., coherent links). In this purposeful creation of my theory, judgment was about what to write and how and why it would matter. A similar process is for example Weick's (1989) description of theorizing as disciplined imagination. I argue that judgment and abduction are essentially the mechanisms behind that process.

My argument contains some interesting parallels to judgment in the entrepreneurship and economics literature, such as the work by Langlois (2007), Loasby (1976); Packard, Clark, and Klein, (2017), and Shackle (1972). All these authors would agree that deduction is limited in its power to explain novelty and that, under uncertainty, opportunities should rather be seen as created than discovered (e.g., Alvarez & Barney, 2007; Langlois, 2007; Loasby, 2001; Packard et al., 2017; and Shackle, 1979). I go beyond what these authors have already said. For example, while Foss and Klein (2012) discuss judgment as well as individual attributes such as heuristics and skills as its micro-foundations, they do so almost exclusively through the lens of economics, which we extend by also working with the literatures on abduction and design. They describe in abstract terms that opportunities are somehow created through judgment, while I present an organizational search process that explains how.

The formalization of behavior and thus computation are central to Simon's contribution to organizational decision making (Simon, 1947; March & Simon, 1958) and a science of the artificial (Simon, 1996). He applied scientific principles and pursued formalization to describe human behavior, and harbored a dislike for arguments that promoted individual human agency

(e.g., judgment), which he considered *"intellectually soft, intuitive, informal, and cook-booky*" (Simon, 1996: 112); such as pragmatism (for a detailed discussion: Cohen, 2007) and many approaches to design education (Simon, 1996). However, staying close to Simon's argument on how to handle ill-structured problems (1973), in fact, by taking it seriously, the role of the problem-solver and thus human agency becomes evident. In his theory, problem solvers decide which existing mental representation to apply from their memory to interpret and handle an ill-structured problem. These decisions need to be idiosyncratic until a problem can be considered well-structured, such that any actor could clearly identify it. During this process, multiple interpretations and applications of mental representations determine the search path.

Human agency through value judgments. In this thesis I have made an argument for complementing mechanistic views of search instead of further supporting it. Despite moving from scientific management principles (Taylor, 1911; Urwick, 1956) to accounting for human characteristics of organizational actors (i.e., their bounded rationality: Simon, 1947) the Carnegie School (March & Simon, 1958; Cyert & March, 1963) maintained the machine metaphor of how organizations work: *"the machine analogy has been updated from a laboring machine to a computing machine."* Kilduff (1993: 28). Human actors brains are treated as if they are functioning like computers, which can be programmed to react to stimuli of the environment (March & Simon, 1958). I argue that going beyond this view matters, especially with regard to artificial intelligence where this analogy is particularly obvious but misleading. Instead of adapting actors to machines, I suggest to make actors more human.[35] Thus, instead of addressing the weaknesses of human agency, I suggest to focus on its strength. The emphasis on agency and

[35] Drawing on abductive logic (e.g., Peirce, 1878) I have shown that this does not mean to leave the realm of science.

judgment is hence not to be misunderstood as directed against artificial intelligence, but rather as necessary to distinguishing the two forms of intelligence and the types of search they inform.

First, human agency as compared to a computational approach provides an explanation for how actors can address the challenge of leveraging the generative potential of doubt to create novel outcomes. Actors experience doubt when many answers and even questions regarding the future are uncertain, ambiguous, or do not yet exist. The crux is to reduce doubt in order to work toward an outcome, while at the same time preserving doubt to keep the outcome open (especially initially). This challenge is core to embracing uncertainty and in the prowess of human agency. On one hand, referring to Locke et al. (2008), it is a human strength to sense doubt as an unsettling feeling that actors are inclined to reduce and which they can use as a (generative) trigger for search. *"The physical feelings of doubt are signals that we have some work to do."* (Locke et al., 2008: 913). Thus, doubt allows for new explanations (e.g., *"performance potentials;"* Grandori, 2010: 487) and unlike simply being resolved (like solving a problem), doubt is generative if the response to it is abductive instead of deductive reasoning (Locke et al., 2008). On the other hand, satisficing heuristics as stopping mechanism are inappropriate as they would require actors to have adequate representations of the uncertain search outcomes ex ante—although these representations would be simplifications, they still would need to be adequate (Loasby, 2001). However, the knowledge to form such representations is only created through the search process.[36] Thus, in theory, stopping search would result from running out of resources. What I have shown through my empirical insights is that actors will seek better hypothesis to resolve their doubt and stop searching because they run out of

[36] If stopping rules existed before, they would not lead to novel outcomes, but resemble what I am referring to as coping with uncertainty (i.e., relying on pre-established mental models; as also described by LeRoy & Singell (1987) in terms of individual actors; see also chapter 2). Thus, while satisficing certainly is one stopping rule under uncertainty, and I agree that the creation of new knowledge structures does not exclude bounded rationality, I maintain that a stopping logic should be distinct from satisficing heuristics.

alternative hypothesis (chapters 3 and 4). Actors rely on value judgments of individual hypothesis, which spares prior cirteria for assessment and is ultimately agentic—as compared to satisficing heuristics that root in probability assessments. Value judgments relate to a stabilization of the created structure (e.g., business model, product), such that further search is not assumed to change it (Grandori, 2010). Here, the assessment to stop searching is not related to a prior (simplified) representation of potential outcomes, but solely made in terms of what may be additionally created and if this would add value. Thus, through value judgments, actors seek the best possible explanation despite their cognitive constraints, instead of selecting the first sufficient one because of these limitations (when satisficing).

Second, I suggest that value judgements are not merely about what is plausible but they also require responsibility in terms of what is sought. This is especially important when it has a significant impact on many people; such as when tackling societal challenges such as, for example, digitalization, ecology, and healthcare (e.g., grand challenges: Ferraro et al., 2015; George, 2014; George et al. 2016; Grodal & O'Mahony, 2017). The area of social and sustainable entrepreneurship seems hence particularly suitable for an application of the conceptual ideas of this thesis, given the salient role of human actors in creating good (e.g., Muñoz & Cohen, 2018; Tracey & Scott, 2017). Further, I refer to responsibility with regard to the application of popular frameworks for new venture creation (Blank & Dorf, 2012; Ries, 2011). While promoting a better understanding of users in these frameworks is a valuable route and in line with the design literature that I draw on for my argument (e.g., Cross, 2007), this should not be misunderstood as transferring agency to users such that, in fact, they will decide what is created. In my empirical findings this notion is salient for the founders who search in what I label ‘leaping mode’ (see chapter 3). Although feedback on hypotheses matters, responsibility means that founders are in charge of judging what is needed and why in the first place. In the face of novel and complex

solutions this agency seems particularly important, given the sheer amount of configurational options of potentially viable hypotheses (Camuffo, Cordova, & Gambardella, 2017) and that feedback is often ambiguous (Alvarez et al., 2017).

The Cognitive Foundations of Exploration

Following previous line of arguments, one implication is to treat agency and explorative search as first and foremost originating in actors' cognition (i.e., "thinking"). However, prevalent explanations for agency in exploration that closely build on actors' computational constraints of anticipating novel outcomes, ultimately rely on action (i.e., "doing"). I generally agree that a mindset of less planning—as common in entrepreneurship theory and practice—is desirable and practical in uncertain contexts, but I do not agree to mainly rely on action (e.g., Baker & Nelson, 2005; Sarasvathy, 2001) and rapid trial-and-error learning as an explanation for agency (e.g., Blank & Dorf, 2012; Ries, 2011)—especially when novelty is concerned. Drawing on the philosophy of science, I maintain that any deliberate action requires prior hypotheses (Peirce, 1957; Popper, 1963).[37] While agency can be observed in terms of action, first the question of what will be tried out and why needs to be answered, which suggests a conscious and cognitive process. Thus, I argue to either feature cognition more centrally in explanations of actors' agency under uncertainty or to remain limited to explaining novelty in terms of random events.

While cognition gradually disappeared in later writings of the Carnegie School (from Simon (1947) to Cyert & March (1963)), this view has increased its importance in strategic management, where recent calls for research are concerned with a more detailed understanding of actors' mental representations—that addresses cognition beyond the basic assumption of bounded rationality (Gavetti, 2012; Posen et al., 2018). However, most perspectives still focus primarily

[37] This need not require prior goals.

on how actors bypass their computational limitations and augment their search process on existing solution landscapes via superior mental representations (e.g., Csaszar & Levinthal, 2015; Gavetti, 2012; Gavetti & Levinthal, 2000; Gavetti & Menon, 2016). This augmentation allows actors to reach more distant solutions (Gavetti, 2012) but also to recognize near ones that they previously left unnoticed (Csaszar & Levinthal, 2015). Central to these views is that actors need to select potentially useful mental representations (e.g., analogies) from their past knowledge in terms of their fit with the current context (e.g., Gary et al., 2012; Gick & Holyoak, 1980).

Yet, with regard to novel and uncertain outcomes, it remains unclear how such fit can be assessed and thus, despite inductive insights (e.g., Bingham & Eisenhardt, 2011), we still know little about why actors select particular mental models. Further, if fit can be established, how can the respective mental representations still lead to novel outcomes other than through luck? My findings suggest to question assumptions about this striving for accuracy of mental representations (and fit) when organizational goals reach beyond survival. Instead, I argue that in order to achieve novel outcomes, actors should aspire less fit in favor of abstract mental representations. In my empirical findings in chapters 3 and 4, I illustrate how vague mental representations of a future goal can provide guidance while supporting generativity. For example, instead of fixing the problem and solution space, abstraction maintains two flexible entities from which actors can continuously match elements (i.e., consider current opportunities for the vague future goal that in turn advances through this process and likewise influences which future opportunities may be considered). This keeps the problem or the solution space open and allows actors to generate multiple and divers matches.

I suggest to extend the prevalent view of cognition in strategic management that constrains organizational actors to *select* existing mental representations in order to augment their bounded cognition. I present cognition as a powerful tool for *creating* mental representations, which

means decoupling it from what actors cannot know and tying it to what they want to know. My argument reaches beyond altering search between problem representations or choices (Csaszar & Levinthal, 2015). While this assumption provides some space for variance in search outcomes, it still assumes that actors can select existing mental representation through which they can detect novel choices. Recent theoretical arguments, offer a more holistic view that resonates with the gist of my argument and mental representations as created. These arguments focus on the theories that organizational actors hold about their environment and that provide a lens through which they search (Felin & Zenger; 2009; 2017). Importantly, it is the assumption that actors create, corroborate, and also constantly advance their theories in order to generate new insights (also see March, 1988). I have suggested abduction as a cognitive process through which actors can generate initial hypothesis toward new theories, which in turn can be considered as central to value creation (Felin & Zenger, 2016).

This dynamic characteristic of theories corresponds to the concept of cognitive frames as constantly negotiated perceptions of an uncertain setting (Kaplan, 2008). But it is distinct from the static frameworks that heuristics provide. When applying heuristics, actors draw on fixed mental representations that only allows for (some) variation of the inferred action (e.g., Bingham & Eisenhardt, 2011). While heuristics constitute a mechanism to explain some modification of organizational action, like routines, they are idiosyncratic concepts that ultimately rely on mental models that actors learn through experience. Therefore, heuristics are insufficient to account as behavioral strategies: generalizable mechanisms that explain a modification of organizational action; such as problemistic search (Greve, 2013). However, I can inform this stream of research, by presenting evidence for a generalizable mechanism (i.e., 'integrating'; see chapter 3) that illustrates the interplay of cognition and action in exploration. Instead of restoring performance

relative to an organizational goal, the mechanism I find leads actors to generate hypothesis by matching dynamic mental representations and available opportunities.

I conclude that without clearly conceptualizing the cognitive dimension of a creation process, agency through action must be viewed as simplistic and reactive at best (e.g., Miner et al., 2001), providing weak explanations for how novel and complex outcomes (i.e., departing significantly from status quo) can be realized (also see Camuffo et al., 2017; Levinthal & March, 1993). Thus, a focus on action represents an embarrassingly limited view of agency that builds on the constraints of actors' cognition (e.g., Sarasvathy, 2001; 2003; Sarasvathy & Dew, 2005). In comparison, the view that I suggest emphasizes the potential of human cognition to foster creativity, imagination, and deliberate action—despite these limitations (Felin & Zenger, 2017; March, 1988; Shackle, 1979). It is a bold rather than timid view of agency. Based on this view, I suggest to understand creation processes (Alvaraz & Barney, 2007) in terms of cognition rather than action (first).

