Managing Distributed Innovation: Strategic Utilization of Open and User Innovation

Marcel Bogers
SPIRE Center, Mads Clausen Institute for Product Innovation, University of Southern Denmark
Joel West
KGI — Keck Graduate Institute

Published as: Marcel Bogers and Joel West, "Managing Distributed Innovation: Strategic Utilization of Open and User Innovation," *Creativity and Innovation Management,* 21, 1 (March 2012): 61–75. DOI: 10.1111/j.1467-8691.2011.00622.x

Revision date: October 24, 2011

Abstract: Research from a variety of perspectives has argued that innovation no longer takes place within a single organization, but rather is distributed across multiple stakeholders in a value network. Here we contrast the vertically integrated innovation model to open innovation, user innovation, as well as other distributed processes (cumulative innovation, communities or social production, and co-creation), while we also discuss open source software and crowdsourcing as applications of the perspectives. We consider differences in the nature of distributed innovation, as well as its origins and its effects. From this, we contrast the predictions of the perspectives on the sources, motivation and value appropriation of external innovation, and thereby provide a framework for the strategic management of distributed innovation.

Keywords: open innovation; user innovation; cumulative innovation; communities; social production; co-creation; open source software; crowdsourcing

Acknowledgements: Earlier versions of this paper were presented at the User and Open Innovation Workshop 2009, and the UC Berkeley Center for Open Innovation.

Managing Distributed Innovation: Strategic Utilization of Open and User Innovation

1 Introduction

For most of the 20th century, both the practice and theory of technological innovation emphasized controlling innovations within the firm. In fact, the need to fund and control such innovations was long believed to be a major reason for the existence of the modern industrial corporation (Armour & Teece, 1980; Chandler, 1977; Freeman, 1982). Until recently, only limited objections were raised to this dominant view (e.g., Allen, 1983; Robertson & Langlois, 1995; von Hippel, 1988). More recently, both managers and researchers have increasingly considered exceptions to this vertically integrated innovation model, as reflected by studies of technological innovations created outside organizations and contemporary phenomena such as open source software and crowdsourcing.

There are two major streams of research on these distributed processes of innovation. The research of von Hippel (1976, 1988, 2005) established the importance of **user innovation**, and how such innovations can be disseminated to others. Meanwhile, Chesbrough's (2003a, 2006a) **open innovation** focuses on firms cooperating across firm boundaries to create and commercialize innovations. Other distributed innovation processes have included cumulative innovation, communities, social production and co-creation (Benkler, 2006; Bogers et al., 2010; Murray & O'Mahony, 2007; West & Lakhani, 2008). These perspectives differ in their views of the locus of and motives for innovation, as well as the nature of innovation, its commercialization process and its relevance for firms.

Together, the researchers within the domain of distributed innovation challenge the vertically integrated model and its assumption of innovation being created and

commercialized within a single firm. All allow for dispersed market and technical knowledge leading to distributed innovation creation and commercialization. However, these views have largely been disjoint — with researchers building within each stream rather than across the various streams — and in some cases assuming that one is a proper subset of the other. Thus, the managerial implications of this research offer conflicting predictions for some phenomena and congruent predictions for others. The research also examines different types of external innovation, including raw knowledge and innovation reduced to practice in externally produced components or complements.

The remainder of this paper contains four sections. First, we consider the various definitions of innovation (and innovativeness) in such research. Then we discuss research on the traditional and distributed views of firm innovation, as well as research on related phenomena such as open source software and crowdsourcing. Next, we consider the strategic implications for firms of distributed innovation. From this, we discuss the implications of this integrated view for theory and practice.

2 Divergent Views of "Innovation"

The research on distributed innovation has used differing definitions of what constitutes "innovation." Here we consider two areas of divergence: the attributes of technological innovations, and the degree of innovativeness. We focus particularly on the two major distributed perspectives: open innovation (e.g., Chesbrough 2003a, 2006a) and user innovation (e.g., von Hippel, 1988, 2005).

2.1 Innovation Attributes: Knowledge, Components and Complements

Discussions of distributed innovation processes tend to blur the distinctions between innovation and its origins and effects. However, all the firm-centric perspectives

consider how firms access external sources of knowledge to supplement their own knowledge as an input to their innovation efforts.

