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Where and how to search? Search paths in open innovation

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ABSTRACT

Search for external knowledge is vital for firms' innovative activities. To understand search, we propose two knowledge search dimensions: search space (local or distant) and search heuristics (experiential or cognitive). Combining these two dimensions, we distinguish four search paths – situated paths, analogical paths, sophisticated paths, and scientific paths – which respond to recent calls to move beyond "where to search" and to investigate the connection with "how to search." Also, we highlight how the mechanisms of problem framing and boundary spanning operate within each search path to identify solutions to technology problems. We report on a study of 18 open innovation projects that used an innovation intermediary, and outline the characteristics of each search path. Exploration of these search paths enriches previous studies of search in open innovation by providing a comprehensive, but structured, framework that explains search, its underlying mechanisms, and potential outcomes.

1. Introduction

Organizational search is central to classic and contemporary innovation theories (Laursen, 2012; Nelson and Winter, 1982). However, while firms in search of "new combinations" (Schumpeter, 1934) build on accumulated experience, they are also cognitively constrained by previous choices and resource commitments, potentially resulting in myopia (Levinthal and March, 1993) and high R&D expenses. Segments of the rapidly expanding discussion on open innovation have revisited and revitalized the role of search in innovation (c.f. Afuah and Tucci, 2012; Felin and Zenger, 2014; Laursen and Salter, 2006). A key idea in open innovation is that firms should exploit search outside the confines of their organization (c.f. West et al., 2014), making the search for external knowledge an important managerial task (Laursen and Salter, 2006, p. 147). Search for external knowledge is arguably quite complex and difficult, involving uncertainties and characteristics such as the tacitness, complexity, rivalry, and indivisibility of knowledge which may not be conducive to its detection and transfer (c.f. Zollo and Winter, 2002). Despite this complexity, search has been analyzed primarily by using one-dimensional constructs such as local vs. distant (Knudsen and Srikanth, 2014), which seldom recognize how different heuristics interact with the solution location (Nickerson and Zenger, 2004).

This paper explores the dynamics and direction of search. We suggest that organizational search involves two dimensions (Gavetti and Levinthal, 2000). The first refers to *where* to search, i.e., the location of solutions – local or distant – in relation to currently available solutions (Katila and Ahuja, 2002; Levinthal and March, 1981). The second concerns *how* to search, and which search heuristics to apply, i.e., experiential or cognitive search (Gavetti and Rivkin, 2007; Nickerson and Zenger, 2004). So far, research on open innovation focuses mostly on where to search in a given search space (Garriga et al., 2013; Laursen and Salter, 2006; Piezunka and Dahlander, 2015), and several scholars lament the relatively small attention given to how search takes place, and what alternative search heuristics are applied in open innovation (Felin and Zenger, 2014; Jeppesen and Lakhani, 2010).

Combining the "where" and "how" dimensions of search, we propose a framework for firms' search for external knowledge that encompasses situated search paths, analogical search paths, sophisticated search paths, and scientific search paths. In pursuing these search paths, firms can exploit two mechanisms to identify solutions in idea and technology markets: first, a problem framing mechanism (Baer et al., 2013; Kaplan, 2008; Von Hippel and

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Von Krogh, 2015) that involves focusing on and articulating the problem as a technology need before its dissemination, and second, a boundary spanning mechanism (Fleming and Waguespack, 2007; Rosenkopf and Nerkar, 2001) that involves recognizing and connecting the technology need to a specific crowd of technical or scientific solvers. We address the following research questions: (1) What are the characteristics and objectives of each search path? (2) How do problem framing and boundary spanning mechanisms facilitate the identification of solutions?

Our findings draw on 18 open innovation projects to study how innovation intermediaries (c.f. Chesbrough, 2006; Roijakkers et al., 2014) help clients find potential solutions to their technology problems,[1] by selecting a search path and exploiting search mechanisms. Our research involves an embedded case study conducted at a leading innovation intermediary-NineSigma. A new breed of innovation intermediaries (e.g., NineSigma, InnoCentive, Yet2.com) is offering services to assist firms in their search for external knowledge and intellectual property (IP) management. We focus on intermediaries that facilitate connections between firms (knowledge-seekers) pursuing search for solutions and ideas in technology markets, and a global network of solution-providers such as R&D laboratories, university faculty, and specialist companies (Boudreau et al., 2011; Jeppesen and Lakhani, 2010; Sieg et al., 2010).

Our findings make several contributions to the literature. Theoretically, we propose a search path framework to clarify and explain complex search patterns and choices, and to extend theories in the innovation literature that build on the search framework suggested by March and Simon (1958). We also propose two new types of search – analogical and sophisticated – as important search options. Finally, we connect the problem framing (Baer et al., 2013; Kaplan, 2008; Von Hippel and Von Krogh, 2015) and boundary spanning (Fleming and Waguespack, 2007) literatures to propose mechanisms related to the solution of problems within these search paths.