My endeavor to extend the basic concepts of organizational search and structure from the Carnegie School led me back to its rich intellectual foundation. My findings connect to the 'Neo Carnegie' perspective in management (Gavetti et al., 2007) that (re)emphasizes the importance of (1) decision making, (2) cognition, (3) loosely coupled systems, and (4) an integration of multiple theoretical perspectives. First, by accounting for uncertainty I actually contextually situate search and put decision making, as a means of tackling it, center stage. Second, I introduce abduction as a fundamentally cognitive process of a theory of search that reaches beyond computation and which can explain exploration for original outcomes. Third, my insights into 'catalyst' organization designs (see chapter 4) incorporate and extend ideas of loosely coupled systems (Cohen et al., 1972). I suggest loose coupling as a structural feature that facilitates actors' deliberate action to create choices by leveraging environmental uncertainty and unlimited

resources, instead of assuming that such choices result from the serendipitous appearance of problems and solutions. Fourth, the Carnegie School was built on the belief that understanding organizations required an integration of multiple perspectives (Gavetti et al., 2007); integrating literatures from organization theory, strategy, design, entrepreneurship, economics, and innovation, I develop theory on search under uncertainty that resonates with this tradition.

Appendices

A—Data and methods (chapter 3)

Integrating Mode: Exemplary Case Insights

Exemplary Development in Integrating Mode: Case 4—Craft Brewery

	Product	Firm Structure	Performance
Phase 1	The students Will and Harry live in the same dormitory. They love beer and they experiment with producing their own. For them, it is a new experience rather than a serious activity. *"When we were in the third year at university, we bought a home brew kit just as a bit of fun. We did a couple of brews in it and that was it really. […] we just sort of both left uni and put it to bed."* After finishing their undergraduate studies in fall 2012, Harry starts working in a corporate firm, while Will continues with a Master, where for the first time he thinks about making a business out of the beer idea. *"Why don't we make a beer especially for students?* The idea: combining the flavor of ale and the fizziness of lager, to create a younger generation beer. In Fall 2013, they launch their first two beers.	While Harry works for an insurance company, Will studies a Master Program in entrepreneurship, where he is surrounded by people talking about business ideas and starting new firms.*"I was indulging myself in all things entrepreneurial."* Encouraged by his lecturer, who suggested to start businesses in areas of interest, he recalled his brewing experience. *"It was a process of two or three months. I first had the idea and then I started looking into it and I got a bit excited about it because nothing else like this was happening."* Will develops a business plan to specify the idea and enjoys the positive atmosphere in his course. *"The encouragement from staff and the work within the community meant being more confident, being more sort of: oh this will work. […] It was literally like, yes your hands are being held. It breaks down the barriers in your head to stop you from doing it. It almost feels like a safe environment […] they helped us to get confident, helped us start making these big steps, to start looking into it and then yes. I rang [Harry] … 'Sort of imagine…' 'Yes, yes, I think this could work'. You're so naïve at this point."* In 2013, In fall 2013, Will finishes his Masters and Harry leaves his corporate job, together, they found a brewing company. They lack experience and resources, but find a small local brewery to work with and produce their first batch of beer. *"It's quite naïve to try and get into the beer industry, with two home brews under the belt … we came into the industry pretty blind but we've picked it up as we've been going along really. […] the brewers we were with were, I don't know why they did it actually, but they were very good for us and they helped us a lot. And they always held our hand through this whole thing. […] we've been lucky, the people we've met have given help and advice."*	The development is positive. Will and Harry turn a student idea into a concrete business, which they found with 15,000 Dollar capital from a governmental start-up loan. They have an initial business plan of how to approach their venture and developed their first recipe. Further, they convince an established brewery to use their facilities to produce a first batch of beer, which they are able to sell. **Assessment: 3.5/5**
Phase 2	After testing the first batch of beer in late 2013, Will and Harry increase capacity and seriously start their craft brewery in 2014. They now offer a range of three beers for the younger generation (25-35) *"… we want to make a cool and easy drink. You enjoy it, it's refreshing and it sort of goes with the vibe of what you like and it sort of basically makes itself cool."* They sell in kegs (90%) and bottles (10%), mainly to bars, some festivals, and a few bottle shops. Beyond, they want to create an experience that is about having a good time with friends, of which the beer is one element. For this they want to have a space where they may control this experience, be it a beer festival or their own brew bar. So far, they have a mobile bar they set up at local music events and parties. It allows them to interact with their customers and covey the feeling they aspire to create.*"We sort of communicate a lot with them. […] the main thing is just to chat with people, chat, chat, chat. […] Also, our social media profiles are basically big engagement centers."* They identify their young age as a strength, compared to their older competitors. *"A big advantage to us is our age. It's a weird one to say but it gives us an actual advantage over a lot of people in the industry. […] Being close to our market."*	Will and Harry are working closely. They share a flat and spend most of their time together. They divide tasks according to their strengths. As creative person, Will takes care of marketing and business development, while Harry as a precise person takes care of the beer production. *"We've been breaking our business into two things […] my focus has been pushing forward business and his focus has been making sure it's executed perfectly and so like that's the way the dynamic works."* For production of the beer they keep the outsourcing model. *"We do something called gypsy brewing. It's almost better for us not to do [brewing], it's better for us to go on sales for that."* However, ensuring quality and control is a major issue with this model. *"It's just a constant risk hanging over us. If the brewing goes badly wrong, we could go from everything to nothing in one month."* Experiencing this once, they spent a lot of time to figure out why the brewing went wrong and how they can prevent it. Despite the help in brewing, Will and Harry are in charge of the business. *"We operate pretty independently, we're not sort of like, no-one is running our business for us."* They are cautious who they let into their business to support in marketing, sales, and business development, which they see as closely related to them as individuals and their ideas.*"Outsourcing, that's just, it wouldn't work at all."* In the long-term, their aim is to develop an organization of motivated individuals who share their passion and who they like.*"… having a team which is like, you know it's like building the A Team up, a really strongly knit team where everyone's there because they're sort of really on board. […] find people that we really know we gel with and we can build a team that's very close."* Now, they can draw on a network of mentors: a professor for general business advice, a former venture capitalist for financial advice, and a solicitor for legal advice. "*If we have a problem or some difficult situation, we could phone them: what do you think of this?"*	The progress is remarkable. They moved to a bigger brewery and launched a third beer in their range. They permanently sell in 7 bars / total 75 bars in the major city they are located, but also distribute across the country. Their average growth is at 35% per month. Further, they attracted three investors, one of which they turned down. **Assessment: 4/5**

Phase 3	In late 2014, they offer a core range of five beers. Still targeting a young generation mass-market consumer between 24-35 years, their focus is on the experience around their beer, not the beer itself. *"Everyone [in the market] is trying to sort of getting weirder, they are trying to out craft each other by getting weirder […] But what we're trying to do is—a specific type of beer which is this mixture between larger and ale and do it really well. The beer is a sort of lubricant for the experience really. We want our beers to be very good quality and they have to do a certain job for us […] But we are not going to do weird stuff."* Engaging with customers and convey their brand ethos remains an important aspect. To maintain growth and develop their ideas about experiencing beer, they consider two investment options. First, create a joint venture with a bar chain that would be a new independent firm. Second, accept the offer from a business angel who successfully runs a national retail chain and who knows about brand development.	Will and Harry decided to leave the new, bigger brewery due to quality issues and reluctance to pay more attention to their quality requirements. *"So basically the bottles that came in were, not rubbish, but below standard and we weren't happy with them. So we had a bit of an argument and their reaction was: "That's brewing mate, deal with it. That's not an exact science." But it wasn't very satisfactory for us […] and we thought: "We don't particularly want to work with someone with that attitude. We asked more focus from them: that's not good enough."* Instead, they work on a solution to ensure quality and reliability of their production. *"I think a lot of work we actually spend on the supply chain. We spend a lot of time thinking about how we can get […] the best way to describe it is version 2. […] We re-build it so that it is stronger."* They create an organizational arrangement which they call the *"magic triangle."* It first consists of Charles, a retired head-brewer who worked for an international beer brand and who likes Will and Harrys' idea. He supports them with the technical side of the production. Second, a smaller, country-side brewery they now produce in, where Charles knows the brewer well. Both work closely with Will and Harry to specify recipes and develop reliable, industry-scale production processes. Third, the two founders who internally provide new ideas and externally market the business complete this core organizational arrangement. Beyond, the group of mentors (business, finance, legal) stays the same. In terms of roles, Paul and George are step back from strictly splitting tasks, but create more overlap between them, so that everyone understands central parts of the business. They also realize that, if *"playing their cards right"* they could create a bigger business. *"… become a 'Premier League' sort of company where we have got the potential to do something quite big."*	At this point, their supply cannot meet the demand they created. While their beer is selling well in bars who would like to order more, they have only limited capacity in their new, smaller brewery. However, this step back promises more reliable and quality production process that may be scaled. Besides, they are in investment talks, one of which just seems right. Meanwhile they secured an overdraft from their bank to ensure operations. **Assessment: 3.5/5**

- shortened version -

Leaping Mode: Exemplary Case

Exemplary Development in Leaping Mode: Case 21—Legal Services

	Product	**Firm Structure**	**Performance**
Phase 1	In 2012, lawyer Tom has the idea to develop a marketplace for legal services, helping customers to find the best deal. He is inspired by similar services in other industries. *"Why don't we create something like MyHammer just for lawyers? How would that look like?"*	Tom contacts friend and business person Sam, who works for another start-up to discuss his idea. Tom knows that Sam is interested in starting his own firm, but has no specific idea. After some months of consideration, he quits his job in 2013 and starts working on the marketplace idea. Tom is not committed and continues his old job at a big law firm in another city. He is only passively involved, occasionally providing contacts. Sam works full-time on the venture, trying to understand the market, which is difficult, and talking to investors, who decline an offer at this stage. But he is determined to continue and bootstrap the development. *"Let's fight. It always goes on."* He officially founds the firm in fall 2013. Tom becomes a minority shareholder and digital expert Joe joins the founding team as an active member. Sam, Joe, and one intern for product development enter an accelerator program to develop the first website, outsourcing the programming to a development team abroad.	The development is positive. Sam and Joe are working full-time on the marketplace idea. They attend a prestigious accelerator program, despite only having a rough prototype of their website. Further, they receive 25,000 Dollar funding, start programming, and acquiring lawyers for their service. **Assessment: 3/5**
Phase 2	They officially launch in spring 2014, offering an open marketplace that connects clients with lawyers. *"What we create is a purely intermediary platform. There are lawyers and there are clients and we are in between and just connect the two."* Clients describe their case and lawyers can make offers. The aim is to provide B2C clients with the cheapest offer and connect them with a lawyers. They are specialists only (labor law, family law, and traffic law).	The organization rests on the full-time members Sam (CEO), Joe (COO), and programmer Luc (CTO), who joined as full-time employee. Sam directs all product and business development activities. He is aware of his central role and his demands. *"You need people you can trust a hundred percent […] who take work out of your hands. Only then you are a firm. You can't do anything on your own. […] You must be able to delegate, and that's only possible if you really trust in people, and that's something I am not entirely doing at the moment. People need to prove themselves first. […] It's really like Formula 1: if you want to be at the top, it's not just the driver, but the whole team. You need a exceptional team you can trust a hundred percent. One mistake and you're out—that's how it is."* Joe, Luc, and the external developer team work on the product development. A flexible team of ten interns, supports the start-up for several days a week, fulfilling specific tasks in product and business development. Only loose contact exists to their network: the accelerator and their new investors.	The progress is significant. Importantly they attract a corporate and a private business angel to invest 250,000 Dollar in June 2014. They also managed to launch the website, get first customers, and to generate insights of how to improve their offer. **Assessment: 4.5/5**