The idea that commercially valuable knowledge is dispersed outside the firm is the key antecedent to the distributed view of innovation. For example, Chesbrough (2006a: 9) writes, "In open innovation, useful knowledge is generally believed to be widely distributed, and of generally high quality." Moreover, von Hippel (2005: 70) argues that, as "different users and manufacturers will have different stocks of information … each innovator will tend to develop innovations that draw on the sticky information it already has." Some disitributed production processes such as open source software and Wikipedia would also not exist without bringing together different knowledge bases distributed across the world (Benkler, 2006; von Hippel, 2007).

In some cases, firms will rely on external actors to supply knowledge that serves as an input to creating their own innovations. This includes basic scientific research produced and disseminated through open science[1] processes, knowledge of market needs and demands obtained from customers, or broadcast search used to identify promising avenues for future innovation (David, 1998; Jeppesen & Lakhani, 2010; Lilien et al., 2002).

In other cases, the external parties may supply innovations, which are then used or commercialized by firms (e.g., Baldwin et al., 2006; Chesbrough, 2003a; von Hippel, 2007). Von Hippel (1994, 2005) focuses on the "sticky information" held by users that

---

[1] "Open science" is the term used by David (1998, 2002) to describe the spillovers between scientific researchers that are possible when basic research is subsidized as a public good — consistent with Merton's (1973) model of government funded research in the postwar U.S. The recent emphasis on faculty patenting and industry collaboration has been seen to threaten these norms of open collaboration (Fabrizio & Di Minin, 2008).

is more effectively developed through user innovation rather than by transferring that information to producer-innovators. Moreover, innovations developed by one firm may involuntarily spill over to rivals (Allen, 1983). Either way, these externally developed innovations are obtained by the firm — either on an exclusive or non-exclusive basis — and incorporated into a firm's goods and services.

The external innovator may also commercialize his or her innovation in the form of a product that is sold to the focal firm (cf. Shah & Tripsas, 2007). These products may be components or other materials that are integrated by the firm into its own products, as has become the norm in the personal computer industry (Dedrick & Kraemer, 1998). Alternatively, the research and development (R&D) of an equipment supplier is used to produce innovations incorporated in tools purchased by producers, as when domestic machine tools improved the postwar German auto industry. Supplier innovations may thus come in the form of materials, components and equipment; Laursen and Salter (2006) found that suppliers were the most common source of external knowledge for innovation among 2707 U.K. manufacturers.

Finally, complementary innovations produced by external participants may be provided directly to users. In some cases, these complementary products are sold by for-profit firms, as is common with third party computer software (West, 2006). In other cases, the complements are provided by individuals, whether in the form of user support (Lakhani & von Hippel, 2003), synthesized musical instruments (Jeppesen & Frederiksen, 2006) or game modifications (West & Gallagher, 2006). While such information, goods or services do not directly involve the firm, they do increase the value of the firm's products and thus improve its ability to profit from its innovations (cf. Teece, 1986).

2.2 Varying Degrees of Innovativeness

Extant research on technological innovation has drawn distinctions as to the degree of innovativeness, both for micro-level new product development and macro-level technological change. However, these distinctions have not always been explicitly acknowledged in research on distributed innovation.

2.2.1 What Constitutes an Innovation?

A given innovation is typically classified across two orthogonal dimensions of technical novelty. First, technological novelty refers to whether the innovation constitutes a discontinuous (or radical) or an incremental technological change (Abernathy & Utterback, 1978; Tushman & Anderson, 1986). The discontinuous innovation has a greater impact on the production and use of the technology, while incremental innovation is more frequent and customary.[2] Second, the geographic scope of novelty refers to whether the innovation is new the world or new to a specific producer or adopter (Cooper, 2001).