The paper is structured as follows: Section 2 presents the two search dimensions, discusses the search mechanisms, and describes the four proposed search paths. Section 3 discusses the research design and data collected. Section 4 describes how the search for solutions to problems is associated with our four search paths, and examines the use of problem framing and boundary spanning mechanisms in 18 open innovation projects. Section 5 discusses how the selection of a specific search path influences the identification of solutions to problems. Section 6 presents our main conclusions.

2. Literature review and framework

2.1. The search for solutions to problems

Organizations search for alternative solutions to problems when current routines fail to produce results that match the organization's aspirations (March and Simon, 1958). The screening of alternative solutions and task decomposition are major components of the problem-solving process (March and Simon, 1958, p. 178).[2] For cognitive reasons, "problemistic search" (Cyert and March, 1963, p. 120–122) tends to be both simple-minded and biased, causing organizations to search locally, in the vicinity of already identified solutions. Levinthal and March (1981, p. 309) describe this as "refinement search", which "emphasizes relatively immediate refinements in the existing technology, greater efficiency, and discoveries in the near neighborhood of the present activities."

However, when a problem cannot be solved using current routines, the firm is forced to innovate by developing new knowledge. "Innovative search" (Levinthal and March, 1981) includes distant search for new technologies, based on new combinations of knowledge (Carnabuci and Operti, 2013; Schumpeter, 1934). The subsequent literature on search and innovation investigates the properties and outcomes of refinement-oriented local search (exploitation) vs. innovation-oriented distant search (exploration) in more depth (Laursen, 2012; March, 1991). Also, these analyses focus on the location of alternatives relative to current behavior and "the elements that are to be searched" (Gavetti and Levinthal, 2000, p. 114). Below, we show that this search problem centers on the question of *where to search.*

2.1.1. Search space: where to search?

Firms looking for solutions to problems search among combinations of knowledge in a search space (Knudsen and Srikanth, 2014). How does the firm know where to start? By envisaging the search space as the relative distance from the firm's current knowledge base, search may be *local*, i.e., in the vicinity of the firm's current knowledge, or *distant*, i.e., farther away from the firm's current knowledge. In practice, knowledge categories and knowledge combinations need to be determined in advance. Knowledge categories can be represented by technological domains (e.g., internal combustion, electronics, bioenergy, etc.), industry classifications (e.g., automobiles, consumer retailing, telecommunications), or scientific fields (e.g., electromagnetic waves, particle physics, optimization). However, it is crucial that the focal firm understands where the appropriate knowledge is "stored" (e.g., in individuals, organizations, theories, patents, products, etc.) in order to effectively search for it.

Organizations primarily search in the proximity of existing routines and previous solutions (Levinthal and March, 1993; Stuart and Podolny, 1996). Therefore, when conducting *local search*, organizations look for solutions that build on knowledge already in use. Although local search decreases the probability of finding novel solutions, it increases the chances of finding and acquiring workable solutions. In contrast, *distant search* entails knowledge recombination (Fleming and Sorenson, 2004; Rosenkopf and Nerkar, 2001), which may provide opportunities to identify disruptive innovations and achieve competitive advantage. Building on Schumpeter's (1934) seminal argument, knowledge recombination and integration is a quintessential element of innovative capability (Carnabuci and Operti, 2013). Distant search essentially involves the search for solutions that are unrelated to the firm's current knowledge base. However, organizations often filter out solutions based on distant knowledge, preferring to evaluate solutions from local knowledge sources (Piezunka and Dahlander, 2015).

A mechanism that helps to balance the local–distant search space is *boundary spanning*. Although exploring within the boundaries of the firm's technological domain may satisfy a specific technology need, boundary spanning involving a distant technological domain helps identify new ways to solve problems (Rosenkopf and Nerkar, 2001). Most firms employ mechanisms that facilitate the identification of short-term solutions, i.e., local search, or potential longer-term breakthroughs, i.e., distant search (Hargadon and Sutton, 1997). Understanding the underlying search space is at the heart of the boundary spanning mechanism (Fleming and Sorenson, 2004), which enables information processing, interpretation and translation of knowledge, and negotiation of common meanings among heterogeneous parties and across cohesive technological boundaries (Fleming and Waguespack, 2007).

[1] Hereafter referred to as "problems."

[2] March and Simon (1958, pp. 178–179) also discuss randomness and the hierarchical structure of problem-solving in search. We acknowledge that innovation involves much more than just search for solutions since it requires knowledge integration, implementation, and diffusion, market acceptance, etc. but in this study we focus on the search problem.