Exemplary Development in Leaping Mode: Case 21—Legal Services

	Product	Firm Structure	Performance
Phase 3	They re-launch the website in fall 2014, offering new law areas, improved usability, and an integrated payment system, as well as a shift to non-specialist lawyers. But they also realize shortcomings of this model. *„The money we make with the marketplace—20% from each transaction here and there—does not make you rich. We would need many many cases or big ones."* Based on this insight and feedback from lawyers, they initiate a major change of their business model and offer. They shift most resources into developing the open marketplace into a stand alone software solution—*"the online office."* They change from helping clients to connect to lawyers, toward supporting lawyers to stay-connected to their clients. *"With this software solution we are developing more into a software company. Then, we will only serve one clientele—the lawyers."* The new offer features multiple collaboration tools lawyers can use to manage their cases and to connect with their clients (e.g., digital records, secure video chats, etc.).	The organization structure changes. To better control development, they stop the outsourcing collaboration with the IT firm. Focus is on doing what is possible internally and building a more efficient organization (i.e., they all moved into one office). *"We can now develop the product ourselves. We are quicker and more agile. If anything doesn't work, we can just revise it. [...] You also realize that you don't need a new person for every new job—you can do a lot by yourself.* But they still rely on interns (now reduced to eight). Most of them work on product development to support Luc and Joe. The others and two freelancer support Sam in marketing and sales. For this function, they further hired two experienced full-time manager to promote the new product. They also use their network more. Through the accelerator they get access to an affiliate sales network and Sam regularly talks to one of their business angels.	They relaunched the website with integrated payment system to finally bill customers. More importantly, they react to customer feedback and change their business model from a market place to selling a software. To achieve this, they internalized the programming to have more control and increase speed. Despite having a far developed version of the software, it is not fully developed, impeding marketing and sales. Following the media coverage of their last investment other investors got interested. **Assessment: 4/5**
Phase 4	In spring 2015, they abandon their transformation into a software firm. *"Yes. Forget the software, we are not doing that anymore. [...] We just realized that we have a fancy dashboard, but that's not a software. For a software, you need way more time, more people, and many interfaces. [...] Nobody sees us as a software developer and we don't see us as a software developer either."* Instead, they adapt the open marketplace from B2C, to sell (a) pre-specified consulting packages to B2B clients (e.g., to set up an employment contract) and (b) offering them monthly membership and reduced fees for permanent mandates.*"We want to do it like one of our competitors and say: you get fix bundles and if you really need it, favorable conditions."* For this, they negotiate collaborations with large insurance firms who are interested in a digitalization of their products, integrating the start-up's product as assistance service. This change means a shift from finding the cheapest offer to providing quick and reliable law services online. Targeting B2B customers with defined service packages is more specific and direct than addressing any B2C customer on the open marketplace.	Organization structure changes again. Joe moves to another city to live with his wife and he becomes an external consultant. Due to shrinking resources and the change in strategy, Sam fires the two experienced full-time employees he recently hired for marketing and sales. *„Now, the only full-time employee is Luc, the CTO, the rest are freelancer, just to reduce costs."* Besides reducing salary spending, focus is on producing specific outputs as quickly and as cheaply as possible. *"All of them are freelancer anyway, you just say: ok, we don't need you anymore, your don't have to come anymore."* One intern supports Luc with the new product development. Five work with Sam on sales and distribution, in particular a law student who now defines the service packages to offer. The network remains the same. Sam's contact to the one business angel gets closer while he only talks to the other investors about further funding. New is the contact to two large insurance firms who intend to collaborate with the start-up.	The development is disillusioning. The big change in strategy—from a marketplace to a software—did not work. They are back to a new marketplace solution, which they still need to prove. With Joe leaving the start-up, two of three co-founders have limited, passive, and external roles. With two senior team members dismissed, Sam, Luc, and a group of freelancers pursue the new product development alone. But, the interest of two large insurance firms to collaborate and integrate their service is a promising sign. **Assessment : 3/5**
Phase 5	Fall 2015. The collaboration with the insurance firms did not happen. Instead they launch their own and newly programmed marketplace solution for selling pre-defined packages to B2B customers. *"To be honest, our solution is incredibly awesome and a thousand times better than theirs."* They now offer this professional version as their primary product and in addition, their initial open marketplace for private customers. For both, they return to providing specialist lawyers only. Besides, there is interest from another entrepreneur to role out the office management software in the UK and Australia. But, missing funds and low performance let Sam ponder options of how to continue: (a) Quit, but keep the website running with basic maintenance. (b) Exit through fire sale of the software and developed code. (c) Form a joint venture with a competitor startup.	Sam remains the only person working full-time, supported by three interns and one working student. *"I realized that it also works without all these people. I had to do many things myself. For example, I used Photoshop to quickly produce an illustration, because our former freelance-graphic designer is hard to get hold of. Hence I do things myself in the evening. That's really back to the roots now."* Due to cash shortage, he invests 25,000 Dollar of his private funds in the firm. This underscores his role as the driver of the start-up. *"It is crazy when you realize that it's not other peoples' money anymore. You get more sensitive. I scrutinize people in greater detail and I am more brutal with them. [...] If you pay them with your own money, they cannot just sit around. Everyone has to work, everyone has to do everything."* Sam's communication style in the team is also more directive. *"I am sick of everyone in the firm butting in. I just say: that's how we will do it—end of discussion. For the new product development I said: that's how it works, that is how the software looks like."* CTO Luc has reduced his involvement to two days a week but remains Sam's core employee. *"If he would break away completely, the firm would be quite a wreckage."* Sam's focus is on negotiating investment with the current investors and on convincing Joe to return his shares. Marketing and bug fixing are reduced to the bare minimum. *"My hands are tied. I can hardly do anything."*	Performance plummeted. Given the limited resources, progress is small and the core team reduced to Sam who focuses on finding investors. Anticipated collaborations with the insurance firms did not happen leaving the start-up with a product they developed on their own, without a budget to market it or knowing its demand. But the company still exists, they have a product to sell, and a realistic chance to get investment. **Assessment: 1/5**
Phase 6	In summer 2016, little has changed in terms of the business model and offer. They have paused development, while waiting for the current investors to decide on a new funding round. Sam describes their general positioning as offering *"legal outsourcing",* that is, providing B2B clients with a cheap service to handle their small cases. He is further convinced that improving the professional version with tailored service bundles can enhance conversion rates. *"You need to think of it more in terms of an online shop. You need something that someone can actually buy."* He also wants to target more specific customer groups. *"You need to be way more niched in the Internet."* Without further funding, Sam has two opportunities to further develop the business. The first comes from a large corporate firm, who could help to generate media exposure, but would require to refocus on B2C customers. Sam sees this as a good vehicle to increase awareness and sell to B2B customers afterwards. The second comes from a venture capital and business angel network, who invested in similar firms, in which they would integrate the start-up.	Sam is still on his own, keeping the firm alive with private funds. *"We are limited to the minimum. Honestly, it's just survival now."* Five freelancer still support him if needed. Luc, who has a new start-up, and a former intern, based in South America, help to maintain the website. The others support in upholding basic marketing and sales activities. Sam's main activity is to convince the current investors to reinvest. One of them is regularly meeting with him over the last weeks to develop a new strategy for selling the service packages to business clients.*"They want to get more operationally involved and that's totally fine with me."* Besides, Sam receives two similar offers from competitors who are interested in acquiring the start-up and in him joining their firm. He rejects both offers, because the sum they offer is too low.	The situation is unchanged. Sam is still waiting for the current investors to commit to a new investment round and sales through the platform did not increase either. There is a small chance that the investment will happen or one of the other options will turn out positive and the start-up may survive. **Assessment: 0.5/5**

B—Published manuscript (chapter 4)

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Catalyst Organizations as a New Organization Design for Innovation: The Case of Hyperloop Transportation Technologies. Academy of Management Discoveries, 4(4): 1-25.
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The 21st century has brought paradigm shifts in organization design for innovation. Caused by the spread of the internet and globalization, firms compete on an innovation landscape characterized by 1) increasing environmental uncertainty with interdependencies of technological developments (requiring continuous and coordinated innovation in technology, strategy, and product; Santos & Eisenhardt, 2009); and 2) near-zero information exchange costs (Altman, Nagle, & Tushman, 2015) creating an almost costless supply of external knowledge available to the firm. This supply of external knowledge comes, not simply as information transmitted across various media and formats, but in the form of people sharing their knowledge and labor with the firm. A wealth of potential part-time contributors are available through internet-enabled coordination tools ranging from gig-economy business platforms (e.g., Freelancer.com, UpWork) to interest-based community forums such as reddit and Digg. This supply of knowledge, combined with environmental uncertainty, creates a 'perfect storm' that affects the way we can or should design innovating organizations.

To identify what this may imply for our theorizing, we study how Hyperloop Transportation Technologies, Inc. (HTT) created an organization design which catalyzes the supply of external knowledge as *the exclusive* source of resources the firm uses. HTT's mission is to change the nature of public transportation from largely being slow, expensive, financially insolvent and environmentally unsustainable to a system which is not only financially solvent, but so fast, inexpensive, and enriching that people will decouple where they work, play, and live. Achieving this vision involves the development of a slew of complex technologies, not the least of which is

the hyperloop—a pod magnetically levitated within a vacuum tube able to cost-efficiently travel at speeds up to 700 mph (see Figure 6 for artists' renderings).

Hyperloop pod traveling through vacuum tube (actual tubes are not transparent)

Hyperloop pod with augmented windows simulating external environment

Figure 6. Artists' Hyperloop Renderings

What makes HTT unique from its competitors (and most of the received organizational design literature) is not just its expansive vision, but the organization design it uses to execute on

its vision. At the moment, HTT has fewer than 12 employees, though the CEO notes that this number is fluid. Instead, it is almost entirely staffed by over 800 contributing professionals distributed around the world. They exchange their as-needed part-time work hours for stock options. Another group of over 50,000 individuals on various social media sites provide opportunities for business development. The 800 contributors are not tangential actors as would be used by organizations outsourcing to Upwork or other gig economy platforms (e.g., Barley, Bechky, & Milliken, 2017), or in new organizational forms such as Oticon (Foss, 2003), but are actors pursuing core strategic activities such as business development, partnership agreements, basic R&D, lobbying public officials, marketing, human resource activities such as onboarding, in-field feasibility analyses, and hardware and supply acquisition.

As with many of these emerging organization designs (Fjeldstad, et al., 2012; Gulati et al., 2012; Puranam, et al., 2014), HTT, at its foundation, is designed as would be expected: contributors are self-organizing actors sharing knowledge through a commons with the multi-actor collaboration enabled with "protocols, processes, and infrastructures" (Fjeldstad, et al. 2012: 739). However, such foundational characteristics fail to capture important nuances for how HTT uses environmental uncertainties and knowledge supply to pursue its mission. For example, even though actors are to some extent self-organizing some aspects of their organization, there are other aspects that are not self-organized in order to rapidly proceed with opportunities as they surface. Instead of laterally coordinating, as described for many of the new organizational forms (Fjeldstad et al., 2012; Dahlander & O'Mahony, 2011; Faraj et al., 2011), HTT is organized to allow coordination hierarchically, bottom-up, layered, as well as laterally. Instead of decomposing tasks as is commonly seen even among new organizational forms (Puranam et al., 2014; Baldwin & Clark, 2006; MacCormack, Rusnak, & Baldwin, 2006), HTT does not. Instead of openly sharing projects for external contributors to join, as is commonly done among such new

organizational forms as Wikipedia and open source software, as well as private organizations such as Intel, Accenture, or Dell (Fjeldstad et al., 2012; Bayus, 2012), HTT does not. Instead of recruiting self-organizing actors, as has been described for these new organizational forms (Fjeldstad et al., 2012), HTT leverages actors of all types, including those not particularly self-organizing.

Therefore, we offer HTT as an additional novel form of organizing using the criteria for novelty proposed by Puranam and colleagues (2014). HTT solves the "universal" challenges of organizing (task division, task allocation, reward distribution, information flows, and exception handling) in new ways – but in a way so intermingled, dynamic, and with different foci as to demand new theory. HTT is not so much a new form of organizing built out of "novel bundles of old solutions" (Puranam et al., 2014: 173), but a new form of organizing enabled by an almost costless supply of external knowledge. This catalyst organizational form is structurally different from a collaborative community (e.g., Fjeldstad et al., 2012), or similar organization forms previously hailed as novel (see Puranam et al., 2014).

The novelty of HTT's catalyst organization design may be most easily understood when described as a passion-driven, dynamic organization which uses an almost unlimited availability of specialized knowledge to create and capture an almost unlimited supply of unanticipatable opportunities. This new organizational form (1) uses non-modular task division and allocation to create limitless options, and (2) integrates work in a manner that allows for continuous exploration even in the face of the need to produce. Its opportunity orientation transcends the actor-orientation of other new organizational forms (Fjeldstad et al., 2012) by allowing contributors throughout the system to match opportunities to available resources in a manner in which the matching is not simply of different types of skills, but also in different levels of commitment, different objects of passion, and non-overlapping relational networks. The

organization has those committed and those less committed, with the most committed (such as the CEO, "hyperleaders," Chairman of the Board, Director of Operations) leading the charge. Instead of standardized protocols, there are "guardrails" which allow individuals substantial discretion within broad direction. Instead of basing coordination on dynamic lateral relationships, HTT uses multiple different coordination mechanisms at once.

Despite these differences from common organizational design wisdom, HTT is successful thus far. Within the first 34 months of its existence, HTT had 25 design patents pending; 49 corporate partners with agreements in United States, Slovakia, the United Arab Emirates, Indonesia, India, South Korea, and France; booked $31.8M in cash investments, obtained $29M in commitments and in-kind investments, received $22M in land rights; and had over 150,000 hours in development work provided by contributors in exchange for stock options. Compared to their strongest competitor, HTT has been able to accomplish more with less expenditures. The quality of the HTT hyperloop is meeting such safety, cost, and reliability targets that it is being insured by the largest insurance company in the world.

How HTT has been able to accomplish this with fewer than 12 fulltime staff – of which nine were hired only in the last year – is the focus of our research. Our initial look at HTT indicated that its differentiation and integration organization design schemes were quite different from those described in hierarchical designs (March and Simon, 1958; Perrow, 1967; Thompson, 1967) as well as in collaborative communities (Fjeldstad et al., 2012). Therefore, our intention here is to first describe the literature in terms of the pressures on traditional design characteristics related to knowledge supply and environmental uncertainty, and how we would expect HTT to be designed. Then we describe HTT's organization design. Finally, in the discussion, we summarize the elements of a catalyst organization.