Researchers must consider how much of an innovation counts as "innovative" or at least is worth measuring. For example, should innovation in packaging or support be considered in the same category as a change to the product function? The boundaries (between innovation and non-innovation) become even more blurry as user and open innovation researchers consider areas beyond product innovation, including process innovation, service innovation and administrative innovations. In all three cases, it may be difficult to draw a "bright line" distinction as to what constitutes an innovation,

---

[2] An existing technology provided at a dramatically lower cost will often have the same impact on production and use as a discontinuous technological advance, whether termed disruptive innovations (Christensen, 1997) or radical innovations (Leifer et al., 2000).

particularly for those so-called innovations that are not disseminated to others (such as an incremental improvement of how a user uses a commercial product.)

One way to solve this problem is to operationalize an innovation as one that is disseminated to others, whether through commercial or non-commercial processes (cf. Freeman, 1982; Rogers, 1995). However, efforts to tighten the definition of innovation risks excluding important innovations: a series of incremental process improvements in producing a good can together lead to a major change in the performance (or cost) of the good (Abernathy & Utterback, 1978).

2.2.2 Innovation "Radicalness" in Distributed Innovation Processes

In general, open innovation research considers all possible combinations and recombinations of externally created innovations, as long as the firm can successfully commercialize the insourced innovation. Most specifically, open innovation implies that firms acquire technology that is new to them but not new to the market, whether incremental innovations in personal computers (Chesbrough, 2003a) or discontinuous innovations in consumer electronics (Christensen et al., 2005). Laursen and Salter (2006) specifically explore new-to-the-world versus new-to-the-firm innovation and they find that the importance of external knowledge search is largely similar for each type of innovation. Nevertheless, large parts of the distributed innovation research implicitly argue that openness is particularly effective to find more radical innovations — exemplified by the concept of crowdsourcing as a means to identify innovative input from non-obvious sources through global searches (Jeppesen & Lakhani, 2010).

Users — both consumer users (end users) and intermediate users (user firms) — may be the sources of both radical and incremental innovation, although the existing research on user innovation often fails to identify the degree of innovativeness for user-

generated users (Bogers et al., 2010). In some cases, both business and individual users incrementally improve upon the work of producers and other users, in a process that reflects many of the principles of cumulative innovation (cf. Murray & O'Mahony, 2007).

At the same time, lead users often develop innovations that are new to the world and thus set off a new industry or market niche (e.g., Baldwin et al., 2006). Firms can also solicit innovative input from users to develop breakthrough innovation, as shown through 3M's use of the lead user method (Lilien et al., 2002). Less frequently, researchers have also identified examples of user-developed radical innovations, as exemplified by Lettl et al.'s (2006) study in robotic neurosurgery of a producer-funded doctor's prototype development.

A subset of the distributed innovation research tends to focus on the process of incremental advances within an existing product or technology. In particular, cumulative innovation focuses on the incremental improvements made by innovators to each other's technology — often in the context of a radical innovation that is being refined to become useful (e.g., Nuvolari, 2004). The refinement of radical innovation by competing firms towards creation of a dominant design — as in Utterback's (1994) account of the manual typewriter — directly corresponds to such a process. Direct collaboration in cumulative innovation is often an important goal of R&D alliances (cf. Hagedoorn, 2002).

3 Integrated and Distributed Models of Firm Innovation

Decades of research has identified how firms develop technical inventions into technological innovations, and then commercialize these innovations through an internal process of R&D, production and distribution. Such research has established

both technical and business aspects of the innovation process, as exemplified by the vertically integrated industrial giants of the mid-20th century (Chandler, 1990; Freeman, 1982).

A more recent view of innovation builds upon this research while rejecting the vertically integrated paradigm as incomplete. Pointing to the prevalence of innovation that relies on multiple sources of knowledge not controlled by a single firm, it advocates an external search for sources of innovation. Following von Hippel (1988), we use the term "distributed innovation" to refer to sources of innovation outside the focal firm, whether held by individuals, firms, or communities. Lakhani and Panetta (2007) have also used this term to refer to the fact that sources of knowledge and innovation are distributed within a society — as exemplified by the case of open source software.