Our summary argument from our examination of HTT is that, as organizations become

increasingly open to embracing uncertainty and low-cost external knowledge, organizational design researchers will need to reconsider how differentiation and integration are conceptualized. In these new catalyst forms of organizations, differentiation and integration give way to a constant matching process in which projects, people, skills, and opportunities are morphed to fit each other. The organization works because it focuses on evolving actionable objectives rather than tasks, dialectical learning rather than integration, opportunity seizing from the bottom up rather than exclusively top-down, and emergent and temporary roles aligned with varying layers of commitment, instead of job titles. Managers may become just another temporary and emergent role represented by those most willing to commit the time to broker, negotiate, orchestrate and catalyze those individuals temporarily less committed.

Theoretical Background

Organization design is the process of designing roles, rules, and relationships that govern any organizational activity (DeSantola & Gulati, 2017). To do so cohesively, any organization design must address at least these fundamental challenges: 1) task division and allocation (jointly referred to as the division of labor); and 2) reward provision (motivation), information provision (coordination), and exception management—jointly referred to as the integration of effort (Galbraith, 1973; March & Simon 1958; Puranam et al., 2014).

Research has shown increasing environmental uncertainty (Burns & Stalker,1961; Grandori, 2010; Lawrence & Lorsch, 1967) adds complexity to the division of labor and integration of effort. In addition, some have suggested that decreasing information costs will also affect these two fundamental challenges (Altman et al., 2015; Chesbrough, 2003; Zittrain, 2006). In the presence of *both* a surplus of low-cost external knowledge and environmental uncertainty, there are significant limitations in what is known. For example, despite a burgeoning literature on the

creation of radical, complex innovation through innovation ecosystems (Adner, 2012; Adner, Oxley & Silverman, 2013), there is a still a paucity of work on how to design organizations that would steer ecosystem creation under high uncertainty (Dattée et al., 2018; Le Masson, Weil, & Hatchuel, 2009), in particular when it comes to incorporating opportunities facilitated by increasing connectivity and decreasing costs of collaboration (Tilson; Lyytinen & Sørensen, 2010; Yoo, Henfriedsson, & Lyytinen, 2010). Similarly, in the extensive literature on project- and community-based approaches to radical innovation (Foss 2003; Foss & Dobrajska, 2015), organizational design is focused on increasing efficiency of coordination and resource usage; yet, in a context of significant uncertainty and surplus of resources, efficiency may be less important than effectively capturing opportunities.

Below we examine the literature on the effects of uncertain environments, then the effects of low-cost knowledge, on integration and task division organization design choices. We then show how we build on this research to suggest a series of analytic questions for our case study.

Effects of More Uncertain Environments on Organizational Design

Looking at work on organization design in high-uncertainty contexts, classic research suggests organizations should create structures that are organic, adaptable, loosely-coupled, and ambidextrous (Burns & Stalker, 1961; Davis et al., 2009; Lawrence & Lorsch, 1967; Thompson, 1967; Tushman & O'Reilly, 1996). Organizational actors are expected to deliberately react to the changing environmental contingencies by rapidly changing to new organizational forms (Rindova & Kotha, 2001; Romanelli, 1991), drawing on their dynamic capabilities for change (Eisenhardt & Martin, 2000; Teece, Pisano, & Shuen, 1997).

Yet, as uncertainty and ambiguity of the environment increases, the precise nature of the organic, loosely-coupled, and ambidextrous organization becomes increasingly indeterminable

(Cardinal, Kreutzer, & Miller, 2017; Dattée et al., 2018; Davis et al., 2009). Firms need to continuously search for technological and market-related discoveries before arriving at something that can be successfully commercialized. Any newly arriving piece of knowledge may not only provide a new opportunity individually, but also contain novel information about how all other existing pieces of knowledge are (to be) connected (Drazin & Van de Ven, 1985; Miller, 1987) as they cannot directly anticipate the composition of the eventual value proposition for the market.

Moreover, scholars suggest that organization designs in such highly uncertain environments need to foster broad and external exploration in order to discover all relevant problem aspects and their interconnections, (Katila & Ahuja, 2002), drawing on techniques such as structural ambidexterity (Lavie & Rosenkopf, 2006; Lavie et al., 2010; Tushman & O'Reilly, 1996) or open innovation (Chesbrough, 2003). "Incomplete" organizations (Garud et al., 2008) are one design option for settings where the exploration is so continuous and extensive that the "boundary between the entity being designed and the context for which it is being designed" (Garud et al., 2008: 351) is neither clear nor stable. Such organizations, even when not been labeled as incomplete, have neither defined membership boundaries (Etzion & Ferraro, 2010) nor a statically defined purpose, but the discovery or emergence of said purpose may be the initial goal of the organization (Tsoukas & Chia, 2002). One of the implications of such uncertainty for organizational design may be one of rendering any a priori task division moot or even counterproductive (Reetz & MacAulay, 2017; Sarasvathy, 2001).

An example is Dattée and colleagues' (2018) description of ecosystem creation under uncertainty, which they outline as an abductive process of discovery, rather than a priori planning. Their argument is reminiscent of earlier work emphasizing the nature and importance of design to tackle situations of high uncertainty (e.g., Dunne & Martin, 2006; Gruber et al., 2015; Simon, 1996). That work, which should still be considered an emergent field of study

(Garud, Gehman, & Kumaraswamy, 2011; Jelinek, Romme, & Boland, 2008), suggests that organization designs in high uncertainty environments should not necessarily try to respond to uncertainty through planning, but rather enable the theorizing and exploration of multiple possible trajectories, as well as constantly adapting as new knowledge is discovered.

Effects of Low-Cost Knowledge Supply on Organizational Design

Resources are a natural limit to such broad explorations. It is in this context that the decrease of information costs, which some even consider as zero given technological progress (Altman et al., 2015), leads to an abundance of the availability of external knowledge. Decreasing knowledge costs will not only allow the organization to explore more broadly for innovation, but also to involve an increasing number of external contributors.

However, to ensure broad exploration with external contributors, a variety of research streams, such as those on crowdsourcing (Afuah & Tucci, 2012), Wikipedia (Kane & Ransbotham, 2016), open innovation (Dodgson, Gann, & Salter, 2006), and open source software (Howison & Crowston, 2014) suggest that the tasks carried out by external contributors should be directed by the focal organization using a priori defined modularized tasks (also see Altman et al., 2015; MacCormack, Rusnak & Baldwin, 2006). This allows external contributors not only to perform tasks that are of the most utility to the focal organization; it also allows external contributors to perform the tasks at will, through self-selection. The literatures on meta-organizations (Gulati et al., 2012), supplier networks (Dyer, 1996), and distributed innovation communities (Bogers & West, 2012; Lakhani & Panetta, 2007) similarly depict the evolution of such organizations as dependent on a central hierarchy to control the task structure.

Hence, at the system level, the organization controls the nature of the innovation. Indeed, we would argue that this logic underlies many crowd-based approaches currently discussed in the

literature, in which surprisingly traditional organization designs (see also Puranam et al., 2014) are implemented to fulfill the purpose of the organization. Although this literature inspires the possibility of new organizational forms with less centralized control, the precise nature of how control is maintained in an environment of an abundance of external knowledge supply needs further development (Cardinal et al., 2017).

We suggest that, if the organization can involve contributors and their knowledge and resources at zero cost, there is an advantage to the organization to engage an almost limitless supply in a variety of explorative efforts (Afuah & Tucci 2012; Argote & Greve 2007; Altman et al., 2015). If during exploration the organization discovers new knowledge that requires a change in course or structure, reliance on external contributors for innovation should allow for faster response compared to a monolithic organization (e.g., Adner, 2012; Gawer; 2014). As such, integration across all the various explorations in the organization may be less important.

In sum, shifting our focus to contexts of significant environmental uncertainty with low-cost knowledge supply suggests that an effective organization design may be one which does not modularize its tasks for external contributors. Moreover, how the organization integrates – if it even tries – these various efforts at exploration is not clear. What would task division look like if there was no a priori definition by the organization, and how would task allocation operate if there was no menu from which potential contributors would choose? How could such an organization ensure that contributors would be motivated, coordinated, and directed? In short, what would be an appropriate configuration of design choices for an organization that would seek to leverage a contributor community? Would there be new interdependencies or complementarities across design elements (Puranam et al., 2014; Fjeldstad, Snow, Miles, & Lettl, 2012), and what insights would these suggest for extant theories of organization and innovation? These are the analytic questions we turn to next.

Data and Methods

HTT exemplifies an organization leveraging near-zero information costs within an environment of high uncertainty, trying to develop a radically new technological and market solution by purposively drawing on external contributors to explore broadly and deeply. To our knowledge, Hyperloop Transportation Technologies, Inc. (HTT) is the first commercial, large-scale organization involved in co-creating an entirely new industry ecosystem and technology developments with the involvement of thousands of contributors changing the future of transportation. We selected HTT purposefully because of this vast ambition.

Background on Hyperloop Transportation Technologies, Inc. (HTT)

> *"The transportation industry is broken."* (Co-founder, Dirk Ahlborn)
>
> *"There is no profitable mass transport system using available real estate today that is human-centric, giving customers a rich humanistic experience."* (Co-founder Bibop Gresta)
>
> *"Transportation is overcrowded, overloaded, overwhelmed."* (Chief Marketing Officer, Rob Miller)
>
> *"The hyperloop is one answer to the transportation industry's woes but only if it is made to be fast, safe, beautiful, net energy positive, and financially profitable, and the only way to do that is to use existing technology when possible, the brightest and best minds to fill in the technology gaps, and the willingness of thousands of people and organizations to partner in order to help us change the worlds of insurance, finance, government regulations, and customer experience."* (Dirk Ahlborn)

HTT was inspired in 2013 by an Elon Musk white paper reminding the world of the technology for a hyperloop, that it was time for the world to move forward with hyperloop transportation, and Elon saying he was too busy to pursue it himself (more recently, one of Musk's firms, The Boring Company, is signaling that it might take up the hyperloop challenge, Gibbs, 2017). A hyperloop refers to a fully enclosed vacuum tube with a levitated capsule running inside the tube at up to 700 mph; the lack of air reduces the amount of energy needed to move the capsule forward.

Shortly after the release of the white paper, HTT co-founder Dirk Ahlborn posted a project on jumpstartfund.com, a community of entrepreneurs, asking

> *"[…] our community if they thought we should be working on the [hyperloop] project. The response was overwhelming. Many people said we should definitely do it, but there was another button on that response page, one which said, 'I would like to do this.' The overwhelming majority of people clicked that button as well. We then asked what the company should be called and that is how the company started."* (Co-founder, Dirk Ahlborn)

HTT's co-founders selected a core group of about 100 top engineering and aerodynamics specialists from around the world based on applications submitted on jumpstartfund.com. The specialists spent some of their time not working on their day jobs to look at the technology side of hyperloop in exchange for becoming stakeholders in the company. The specialists concluded that the building of a hyperloop was possible by integrating existing technology, but that further research and development would be needed to make the hyperloop financially solvent and energy positive, and that substantial work would be needed to develop an ecosystem supporting fast, cheap public transportation.

Ahlborn and co-founder Bibop Gresta accepted the challenge:

> *"HTT would be a technology licensing company providing solutions that are technical, marketing, and a series of tools to create a hyperloop. We are not going to build. We are rarely going to be involved directly in the design-and-build. We will be a provider of solutions in R&D and project management in the implementation of the project. Our project management approach will be a local approach with a global mind; nation by nation we will identify local partners."* (Gresta)

Together they developed a business model for the company which was to engage the world in a movement of passionate engineers, designers, programmers, lawyers, marketers, videographers, people with connections to government agencies, people with ideas, research and development labs, universities, engineering firms and more.

> *"Our model is the unique opportunity of contribution…We have $60M in assets through work, through land, through pumps, travel around the world, companies paying us to hear us speak which is financing our business development; if we need a simulator we use the university; if we need a wind chamber, we have 11 available to us. We are trying to use resources that exist instead of creating new ones. It's for improving this planet. It's not philosophical and hippie. We are building this hyperloop in a different way for the solution of humanity. Our model implies*

> *coopetition with external partners. If we are successful we open a new path. We can inspire others to embrace and dig into this."* (Gresta)

In their vision, this notion of involving others in changing the world of transportation is not only inspiring but essential.

> *"I looked at why 100's of prior 'hyperloop-like' projects have failed. They failed because they were dependent on one company of one person. So, we need to build a movement not dependent on a single person."* (Ahlborn)

As of December 2017, HTT's organization consists of approximately 800 individuals, some of which are working independently in exchange for stock options and others are working with 44 industry-leading companies who are partnering in exchange for stock options. There are minimal cash transfers. The work is primarily virtual (except when conducting in-field feasibility tests), but takes advantage of in-person conversations when members of the executive board travel to locations where external contributors and partners reside.

The core of HTT are the external contributors who have signed a contributor agreement with a minimum 10 hour/week commitment in exchange for stock options. These contributors vary broadly across professional disciplines including people from engineering (representing a wide swath of industries and all subspecialties), project management, business development, human resources, social media, videography, marketing, legal, financial, government relations, and construction. While the contributors number 800 people, about 300 are actively working on issues at any moment, conducting the work of preparing proposals, meeting customer requirements, research and development, marketing, and management. Contributors are from all over the world, doing their work typically in addition to their formal, more traditional, jobs. Additionally, there is a broader set of thousands of contributors who come to HTT via social media and who completely self-determine how much time they want to contribute and what they want to contribute with no promise of stock options; these contributors have led to discovery of new ideas, new knowledge, social media recognition, business opportunities, and designs.

Data Collection

In the tradition of engaged scholarship (Van de Ven, 2007), we combined an ethnography with a series of interviews and private and public data on HTT. The first two authors joined HTT for 18 months on a ten-hour per week basis and are assigned to the global operations group as experts on virtual collaboration and crowdsourcing. At the point of their onboarding, HTT rolled out an enterprise collaboration tool (Facebook @ Work, FB@W, rebranded by Facebook as Workplace in 2016) for which they became administrators, as well as serving as the liaison between engineering and global operations. This involved attending 80 engineering design and operations meetings. In addition, they conducted repeated semi-structured interviews with 15 team leaders and five other engineering team members, as well as seven interviews with the CEO (five lasted an hour, one three hours, and one five hours). They used a structured interview guide including questions about reasons why individuals were involved in HTT, status of work, and issues of concern. Finally, the research team reviewed all 4,000 posts to the FB@W collaboration site. Table 3 provides an overview of the data sources.

Format	Source	Focus of Content
Interviews	Hyperleaders (i.e., team heads) for engineering design: Design Execution, Engineering Integration, Systems Structure, Pylon Design, Tube Design, Demonstration Project, Pod Design Hyperleaders for non-technical design: Marketing, Human Resources, Culture, Animation, Business Development, Media, Global Operations, Strategic partnerships	Why participants joined, how they learned about HTT, goals they hoped to accomplish, roles played in the organization, changes seen in the organization since joining, and background on the reasons for changes.
Interviews	CEO, COO	Strategic vision, cultural values, expectations, progress
Organization documents	On-boarding website, contributor agreement, press releases, press descriptions of HTT, organization chart, HTT executive summary	Changes experienced by the organization over the 18 months
Engineering documents	Design drawings, system architecture, design assumptions, project	Reconfigurations of teams in terms of responsibilities and tasks

	management documents, risk assessments, scope of work, requests for information	
Observations of teleconference meetings	Listened to 80 engineering related meetings, each lasting between 45 - 120 minutes	Changes to how engineering is organized and reasons
Observations of posts on the collaboration technology	Reviewing the 4000 posts to the collaboration technology, including events, group descriptions, likes, chat messages, comments, replies, and votes	Focused primarily on comments related to changes in organization design, and changes to the how the technology is used by members

Table 3. Sources of Data

Data Analysis

We started our analysis by examining HTT's organization design. For guidance, we used the literature on challenges of organization design – the challenges all organizations must address to support their existence. Here, we found it useful initially to follow Puranam and colleagues' (2014) classification of task division, task allocation, incentives/rewards, coordination, and decision-making for exceptions (Table 4 includes a summary of this assessment). Drawing on this framework as a lens, we tried to identify the design choices that allowed HTT to operate at the fruitful intersection of addressing uncertainty by leveraging a contributor community. Other relevant work, especially Fjeldstad et al. (2012), was integrated the further we moved into the interpretation of the data.

Our intuition from early conversations about HTT was that HTT's design seemed to be different from those previously described organizations making use of crowd-based actors. We elaborated this view through repeated discussions with HTT leadership, in which the first two authors, based on their initial notes, inquired about features of HTT's organization design. We then compared these features, individually and as a set, with existing literature describing related phenomena (as reflected in Table 4), similar to cross-case comparisons (Yin, 2009).

Characteristic of organizing	**Knowledge Production Crowdsourcing: *Wikipedia***	**Innovation tournaments: *NASA Solve***	**Two-Sided Crowds: *Threadless***	**Open Source Software: *Linux***	**Catalyst Organization: *HTT***
Purpose	Give every single person on the planet free access to the sum of all human knowledge.	Engage the public in NASA innovation	Design fashionable t-shirts	Develop free and accessible software	Change the world and produce corporate revenue
Problem Clarity & Ambiguity of Solution	Clearly stated; no room for interpretation: "Write an encyclopedia that is modelled after the Encyclopedia Britannica."	Clearly stated; interpretation within strict boundaries: "Solve a [specific] technical problem in space flight."	Clearly stated; interpretation within strict boundaries: "Create a t-shirt print."	Clearly stated interpretation within strict boundaries: "Program lines of code that provide a specific function."	Broadly stated, interpretation within fuzzy boundaries: "Develop a low-pressure tube transportation system."
Task Division	No centralized task division.	NASA and their governmental partners create the challenges	Artists submit designs; communities score designs	Founder provides layer 1 architecture; visible to everyone	Broad descriptions of tasks
Task Allocation	Self-selection (based on preferences) into articles	Self-selection (based on skills and preferences) into contests	Self-selection (based on skills and preferences) into design submission, feedback, and/or voting	Self-selection (based on skills and preferences) into coding, bug fixing, support	Self-selection into extended membership pool. After vetting, self-selection into tasks
Motivation (Reward Distribution)	Intrinsic motivation, visibility within community	Mainly prizes, status, and signalling	Artists: learning, status, signalling, community. Community: access to unique goods & engagement	Universal free access to OSS; learning, status, signalling, community	Stock options, passion, intrinsic motivation
Coordination (Information Provision)	Through "talk page"	When outcomes are shared	Crowds and artists vote, see votes and feedback	Comments, forums; source code	Guardrails, socialized control, collaborative technology
Exception Management	Lateral authority for articles. Structural decisions by firm	None (problems are one-shot games)	Lateral authority for challenges. Structural decisions by firm	Founder-led hierarchy for key tasks; lateral authority for crowd work	Collaborative decision-making on what is explored.

Table 4. Comparing Crowd-based Approaches to Innovation

To refine our understanding, and to follow good practice for qualitative work (Denzin & Lincoln, 1998; Gioia, Corley, & Hamilton, 2013), the two authors involved with HTT discussed their insights with the authors who were not. These discussions took place in person and electronically, and facilitated by the iterative drafting and discussion of working papers expressing preliminary findings. The team shared these drafts with HTT to ensure accuracy.

Proceeding in the above way, we became increasingly able to build bridges to existing theory and enter a process of abductive reasoning (Mantere & Ketokivi, 2013; Peirce, 1878). That is, we combined our increasingly refined observation of HTT with established logics of organization design (as also described in our literature review) to derive a novel explanation of how organizations may operate *differently* when leveraging high uncertainty by exploiting near-zero information cost. We believe that the following offers the "best" explanation of the data, but we also acknowledge that other scholars might look at the same data and find a different best solution (Mantere & Ketokivi, 2013: 73). We look forward to other interpretations, but also offer that our hybrid team (two authors involved with the organization and data collection, and two not—as well as our editor and reviewers), helped in mitigating interpretive bias.

Findings

We found that HTT's organization design showed considerable overlap between the five dimensions identified by Puranam and colleagues (2014). Accordingly, we collapsed the dimensions into the classic two fundamental organizational design challenges of labor division (i.e., task division and allocation) and integration of effort (i.e., information and reward provision, to which we also add exception management). Below we describe the findings with respect to the two aggregate dimensions, summarizing them in Table 5. To distinguish between data obtained from the sources and our interpretations, we have put data in single-spaced italics,

indicating the source or set of sources.

Organizational Design Challenge	**HTT's Characteristic Features**
Division of Labor: Task Division, Allocation, and Execution	• Holistic, less modularized tasks • Mutual agreement on task assignment • Tasks related to entire ecosystem • Task performers come from entire ecosystem • Multiple competing tasks • Use of one-week sprints for task completion • No pre-defined task-skill matching but instead ensuring range of skills within talent pool • Tasks are often duplicated to get competing viewpoints • Tasks include environmental scanning by contributors providing the organization with opportunity to pivot quickly • Community-driven micro tasks given to HTT management
Integration of Effort: Motivating Contributors, Coordination, Collaboration, and Control	• Contributors work for future stock options & guarantee minimum 10 hrs/week • Cultural guardrails encouraging disruption and collaboration & movement and membership rather than tasks and individual ideas • Socialized control methods through collaboration • Use of technology for socialization, coordination & collaboration • Part-time managers • Control through parallel paths to see which path is more fruitful • Tools for collaboration

Table 5. HTT Case Description

Division of Labor

There is an overwhelming amount of work that needs to be accomplished for HTT to develop a financially and environmentally sustainable hyperloop-based transportation system. The list of work, as compiled from a range of documents and interviews, includes:

- *Negotiating with governments and regulators to allow a "flying" device using magnetic levitation and support initial costs of building one, as well as developing a new system of regulations with governments since the hyperloop is neither a plane nor a train.*

- *Developing a range of technologies such as the hyperloop itself to meet the specifications of being locally maintainable, safe, customer-centric, componentized to fit with different nation needs, and low-cost; developing complementary products such as special steel and windows to absorb impact; developing algorithms such as those for engineering the best routes for the hyperloop in any nation undertaking a feasibility study; and integrating alternative sources of energy to minimize the costs of operating the hyperloop.*
- *Developing organizational practices and information systems for managing a large population of interested and contributing parties.*
- *Encouraging societal acceptance of transport through a tube.*
- *Developing alternatives for the "last mile" between the hyperloop station and final destination.*
- *Convincing an entire ecosystem of insurers, construction companies, and transportation companies to collaborate and reuse for sustainability rather than design and develop from scratch.*
- *Developing and brokering licensing deals.*

To execute on this work, a variety of organizational structures have been proposed over time, with the latest shown in Figure 7. In this circular figure, the larger community of people interested in the hyperloop provide the "*talent pool*" to staff "*sprints*" of short-duration. Sprints are projects conducted within the purview of one or more specialty teams managed by "*heads*" (also called hyperleaders) who are associated with one of six divisions in the company: engineering, marketing, legal, operations, finance, and digital. There is a multi-person strategic committee which generally does not engage in day-to-day activities, consisting of the CEO, Chairman, and Chief of Global Operations.

There have been many conversations among HTT contributors about how all the work that needs to be done should be divided into tasks. A variety of different approaches have been used including the sprints described above, posting narrowly defined micro-tasks, announcements to the community of broad sets of needs, and no announcements at all allowing community members to do what they thought best. We outline below HTT's labor division design in terms of three insights: how tasks are designed and selected, how cross-task work is managed, and how tasks are actually given to HTT from the external community.

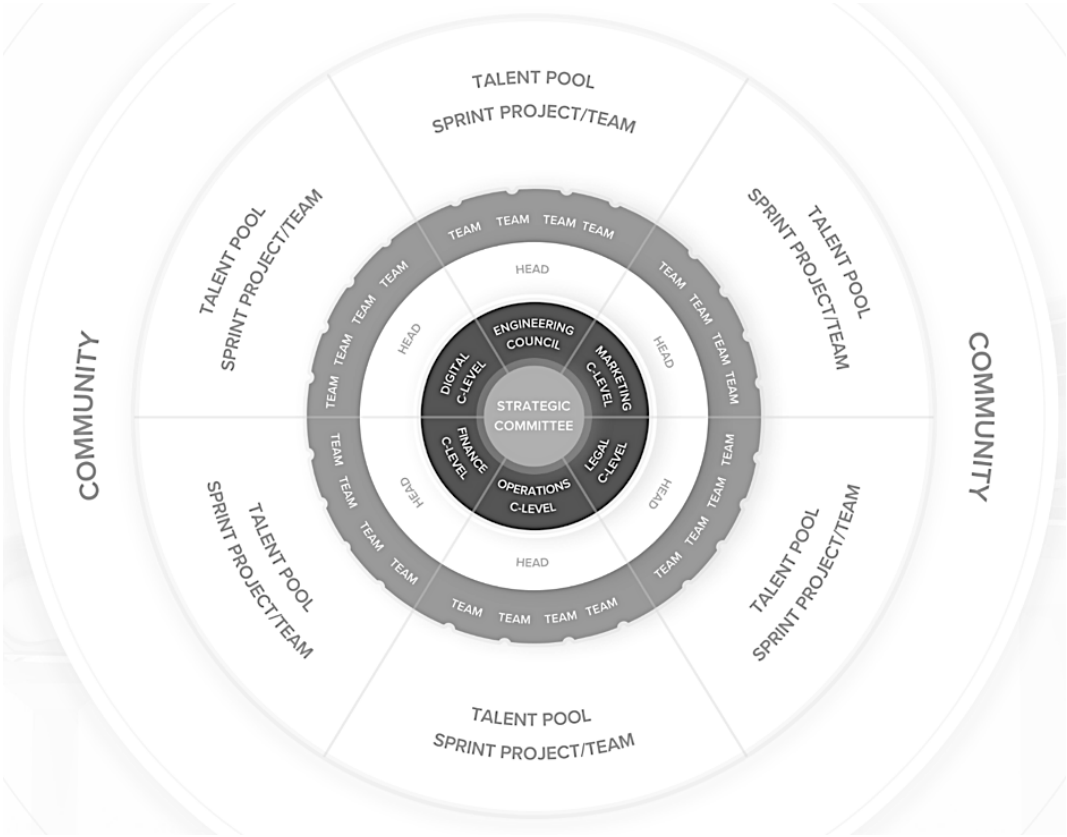

Figure 7. HTT Organization Chart

How tasks are designed and selected. The current approach for those within the formal contributor boundaries, where legal agreements have been signed and contributors are working in exchange for stock options, is to design tasks and projects collaboratively. Tasks are considered open-ended problems to be solved such that they require multiple perspectives, but there is no agreement on the scope of a task. Some tasks are quite broadly scoped such as "CFD" (run some computational fluid dynamics analysis) while others are quite narrowly scoped such as: "take a look at this beta software and let us know about the user interface." About a year ago, several agile software consultants became contributors, bringing a partnership with the Trello agile software product, and offered to help teams keep track of their task lists more effectively on a Trello board. One of the learnings shared by the consultants was that the definition of a task

differed to a great extent between the teams.