The two major streams of distributed innovation — open innovation and user innovation — were originally motivated by the observation of gaps between the actual practice and the accepted vertically integrated innovation model. These and other distributed perspectives are based on a fundamental rejection of one or more of the premises of the older model. Accordingly, these complementary perspectives offer a shared critique of the vertically integrated model of firm innovation by considering innovations created beyond the boundaries of a single firm.[3]

Table 1 summarizes key differences between the vertically integrated, open and user innovation perspectives, which are developed further below. Subsequently, we also offer a brief review of other perspectives, which together contribute to the distributed

---

[3] User innovation and open innovation offer complementary views on the nature of distributed innovation, which are overlapping in some areas (e.g. role of users as a source of innovation) and disjoint in other areas (IP markets for open innovation, nonprofit user communities for user innovation.)

innovation model. We conclude this section by describing open source software and crowdsourcing as two contemporary applications of these distributed perspectives.

Insert Table 1 about here

3.1 A Vertically Integrated Model of Industrial Innovation

As conceptualized by innovation scholars, the industrial innovation process comprises both a technical component (invention) and also the commercialization of that technology (innovation). Schumpeter (1934: 88) concluded that technical inventions "not carried into practice … are economically irrelevant," while Freeman (1982: 7) argued that "inventions … do not necessarily lead to technical *innovations*. In fact the majority do not. An *innovation* in the economic sense is accomplished only with the first *commercial* transaction." However, because innovations can have economic or societal impact even if diffused through a non-commercial process (Rogers, 1995) — as with many open source software projects — a more generalized definition is given by Roberts (1988: 12): "Innovation is composed of two parts: (1) the generation of an idea or invention, and (2) the conversion of that invention into a business or other useful application."

The traditional innovation process is thus a path from basic scientific discoveries, through firm R&D, and then commercialized and distributed to the customers through the market (Chesbrough, 2006a). Freeman (1982) divides that process into four stages: basic research, invention, development and production. Such technical aspects of the innovation process include basic and applied research to discover scientific knowledge, invention of new commercially relevant technologies, and the development of those technologies into marketable innovations to serve a specific market need.

These scientific discovery, invention and R&D processes are enabled by the knowledge of the participants — not only of science, technology and development

processes, but also the knowledge of basic or applied problems in search of a solution (Freeman, 1982). Controlling this end-to-end process is a key reason for the existence and success of large industrial firms (Armour & Teece 1980; Chandler, 1977). Vertically integrated firms exist because they are better able than markets to internalize and control dispersed knowledge (Galunic & Rodan, 1998; Kogut & Zander, 1992), due to failure of markets and the inability to appropriate benefits of innovation (cf. Chandler, 1977, 1990). Smaller firms that lack the complementary assets to control this commercialization process face (often insurmountable) difficulties in profiting from their technical innovations (Teece, 1986). As such, vertical integration is the direct and indirect outgrowth of industry maturation. As the rate of change slows, firms seek to control their value chain. Eventually, mergers, exits and other sources of consolidation give firms the scale (often by creating oligopolies) necessary to perform their own R&D (Allen, 1983; Utterback & Suárez, 1993).

A distributed perspective on industrial innovation goes beyond this view by arguing that innovation is not (purely) a vertically integrated process, but rather relies on recombining knowledge that is available outside of the focal firm's boundaries, across various external stakeholders. We now review the main streams of literature that fuel such a critical view.

3.2 Open Innovation

As conceived by Chesbrough (2003a), open innovation describes a modification to the vertically integrated paradigm in which firms are more open to external innovation-related activities.[4] This stream of research postulates that firms are often better off

---

[4] The term "open innovation" has been used in other contexts, but in this paper we reserve the phrase for the context conceived by Chesbrough (2003a).

commercializing external sources of innovations, and finding external paths for commercializing internally sourced innovation (Chesbrough, 2003a, 2006a; Dahlander & Gann, 2010; Enkel et al., 2009). Open innovation has many similarities to the vertically integrated model of industrial innovation, combining with and supplementing the practices and concepts of the integrated model including an emphasis on firm success (Chesbrough, 2006a, 2006b). Unlike other distributed perspectives, such as user innovation, open innovation often allows for (if not depends on) achieving economies of scale, as when Intel designs standardized microprocessor components that are used as external innovations by systems integrators (West, 2006).