> *"Each team is responsible for its own board. Teams can setup the board any way they like and they can change their board any way they like. In general, a board should be setup with a prioritized backlog list on the far left which the team can use to pull tasks from. To the right of the backlog list are usually a blocked list, an in-progress list and a completed list. Note that teams can add lists as appropriate for them. During each team meeting it is important that each task on the board is discussed. Tasks should flow across the board to the completed list. If tasks are not flowing, they are blocked or no work is being done or the tasks are too large to complete and need to be decomposed. Hope this helps." (Hyperleader on FB@W)*

Contributors are encouraged to collaboratively suggest new tasks for their own teams, either on the Trello board or on FB@W, as well as tasks that could be done by contributors not on their own team, and listed on FB@W. Examples from FB@W include:

> *"Hey HTT..,we have an urgent video shoot at the Design Studio tomorrow. I need a few able body folks to help me carry gear and help with general PA stuff. Please message me ASAP."*
>
> *"To anyone in the crowd: There is a Facebook at Work API for the social graph. Can anyone from this wonderful crowd of ours help us with this?"*
>
> *"To the Energy storage team only, we need to identify potential partners for low-cost, high-storage, and small batteries for energy storage."*

For HTT, collaboratively suggesting or designing tasks means that once a suggestion has been made, if someone is willing to respond to perform the task, then the task has been designed and allocated! If the task takes more than 20 hours of someone's time, then a "project" is created. Example projects include: "*Design the geometry of the capsule*," and *"Develop a software platform that creates routes from point A to point B with a variety of parameters specified."*

We were able to note several reasons why HTT evolved this approach to task division. First, they found that narrowly defined micro-tasks often became obsolete within a matter of hours or days in such a high-change environment. For example, a task of *"having someone translate a drawing into a 3-D CAD tool"* changed when a new partner stepped in to offer a new 3D CAD tool to use. Second, tasks that were too narrowly defined did not allow sufficient innovativeness to provide both value to HTT and sufficient responsibility for contributors to take the time to review the quality of their own work:

> *"When I tried to precisely tell a contributing partner how I wanted the video to look, it came out in a way I didn't like it. Then I found a different contributing partner who is more creative and we collaborated about the storyboard and they provided some real strong creative input and the marketing video is much better." (Chief Marketing Officer)*

Not standardizing the meaning, scope, and definition of tasks seems to allow for much more flexibility about requests for needs to be filled by the crowd. For example, in response to the interview question: "*What are your engineering needs?*" responses were quite varied:

- Specific skills (e.g., *"ability to do dynamic flow analysis*"),
- Actions ("*people to input CAD models*"), and
- Roles (e.g., *"systems engineer*").

Moreover, this flexibility was embraced by the strategic committee since it allowed for the creation of multiple competing projects! If contributors identified an approach to solving a problem that was quite different from the approach being followed by an existing team, a new team was created, competing against the existing team. This allowed for parallel exploration to occur, leveraging both the abundant knowledge supply as well as the need to consider alternative breakthroughs in an uncertain environment. Initially, contributors were taken aback by having "to compete" within their own organization, but over time, the value of having multiple design teams for various problems has proven itself as some approaches ended up providing a better match to supplier and/or customer interests.

When announcements of new tasks are posted on FB@W, they are responded to extremely quickly—often within an hour. For example, in the screenshot below (Figure 8), the original request was made at 10:47am, with a response by 11AM!

No one, even contributors assigned to a particular team, is directed to perform a task; the tasks are just laid out (e.g., using a Trello board or FB@W or an email or a WhatsApp message) and then contributors indicate their willingness to complete the task. Initially, contributors assigned to a team were encouraged to only sign up for tasks within their own team. However, that expectation has evolved so that both the executive team and hyperleaders no longer feel they

own the individual team members' time. This enables any contributor to commit to any task that is posted.

Figure 8. Screenshot from Facebook@Work

One consequence of allowing anyone to commit to any posted task is the surprises about who commits to perform which tasks. For example, one member who originally joined HTT to help teams adopt the agile development methodology, later contributed to engineering the propulsion system. Why? "*Because I am interested in reducing road blocks across the design and I thought I might have something to contribute.*"

This openness to have work accomplished by unanticipated contributors is a prized aspect of the catalyst nature of HTT. Hyperleaders and at least one member of each team are professional specialists on the team's topic (for example, the hyperleader for the capsule is someone who has engineered fuselages for airplanes in the past and thus is extremely expert at designing capsules). Consequently, if someone less expert on the topic is interested in joining the team, this is welcomed. This diversity allows for the incorporation of new ideas and perspectives into the design discussions, as illustrated in the example above with the agile development consultant

joining a propulsion system team.

This openness to pleasant surprises is particularly important given the interdependencies and multi-dimensional aspects of the hyperloop technology and transportation ecosystem (e.g., political, technical, geographic, social, regulatory, financial, as well as engineering, project management, risk reduction, and construction). The executive team and hyperleaders have increasingly supported the need for unplanned cross-fertilization across teams and specialties:

> *"Every tiny change in one area has implications for other areas. For example, if change in size of door, this has implications for vacuum team, pod team, interior design, electrical, mechanical, etc."* (Report by contributor on interviews with hyperleaders)

Consequently, managing the interdependencies across tasks has become a significant focus of the organizational design.

Managing across tasks. HTT's executive team envisioned early on to use agile project management techniques (agilemanifesto.org), even though agile methods are generally used for tasks which can be micro-managed such as standard software development rather than highly interconnected, complex, and uncertain tasks (Dybå & Dingsøyr, 2008). They had hoped to institute short three-week sprint tasks focused on an engineering design problem but found: *"The three-week sprints don't work*" [Co-Founder]. One reason for why they do not work appears to be that it is difficult to define a do-able three-week sprint such the tasks are sufficiently independent and require relatively little knowledge of what has transpired before the start of the sprint. If the actors were full-time, the intensity of a three-week collaborative effort might be feasible.

Instead of three-week sprints, contributors appear to prefer structured weekly teleconferences so that they can plan their busy full-time, non-HTT, work schedules around one-week sprints. During the teleconferences, contributors enjoy engaging in a collaborative design effort, as well as discussions to identify engineering issues that need resolution, and alternatives for resolution.

They then volunteer to explore the alternatives over the course of the week before the next teleconference. While the engineers tend to use FB@W to keep others informed of their progress during the week, other parts of the organization, including the executive team do not, preferring less open and more controlled communication tools of email, Slack (another internet-based messaging system), and WhatsApp (a texting tool).

Tasks Given to HTT From External Community. Instead of tasks being defined by HTT and assigned to the external community to perform, HTT does the opposite. The external community of 30,000-50,000 on various social media sites frequently identifies tasks – as opportunities - for the HTT executive team to perform. These tasks, as compiled from a series of interviews with the Strategic Committee include:

- Specific opportunities for executive team members to speak at conferences about HTT. For example, Gresta was invited to give a keynote speech to a global entrepreneur forum in India, an invitation which was made possible by local people in India interested in HTT. *"It turned out to be about 14 people locally. We asked them to notify the media, and then to help us make appointments with relevant government officials while we were there. They did this because they would like a hyperloop in India; they didn't receive stock for their time."*

- Scheduling meetings for the HTT executive team with high-level government officials including prime ministers and directors of transportation. *An inquiry from a community member about the possibility of meeting with officials in Toulouse, France led eventually to the negotiation of a major hyperloop test track, land, and an R&D center situated in the booming industrial park of Toulouse.*

- Early-stage technology developments to be pursued for incorporation into hyperloop development. *The exclusive license which HTT is using to power its hyperloop started with an inquiry posted by a community member.*

- Suggestions for companies to partner with. *Some of the companies that HTT is partnering with today came about because someone in the community suggested that HTT contact the company because the potential partner is doing some work that would be relevant to HTT and, a partnership would result in mutually beneficial outcomes.*

While only those speaking engagements that occur in a strategic area of interest are responded to, most of the other inquiries are almost always at least initially examined.

Integration of Effort

For Puranam et al. (2014), integration refers to how contributors are motivated and provided the necessary information to perform their work in a coordinated fashion (see also Malone & Crowston, 1994). We find that HTT integrates by using a variety of design elements, many of which alone are not novel, but together help create a highly fluid organizational design. We highlight these elements in Table 5, with examples from HTT's approach to their talent pool, culture, on-boarding and engagement practices.

Talent pool. Apparent from Figure 7 is the importance of the talent pool. The talent pool refers not to people, but the relational networks, skills, passion, and commitment available to HTT. The CMO has coined the phrase: *"What we need are people who have* ***Talent*** **+** ***Passion*** **+** ***Responsibility****"* [emphasis from the original]. The larger external community provides talent in the manner of tasking described above: of providing opportunities for introductions to CEOs, investors, government officials, speaking engagements, and regulatory agencies. The smaller, core crowd of contributors are those who have been on-boarded and signed the contractual stock option agreement. These contributors – either as individuals or as representatives of partnering organizations—are charged with executing on the opportunities provided by the larger community. Such activities include designing the hyperloop and ancillary technologies, writing proposals and marketing collateral, sharing design specifications back and forth with collaborating companies, and providing the "boots on the ground" to accomplish feasibility studies and testing. This requires professionals who feel responsible for the success of the community, rather than just an organization. In the words of one member: *"the people you meet at HTT are absolutely amazing: smart, hard-working, committed, creative, fun, and passionate—just the people I love to hang around with online and off."*

There has been no problem in obtaining resumes. Estimates from the CEO, Chief Operating Officer, and Human Resources Director, indicate an average of 100 resumes are submitted every week, either via LinkedIn or to one of the company's websites. There are triggers that tend to spark an influx of resumes: Executive speaking engagements, recruiters/contributors who look for specific talent defined by the executives, and advertisements on online job markets such as AngelList. The challenge comes in matching the resumes to HTT's organization culture and the available opportunities.

Culture. Over time, HTT contributors helped to create the company's mission and values statements, as shown in Figure 9.

Vision: **We move humanity forward**

Mission: **Deliver the next breakthrough in transportation**

Core Values:

1) **We are champions of tomorrow**: From the way we work to what we create, we are fervent champions of new and better ways to deliver tomorrow's innovations today
2) **We are better together**. We are a global community of problem-solvers who believe that all of us is better than one of us
3) **We are passionate**. We are a movement, not just a company
4) **We are dreamers and doers.** The only way to change the world is to dream big; the only way to make a lasting impact is to make those big dreams reality
5) **We are dedicated to the details**. Care for our passengers and communities requires absolute precision of every task
6) **We are "hand raisers".** We are the ones who step forward to make things happen

Figure 9. Culture Statement from HTT Onboarding Documents

The vision of moving humanity forward is meant to signify that HTT is concerned first and foremost with the passenger, not with the technology or stock market or investor value. Delivering the next breakthrough is intentionally chosen to indicate that HTT is a technology licensing company, intent on continuing to develop technologies associated with, and ancillary to, the hyperloop. The core values emphasize the nature of the people they want in the organization; people who don't "sit on the sidelines but instead make things happen," take responsibility for professionalism in their work, don't just dream but engage in doing, recognize that HTT is a

passionate movement rather than just a company, and solve problems that require a vision of tomorrow and collaboration today. We summarize the culture these statements exemplify into four essential elements: 1) being extremely collaborative when disruptive, 2) being willing to take the initiative without knowing if it will bear fruit for the organization or oneself, 3) working as part of a proliferating potpourri of largely self-governing teams with uncertain interdependent elements between the teams, and 4) knowing how to catalyze others to perform tasks in a context in which many tasks are self-selected. This four-part culture is a direct function of the environment in which HTT operates.

The first element—intense collaborative disruption—is needed as a check-and-balance on disruptive ideas. If one contributor offers an idea that is too disruptive for the organization, the collaboration required to bring that idea to fruition will help to smooth out some of the disruptiveness of the idea. The following example of intense collaborative disruption comes from a series of interactions via FB@W between the first author and the hyperleader responsible for Engineering Integration:

> *One contributor interested in organizational design suggested that the engineering department be reorganized into project management and R&D so that those engineers interested in project management could be engaged in that discipline and those interested in R&D could be engaged in the R&D activities. Since several engineering hyperleaders agreed, plans were made to disrupt the organization to make the change. Then, unexpectedly, an opportunity surfaced to conduct a hyperloop feasibility study for a government. During the feasibility study, both project management and R&D engineering became quite intertwined, making it clear that such a bifurcation of engineering would not have been a good idea. Consequently, the idea was not pursued further.*

The second cultural element—being willing to take initiative without knowing if it will bear fruit for the organization or oneself—is needed since there are so many uncertainties and the organization must be responsive to changes in market and technology conditions, that an initiative which seems worthy at one point, may no longer be needed at another and vice versa. The first author compiled the following example over several months based on initial engineering

design meetings, and then repeated interviews with several members of the engineering team over time.

> *The engineering R&D team took the initiative to develop the hyperloop design on the assumption that the capsule will be run through concrete tubes because ultimately there would not be enough steel to create all the tubes in the world. The engineers spent considerable time analyzing the safety, risk, cost and feasibility of concrete tubes under varying environmental conditions. Most recently, the CEO announced the completion of a successful negotiation with a steel company in Spain to deliver steel tubes to Toulouse in exchange for stock options. The R&D engineers had to be willing to immediately pivot to consider the possibility that sometimes the tube will be built in steel and other times will be built with concrete.*

Since the hyperloop design is intended to be a "*glocal*" technology customizable to each nation and thus a platform spawning a pluralistic suite of products, the R&D efforts for the concrete tube may be useful later. Initially, the ability to embrace such pivoting was a difficult cultural element for many HTT contributors since it often meant that their most recent work felt unappreciated.

The third cultural component— working as part of a proliferating potpourri of largely self-governing teams with uncertain interdependent elements between the teams —is needed because there are so many interdependent components of the hyperloop transportation industry still under development. Below, two examples illustrate this cultural component:

- *Safety regulations for the hyperloop are being developed as technologies are being developed and as estimates of risk are being developed. Since there is no experience of a vacuum-sealed tube transporting passengers at high speed, analogs to high-speed rail and airplanes are often used. Therefore, engineers on the safety team are often interfacing with the regulatory team. (Compiled from interviews with the Safety Hyperleader)*

- *Passenger Experience. The paramount emphasis on passenger experience permeates most aspects of the design. Some of the basic passenger experience principles being pursued include completely electronic and seamless experience with the passenger's "time never wasted"* [Gresta]. *Therefore, capsules need to be designed not just for comfort but various passenger use cases from working to purchasing. Such a capsule design affects the way seats are oriented. The orientation of seats affects the speed of egress and ingress into the capsule. Designing the station for a 10-second time window between capsules coming in and leaving the station is affected by this speed of egress/ingress. If capsules are leaving every 10 seconds, do passengers even need tickets in advance? If passengers are using non-hyperloop means to arrive at the station (such as Uber or Lyft), is there a way to integrate with these others to allow a seamless enriched journey from the time of thinking about a trip to the time of travel, and thinking about the next trip? (Compiled from interviews with Station Team member and co-founder Gresta)*

These interdependencies are not unusual in complex engineering efforts. To handle the interdependencies, integration standards are often created, specifying design assumptions such as the weight, speed, or energy load allowed (see Boeing 777, for example, Thomke and Fujimoto 2000). However, with HTT, enforcement of integration standards may remove a market opportunity. So, every team must design to assumptions about what might be feasible integration standards. This can cause frustration. In the words of one engineering contributor:

> *"If we don't know details about this component, we cannot make certain design assumptions, and unless we can make these design assumptions, we cannot move forward with the design of other components."*

However, instead of enforcing integration standards, the executive team repeatedly responded to these frustrations by encouraging the engineers to move forward in designing to the very general specifications of the hyperloop, but not to be constrained by integration standards. This approach, while unusual for engineering, has allowed HTT to be quite flexible in quickly meeting different client requires for feasibility proposals. In other words, each client creates its own requirements which force temporary integration standards, which then lead to rapidly configuring the more general design for the specific client, as a form of *just-in-time engineering.*

The fourth cultural element—knowing how to catalyze others to perform tasks in a context in which many tasks are self-selected—is needed because the company's talent pool is not required to perform any specific task. The Chief Marketing Officer notes:

> *"This is a very important element in our organization. The traditional carrot/stick model does not work. How do we keep our contributors and community enthused? How do you ensure there's a sense of purpose and responsibility?"*

Even though contributors receive stock options in exchange for the work, they exhibit a substantial amount of free will in self-selecting contributions and tasks to perform. The self-selection nature of the contributions means that contributors often need to *be sold* on the personal value of a task and the value of the task for the organization. A compilation of posts on FB@W

provide two illustrate examples of the need to catalyze others to accept tasks:

- *On FB@W, requests were made repeatedly for individuals to contribute to a central project management document. Few responded. However, once an upcoming feasibility study was announced and the connection to the central project management document was made explicit, contributors quickly added their work to the document.*

- *On FB@W, contributors often post media reports about competitors. At one point, a contributor posted a media report announcing a successful public test of a hyperloop component by a competitor. Over a several day period, contributors shared on FB@W and during weekly teleconferences and emails concerns about the implications for HTT's success in such a competitive marketplace. Finally, the CEO posted on FB@W a message indicating the downsides of the competitor's technology and explained how HTT was still ahead of the competitor. This post helped to redirect the contributors back to focusing on the work, rather than discussing the competition.*

The posting of new tasks has, therefore, increasingly been accompanied by a justification of the need for the task. Clearly, tasks requested by the CEO or Chief Global Operations Officer are more likely to be self-selected, but since tasks can be suggested by anyone at any time in response to any opportunity, the importance of justification for catalyzing others to engage in posted tasks has now become part of the culture.

Onboarding. Hiring and onboarding at HTT are challenging because professional specialists need to be collaboratively disruptive, willing to offer new projects, and spend time selling projects to others. Once an HR director was hired by HTT, attention was placed on ensuring that recruiting, screening, and onboarding were identifying people to sign the contributor agreement who represented the best fit. An example of how the application and onboarding process evolved is described below based on a compilation of observations of the changes in the onboarding site over time, and interviews with the HR director:

> *"The application process has evolved from requesting resumes to coupling resumes with short answers about the precise nature of the contribution the contributor wants to make and why the contributor believes she can work in such an environment. Once hired, the new hire self-certifies through an online self-guided process of reading about the company and its culture. The new hire is then assigned to a hyperleader who is asked to monitor the new hire's behavior and offer mentoring."*

Keeping contributors engaged. Once hired and assigned to a hyperleader, new contributors often look for guidance rather than jumping on a task described in a teleconference. Consequently, as more contributors come onboard, hyperleaders (many of whom are 10-hour a week contributors) have the increasing responsibility for not just meeting milestones in their functional discipline (marketing, human resources, engineering, etc.), but also for assigning tasks to new hires. Often these tasks require training—on HTT's tools, current design state and assumptions, HTT's culture, and the proper network of other contributors to ask questions. This takes time. There is some discussion as to whether hyperleaders need to become full-time to manage contributors, but there is also acknowledgment that this might come at a cost of losing hyperleaders who can only work part-time (given many of them are employed full-time in traditional organizations).

Standards and procedures. Since HTT's mission is to collaboratively disrupt by catalyzing change, HTT provides incentives for collaborative disruption in a variety of ways: converting part-time contributors to full-time paid staff if desired, publicly recognizing collaborative work well-done and achievements that are good for the larger organization, and encouraging contributors to take initiative to design the organization as they would like to see it work, rather than looking to senior management as drivers of organizational change.

Designing procedures for an organization like HTT is not simple. Standardization is difficult because each person is working with the language of their own tools, country, business, and discipline, and sometimes substantially different views of what a new transportation system might look like. All this variation means that processes and procedures need to be more of "guardrails," a term used in agile project management (e.g., Sutherland & Sutherland, 2014) rather than rigid ways of working. Creating guardrails that are acceptable to others takes time (and the attention of the Cultural Director and the head of HR). This means procedures such as

certain reporting guardrails about how much time contributors should spend on a task in exchange for a stock option have taken longer to create, waiting for sufficient socialization among contributors. Despite the guardrail indicating that FB@W should be used for collaboration, FB@W is still minimally used by the executive team, marketing, and business development. This allowance of personal preferences in performing the work is part of this concept of collaborative disruption: if others are not ready, then it will not happen.

Discussion

In this paper, we set out to describe how an organization could manage, and even gain from, uncertainty by deploying an organizational design that leverages an environment of near-zero information cost. We described how HTT learned to design itself to accomplish its broad mission of creating a movement for sustainable transportation. The primary contribution of our paper is hence HTT itself; an organization that operates as a crowd-sourced ecosystem capable of proactively leading and reacting to the development of new technology and ecosystems. We label HTT a "catalyst organization" because it serves as a platform to catalyze new technologies, new business connections among contributors, and the creation of a new market and ecosystem. It is the largest crowd-sourced startup, with a community of followers numbering over 50,000. The many contracts it has acquired and the state of its development—accomplished primarily with the labor of part-time professionals in exchange for stock options—is unprecedented. Next, we summarize the core aspects of this novel organization design and then derive implications for theory and practice in research on search, organization design, and communities.

The Catalyst Organization: A Novel Organization Design for Innovative Search

As argued by Puranam et al. (2014), many of the emerging organizational designs are simply

novel bundles of old solutions to age-old challenges of organizational design. We believe HTT is more than that. First, the age-old challenges are based on a notion of efficient operations (which drives the need to differentiate by task and then hierarchically or laterally integrate). But, in a context of near-zero cost external knowledge supply, efficiency is a less important driver of design. Second, the distinctions of the five challenges presume their value for analyzing new organizational form and yet the interdependencies among the five challenges suggest that new sets of challenges may better capture the realities of the catalyst organization. Third, the classic design solutions to differentiation and integration - which fundamentally focus on achieving organizational goals through a hierarchy defining tasks, rewards, and information flow - places people in a responsive passive role. But, under conditions of such significant market and technological uncertainty, coupled with a virtually infinite potential supply of external knowledge, people's choices to make offerings to the firm become much more of the defining role in the design.

The resources people can offer HTT are not just knowledge, but range from networks to hardware supplies, from time to attention, from existing skills to willingness to learn new skills. This creates an ever-changing structure, hierarchy, and workforce. The stability comes from the firm having a clear vision developed not by the founder but by a flow of contributors having frequent catalyzing experiences, a volume of opportunities presenting themselves, a volume of people offering their resources, a number of commons for sharing resource needs and availability, and crossable layers of commitment levels so that the organization and contributors can adjust to changing demands.

This new form is therefore not based on the design solutions to the differentiation and integration challenges. It is neither promoted 1) classically as tasks being divided and allocated, and hierarchy integrating across the task divisions, nor 2) aligned with current views of emerging

designs as self-organizing. A classic differentiation and integration design would create too much filtering and delays in the ability to quickly and proactively engage in the huge range of unforeseen opportunities presented by an uncertain environment, as well as capture unforeseen offerings of passion, resources, skill, and time from the low-cost supply of external knowledge. A pure self-organizing design with standardized practices such as used with Wikipedia also would not work because the process for achieving the mission is too unpredictable.

Therefore, we suggest a new organizational form—which we refer to as a catalyst organization—which is needed explicitly because the intention of the organization is to engage as many opportunities as possible across a broad uncertain and evolving market and technology landscape using an abundant supply of external knowledge and resources available at a low-cost. At the most fundamental level, this new organizational form (1) uses non-modular task division and allocation to create limitless options, and (2) integrates work in a manner that allows for continuous exploration even in the face of the need to produce. It is these differences which allow HTT to operate effectively at the intersection of environmental uncertainty and potential engagement from an almost limitless community of contributors.