The core research questions in open innovation research are how and when firms can commercialize the innovations of others and commercialize their valuable innovations through others. Open innovation is especially concerned with the economic (pecuniary) implications and opportunities provided by external sources of innovation and commercialization. In contrast to some other streams, it mainly focuses on the revenue-generating practices from a firm perspective (Vanhaverbeke et al., 2008; van de Vrande et al., 2009). Typically, the level of analysis is either an individual firm or dyadic pairs of firms, although a limited amount of research has examined value networks of multiple firms/organizations, or communities of individuals (Chesbrough & Prencipe 2008; Vanhaverberke, 2006; West et al., 2006; West & Lakhani, 2008).

While some open innovation research has considered outbound commercialization of a firm's technology (e.g., Lichtenthaler & Ernst, 2007), like most research here we focus on the inbound process, in which firms source external knowledge to reduce cost or increase opportunity related to innovation (Dahlander & Gann, 2010; Enkel et al., 2009). Such research identifies a variety of external stakeholders as possibly valuable

sources of knowledge for innovation, such as suppliers, customers, competitors and universities (Chesbrough, 2003a, 2006a; Christensen et al., 2005; Laursen & Salter, 2006).

3.3 User Innovation

Research on user innovation assumes that users have the knowledge and motivation to create innovations that solve needs unmet by existing producers. Thus, while open innovation research is ultimately interested in innovation benefits for a producer firm, user innovation research focuses on the conditions under which users innovate and how users can be supported to be more innovative. User innovation research typically explores innovation as an outcome variable in empirical studies — with innovation often defined as a new or improved product or service (von Hippel, 2005). The level of analysis is usually that of individual users and user communities, and the contributions they make to firms, although there is also a (renewed) interest in user firms and other user organizations as the sources of innovation (Bogers et al., 2010).

User innovation is different from other perspectives in that it explores the "functional relationship" that a stakeholder has with an innovation.[5] It thus investigates users or user communities as the main stakeholders, and explores when these users innovate and share their innovations among each other or with producers (de Jong & von Hippel, 2009; Harhoff et al., 2003; von Hippel, 2007). Most recently, the dynamic aspects and significance of user innovations has become of interest to user innovation scholars (Baldwin et al., 2006; Baldwin & von Hippel, forthcoming; Shah & Tripsas, 2007).

---

[5] Earlier research also investigated suppliers as the sources of innovation, based on their expectation to appropriate the benefits from selling material or components complementary to the innovation (VanderWerf, 1992; von Hippel, 1988).

User innovation differs from firm-centric perspectives such as open innovation, because the questions and findings revolve around the utility gains for the user rather than any pecuniary benefits. Nevertheless, opportunities for commercializing external innovation created or co-developed by users can exist for profit-seeking firms, as exemplified by the research on toolkits that enable co-innovation with users (Franke & von Hippel, 2003; von Hippel & Katz, 2002), on user communities and open source software (Dahlander & Wallin, 2006; Jeppesen & Frederiksen, 2006), and on user entrepreneurship (Shah & Tripsas, 2007).

3.4 Other Distributed Processes

In addition to these dominant research streams that focus on knowledge flows up and down the value chain (Figure 1), there are three other, complementary flows of knowledge: between firms, between users and other stakeholders, and then interactive processes between firms and users.

Insert Figure 1 about here

3.4.1 Cumulative Innovation

Research on cumulative innovation assumes that unmonetized knowledge spillovers between rivals play a crucial role in advancing technological progress and thus improving societal welfare. The emphasis of cumulative innovation is on rivalrous firms seeking to increase revenues and profits through technological innovation, normally when that technology is immature or otherwise not fully commercialized. These spillovers may reflect intentional collaboration or unintended spillovers that cannot be stopped.

The initial focus of cumulative innovation research considered cases where various parties successively refine a single technology until the improved technology is widely used by a range of producers (Allen, 1983; Nuvolari, 2004). The other pattern of

cumulative innovation is when firms build upon a common, ever-increasing pool of enabling science, as on biopharmaceutical drug discovery (Murray & O'Mahony, 2007; Rai, 2001).

3.4.2 Community or Social Production

Some forms of innovations are developed, disseminated or interpreted through communities — whether for open innovation or user innovation. The interactions in these communities are between individuals, but these individuals could be representing their personal (consumer) interest or instead the interest of their employers (West & Lakhani, 2008). Some communities are sponsored by firms to support their objectives, while others may arise organically to meet the user objectives (Jeppesen & Frederiksen, 2006; West & O'Mahony, 2008).