As we show in Table 6 below, HTT also differs from Fjeldstad et al.'s (2012) actor-oriented organization design. Apparent in this comparison is that HTT is not easily characterized as exclusively an actor-oriented design, although it has elements of such a design. Instead of decomposing tasks, there is a substantial amount of opportunity-to-available resource matching distinctions that surface as projects unfold, and in which the distinctions are not simply in different types of skills, but also in different levels of commitment, different objects of passion, and non-overlapping relational networks that can be brought to bear. Instead of direct control and exchange, there is an attempt at orchestration that is not done by any single conductor, but rather by those committed to completing a project. Instead of standardized protocols, there are

"guardrails" allowing individuals substantial discretion within broad direction. Instead of basing coordination on dynamic lateral relationships, there are multiple different coordination mechanisms in use at the same time. In sum, the novelty of HTT's catalyst organization design may be most easily understood when described as a passion-driven, dynamic movement organized to create and capture an almost unlimited supply of unanticipatable opportunities through the supply of low-cost and highly specialized knowledge. While Wikipedia and open source development projects are movements, their organizations are not intended to create unanticipatable opportunities. While Oticon (Foss, 2003), Blade.com (Fjeldstad et al., 2012), and R&D teams (Ben-Menaham et al., 2016) are organizations looking for opportunities, they are not drawing on the contributions of external actors.

HTT – Catalyst Organization	**Actor-Oriented Architecture (examples from Fjeldstad et al., 2012)**
Organizational design is a combination of hierarchy, bottom-up information flows, and networks	Organizational design is focused on dynamic lateral networks of relationships
Hierarchy used for orchestration, not control or coordination. Work is prioritized based on what people and skills are present.	Direct exchange (rather than hierarchical planning, etc.) among the actors leads to control and coordination
Goals are not determined through control but through the direct exchange among the contributors to match opportunities and knowledge, problems and solutions, needed actions and available free time, roles and commitments.	"Control is the determination of goals, the allocation of resources to pursue them, and the monitoring of goal fulfillment and resource use." p. 746
Matching of talent to goal by identifying niches/distinctions across people in available time, passion, knowledge, resources and identifying distinctions in work across time, tacit knowledge required, and resources needed	Decomposing tasks
Some decisions handled hierarchically, some handled by default from lack of resources; division of returns handled contractually in layers	Lateral nature of decisions regarding projects to pursue, resources to share and division of returns
Broad purpose with opportunities driving dynamically created objectives	Singular specific objectives
Infrastructures that encourage actors to bring own information, knowledge, and other resources which are only shared in layers with rarely a single shared situational awareness	Infrastructures of commons for allowing "actors to access the same information, knowledge and other resources" for "shared situational awareness" p. 739
Range of actor competencies with many not setting their own goals but simply responding to others' calls for action.	"competent actors who have the knowledge, information, tools and values needed to set goals, and assess the

	consequences of potential actions for the achievement of those goals" p. 739
Guardrails not as a code but as encouragement to take measured initiative	"Protocols are codes of conduct used by actors in exchange and coordination activities" p. 739
No centralized investment in contributors but expectation that contributors will only stay if they engage in learning-oriented conversations	Significant centralized organizational investment by organization in long-term development of consultants (e.g., Accenture)

Table 6. Comparison of Catalyst Organization HTT vs. Actor-Oriented Architecture

HTT stands out even when examined in the logic of real options where a few technological pathways are explored in parallel (Adner & Levinthal, 2008; Gruber et al., 2013). Given the abundance of potential contributors, in principle, HTT can explore a sheer *limitless* amount of parallel ideas, as long as there are individuals interested in executing them. At the same time, this dynamic mandates that HTT *not prescribe the precise way* in which things are done. Put differently, HTT cannot dictate a modular task division because it cannot precisely predict what the right task division is (Reetz & MacAulay, 2017). In addition, modularization in the hope for skill-matched self-selection should also not be an aim, as it is not foreseeable precisely which talents will be required. Rather, HTT can be continuously informed about potential avenues for further development when contributors decide to embark on them, or when new knowledge enters the organization through its many connections to the outside world.

To integrate these dispersed external contributions, the catalyst design needs to incentivize as well as react to discoveries which may fundamentally alter the way HTT should operate. HTT seems to have set up a structure which is continuously able to adapt. The work, and who does it, is emergent. Given uncertainty, it is important that a continuous process of discovery and disruption is kept in motion. By providing team- and community-level incentives, and by relegating information dependencies to the team level, HTT can foster diversity in the explorative efforts undertaken. The large amount of available slack (interested contributors) sustains these efforts. Furthermore, HTT explicitly reminds contributors that "*we all are disrupters*"—

contributors are constantly challenged, and evaluated on, their ability to generate new proposals and suggestions for implementation. A Cultural Director, who has taken on a role of sharing to all HTT contributors descriptions of other companies known for disruptions, facilitates this. At the same time, the relatively stable onion structure and the official cultural guardrails ensure that some control/agency over the development and integration is kept by HTT.

We think that the catalyst organization may become a template to create organization designs for contexts like HTT's: where uncertainty is high and systemic, and for which a large contributor base can be activated at near zero knowledge acquisition costs. For example, such a design may prove fruitful for organizations tackling wicked problems (e.g., Rittel & Webber, 1973) or grand societal challenges (e.g., George et al., 2016), which will also feature difficult-to-foresee interdependencies as well as large communities of potential contributors.

At the same time, we do not claim that the catalyst organization is an optimal organization design. Rather, we suggest that is well-functioning in the setting we have identified, and call for future research to identify not only (in line with our above suggestions) other settings in which this design may be suitable, but also to inquire more generally which shifting boundary conditions (see also: Gulati et al., 2012) would impact the efficacy of this model.

Implications for Theories of Organization Design

HTT's non-modularity of task division may have implications for work on organization design more broadly than the description of a new organizational form. If it is true that we are moving toward a gig economy (see: Barley et al., 2017), where a temporary workforce with, at best, weak organizational affiliation or commitment assumes temporary responsibility for tasks, task division becomes the pivotal point of contact. So far, as we have noted, the literature on organization design argues that modularity is essential to engage volunteers (Afuah & Tucci, 2012;

MacCormack et al., 2006). Yet, as observers of organizational design, we must remind ourselves of the equally well-known research showing that broader job responsibilities lead to more perceived meaningfulness in work (Hackman & Oldham, 1980) and job satisfaction (Wood, Veldhoven, Croon, & De Menezes, 2012). Broader job responsibilities may also be aligned with the preferences of millennials (Ng & McGinnis, 2015). Therefore, research on organization design will need to consider not just the design of the organization, but the design and meaningfulness of the broader ecosystem. That is, instead of thinking of organization design as focused on tasks as requirements for individual or group performance, our understanding may be deepened if volunteers could not just pick from a set of well-defined tasks, but even partake in designing and redesigning the tasks themselves as conditions and contexts change (Oldham & Hackman 2010).

HTT's form of integration—to focus on time, skills, commitments, actions, and passion of people to disrupt, learn, and instill learning in others – instead of coordinate, control (Fjeldstad et al. 2012), and execute tasks —may increasingly be expected of 21st century organizations. Instead of having funding rounds, we might foresee that 21st century organizations such as HTT have talent and commitment layers and rounds (Applegate, Griffith, & Majchrzak, 2017), where people can shift from active to inactive, from inactive to active, from not involved to onboarding, from a community fan to active business opportunity creator. The challenge then is not growth in a traditional sense of resource spending, or even talent acquisition, but rather catalyzing new "bundles of energy" willing to dialectically engage with others, act rather than "sit on the sidelines," demonstrate passionate professionalism in everything that is done, bring personal networks of relationships and resources to bear, learn new skills, and collaboratively disrupt the world. In turn, this could become a fertile ground to use ideas generated in the context of catalyst organizations to study the boundary conditions of traditional organizations.

Implications for Theories of Exploration

Classic perspectives on exploration (e.g., Simon, 1973) usually still assume organizations and tasks to be structured around decomposable goals (Clement & Puranam, 2017; Puranam & Swamy, 2016). While this may be true if the set of all eventual tasks is known a priori, when this is not the case and tasks are modularized too early, the organization may end up exploring in the wrong places (Dattée et al., 2018).

Flexibility then is needed both in how exploration is carried out and how to evaluate the results. The specter of unlimited and broad contributors provides the ability to use contributors to define and conduct the exploration, as well as evaluate options received. Essentially, the catalyst organization is maximizing structural ambidexterity (e.g., Tushman & O'Reilly, 1996) down to the level of the individual opportunity and unique skill, since a sheer limitless number of real options can be explored in parallel. Consequently, a catalyst organization offers an alternative to one of the central premises of Afuah and Tucci (2012) about when a firm should engage in crowdsourcing. Afuah and Tucci argue that crowdsourcing requires modularization so that specialized actors can use their local search knowledge. Similarly, MacCormack, et al. (2006) highlight how the open source project Mozilla, the organization behind the Firefox browser, only took off after being modularized so that potential volunteers could identify more "chunk-size" contributions. The alternative presented by the HTT case is that, given a sufficiently large and diverse contributor base encouraged to collaboratively engage in the design as well as the accomplishment of work, non-modularization will lead contributors to explore more broadly as their worldviews collide with other worldviews—a likely prerequisite for successful explorations under high uncertainty (Dattée et al., 2018; Santos & Eisenhardt, 2009).

Implications for such a design on organizational design scholarship are many. We know little about collaborative exploration behavior. What is the process by which seekers and solvers co-

define an exploration need to ensure disruptive thought? How are alternatives evaluated when generated from collaborative exploration? How is the decision to stop exploring made?

Implications for Theories of Communities

The HTT case highlights how communities and formal organizations (with senior managers and bounded legal status) are increasingly merging given zero information costs and environmental uncertainty. Given high uncertainty, it is unclear who forms today's periphery of the community, and whether the notion of a periphery of a community even makes sense anymore. With uncertainty comes the need for shifting roles, in a manner like HTT's, where contributors can select which roles to play in the onion structure, playing multiple roles across boundaries at the same time. Also, contributors not yet involved with the organization need to be considered, given their potential relevance if the organization were to change. This is necessary to avoid developing path-dependencies that would prematurely include or exclude specific subgroups.

There is also the question of the value that catalyst organizations add to the community. HTT is an example of a collaborative organization rooted in a desire to reuse existing resources among contributors rather than reinventing new resources. Unlike research on collaborative organizations (Fjeldstad et al., 2012; Snow, Håkonsson, & Obel, 2016), HTT seems to suggest that a central organization is needed to help catalyze a larger contributor community. The catalyst is not the supervisor of the contributor, but how the organization provides the contributors a virtual room in which to meet, become stimulated by other's work, make new connections, and become energized in the talent and skills contributors have and how they can use them for worthwhile purposes. Research questions are many, however. Why, for example, has the notion of a hyperloop stimulated such world-wide attention? Is there a "cool factor" that defines successful and less successfully sustained communities? Does this mean that apparently mundane

problems, like reducing mosquitos, will not be able to sustain their communities? Do catalyst organizations redefine benefits for contributors such that contributors may be able to receive no payment, no recognition, and no physical evidence of involvement purely in exchange for the glow of being listened to?

Implications for Practice

Dirk Ahlborn and Bibop Gresta, HTT's co-founders, have spent the last four years attempting to convince CEOs, investors, and customers to adopt HTT's organization design. They encourage executives to help employees gain an ecosystem orientation to work. They argue that everyone has the potential to offer ideas and business opportunities, that boundaries around organizations are simply mind games rather than realities, and that any product today is simply a product on its way to obsolescence. While it may take a village to raise a child, it increasingly takes worldwide communities to make societal change.

Limitations and Suggestions for Future Research

Our case of HTT, while offering exciting insights, also has limitations. We see both direct next steps for future research and opportunities for these ideas to inform other streams of research. Validation of the catalyst organizational form, and its generalizability, is of the essence. While we identified many organizations similar to HTT on one or several dimensions (see Table 4), we could not find another organization that was the same on *all* of them. Future research should strive to find and assess organizations with parallel dimensions to HTT to better understand the interdependencies we found here. Additionally, it is crucial to study the conditions under which organizations with a similar purpose (but different design) could be more efficacious than HTT, and vice versa.

The context provided both strength and limitations. HTT is not simply building software (as in open source), knowledge (as in Wikipedia), t-shirts (as in Threadless), or a one-off innovation challenge such as promoted by InnoCentive, but rather an entire industry supporting the creation, implementation, and ongoing service of self-sustaining public transportation. This makes HTT unique among new organizational forms. The broad nature of the goals gives us confidence that it is not the digital nature of the product which is driving the effects we are observing. Consequently, our findings may translate broadly to other industries that are capital-intensive and/or high in the importance of complementary assets. We do, however, acknowledge that it may be precisely because HTT is not just building a product, but rather an entire industry ecosystem which may create one-time effects which could influence our results.

Finally, our findings give a renewed impetus for research trying to identify "new" forms of organizing (Dunbar & Starbuck, 2006; Greenwood & Miller, 2010; Walsh, Meyer, & Schoonhoven, 2006; Puranam et al., 2014). Indeed, our results highlight that new organizational forms emerge as traditional distinctions between task division and integration become increasingly less important than the nuances of how work gets done. We see the HTT example challenging assumptions held in our theories, and pushing their boundary conditions.

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