Research has particularly focused on communities of individuals practicing user innovation, whether in software (Lakhani & von Hippel, 2003) but also physical products (Franke & Shah, 2003).[6] Such production by user communities has also been termed "distributed production" (Weber, 2004) or "social production" (Benkler, 2006). Firms practicing open innovation may leverage user communities as sources of external innovation, by assigning employees to participate in these communities (Henkel, 2009; Jeppesen & Frederiksen, 2006; West & O'Mahony, 2008).

3.4.3 Co-creation

Other researchers have moved beyond the single-inventor perspective to consider co-creation, as the collaborative development between two or more stakeholders. This process involves knowledge inflows and outflows between complementary partners,

---

[6] Such innovations may also be produced by networks of users that, while connected by computer-mediated virtual networks, lack a common community identity or interpersonal ties (von Hippel, 2007).

including horizontal and vertical alliances (cf. Bogers et al., 2010). These may reflect formal alliances between direct rivals (Hagedoorn, 2002; Mowery et al., 1996) or efforts by suppliers to collaborate with customers (Sawhney et al., 2005). Beyond creating product innovation, co-creation can also be a way to create value more generally (Prahalad & Ramaswamy, 2003; Vargo & Lusch, 2004).

3.5 Applications of the Perspectives

Open innovation, user innovation and the other perspectives have studied various distributed innovation phenomena. Here we consider how these perspectives have been applied to two such phenomena: open source software and crowdsourcing.

3.5.1 Open Source Software

Open source software has been extensively studied by user innovation scholars who build upon the maxim of open source pioneer Eric Raymond (2001) that "every good work of software starts by scratching a developer's personal itch." While they recognized early how open source software demonstrated principles of user innovation in terms of for example feature improvements and peer-to-peer support (Franke & von Hippel, 2003; Lakhani & von Hippel, 2003; von Hippel & von Krogh, 2003), the development process has strong parallels with the social production/community perspective.

At the same time, from an open innovation perspective, firms can use open source as a source of external innovations, or to spin off technologies that cannot be commercialized by the firm, while they can also combine efforts to use open source software to create pooled R&D as inputs to their own innovation processes (Dahlander & Wallin, 2006; Jeppesen & Frederiksen, 2006; West & Gallagher, 2006). However, we

believe that the understanding of the phenomenon would be enhanced by approaches that combine the various perspectives on distributed innovation.

3.5.2 Crowdsourcing

Coined by Howe (2006, 2008), crowdsourcing refers to the outsourcing of a task that is traditionally done by an organization's employee(s) to an undefined, generally large group or network of people in the form of an open call. When the sourcing serves a corporate goal, these are consistent with the open innovation paradigm, while in other (overlapping) cases the crowd is being asked to share its knowledge as users to improve its own experience — as with user innovation.

This umbrella term "crowdsourcing" subsumes a range of different approaches, including corporations acting as open innovation intermediaries, firms managing their own crowds, communities that aggregate online content or coordinate peer production, or the open call organized as a contest (Ren & Levina, 2010). It should be noted that not all of the research on crowdsourcing — or even "open innovation" and "user innovation" — involves the creation of innovations (as defined by Freeman 1982 or Roberts 1988); in particular, most user-generated content would not qualify as an innovation in the usual sense of the term.

Researchers have recently examined examples of each of these approaches, including the innovation intermediaries such as InnoCentive (Jeppesen & Lakhani, 2010), direct firm solicitation of innovation by P&G for consumer goods and Threadless for T-shirts (Dodgson et al., 2006; Ogawa & Piller, 2006), or the open contests represented by TopCoder (Archak, 2010). Some research has contrasted the internal and distributed sources to innovation, as with Huston and Sakkab's (2006)

study of P&G's Connect and Develop, which contrasts searching for a solution in its global networks of individuals and institutions with those within a particular lab.

4 Strategic Management of Distributed Innovation

Firms that seek to profit from distributed innovations face three challenges (West & Gallagher, 2006): identifying a supply of external innovations, making sure that supply continues, and finding a way to appropriate value from those innovations (Figure 2). Here we consider those three issues in turn as they have been presented by prior research in distributed innovation, with most emphasis on the core perspectives of open and user innovation.

Insert Figure 2 about here

4.1 Identifying/Searching for Distributed Innovation

Where can a firm find innovations that originate from its many external stakeholders? Here we apply a value network perspective, which considers the sources of innovation outside of a focal firm and thus reveals how knowledge and innovation might effectively flow across various stakeholders in general and to the focal firm in particular. Such perspective suggests how the different perspectives on distributed innovation emphasize different external stakeholders and other members of the value network, including suppliers, rivals, users and complementors (see Figure 1).

4.1.1 Sources Within the Value Network

Research on distributed innovation has identified a number of valuable sources of knowledge and innovation. More generally, open innovation assumes external actors with different knowledge and perceptions (Chesbrough, 2003a: 43). Possible sources of external innovation that have been identified are suppliers, customers, competitors and

universities (Chesbrough, 2003a; Christensen et al., 2005; Laursen & Salter, 2006; Mowery et al., 1996). There is also increasing recognition of the importance of innovation networks more generally (Chesbrough & Prencipe, 2008; Vanhaverbeke & Cloodt, 2006). Universities are not only generally important but scientists can moreover serve as sources of external innovation through processes as open science and crowdsourcing (David, 2002; Jeppesen & Lakhani, 2010; Perkmann & Walsch, 2007).

Customers or users are identified by many studies on distributed innovation as the main source of innovative knowledge. They are often the key source of innovation in crowdsourcing and open source software (Poetz & Schreier, forthcoming; von Krogh & von Hippel, 2006). Because innovation requires combining knowledge of the user's need with knowledge of the solution to solve that need (von Hippel, 2005), users play a central role when the local and sticky nature of innovative knowledge makes it difficult or costly to transfer the knowledge (Lüthje et al., 2005; Ogawa, 1998; von Hippel, 1994). Because revealing their innovation can enhance users' utility, they often distribute that information to both producers and other users (Harhoff et al., 2003). Consequently, it is beneficial for users to organize their innovative activities in communities with other users (Franke & Shah, 2003; Lakhani & von Hippel, 2003; von Hippel, 2007).

4.1.2 Searching for Distributed Innovation

Firms have various ways to search for distributed innovation, while the external stakeholders may approach firms to reveal their innovation on their own initiative (Harhoff et al., 2003; von Hippel, 2007). Some distributed innovation approaches rely on actively soliciting innovations from external stakeholders by using platforms such as

innovation toolkits and crowdsourcing. In other cases, external stakeholders create (personal) value from an innovation, which must be identified and captured by the firm.

Searching for and internalizing innovative knowledge from the external environment thus becomes a central part of a firm's innovation strategy. Laursen and Salter (2006) provide a holistic perspective with regard to firms' search for external knowledge for innovation, arguing that firms must optimize the search for and use of external knowledge. One complementary approach to search for distributed innovation is making use of communities of external stakeholders, turning community management into an integral part of a firm's innovation search strategy (cf. Dahlander & Wallin, 2006; Jeppesen & Frederiksen, 2006; O'Mahony, 2007).

4.2 Maximizing/Motivating the Supply of Distributed Innovation

Given the large variety of possible sources of external innovation in a firm's value network, firms are challenged by how to maximize the supply of innovations that originate beyond their boundaries. Motivating external stakeholders to supply innovations is a particular challenge because of possible misaligned interest between these stakeholders and the focal firm (cf. von Hippel, 2005; West & Gallagher, 2006).

Here we discuss how distributed innovation creates value for different stakeholders, and how such innovation can be identified and motivated through both pecuniary and non-pecuniary mechanisms. Table 2 gives an overview of different distributed innovation perspectives with respect to the implied motives (pecuniary vs. non-pecuniary) and the type of innovator (individual vs. organization), while Table 3 gives an overview of the types of innovation flows (use and restrictions) according to the different distributed innovation perspectives.

Insert Tables 2 & 3 about here

While firms may wish to incorporate external innovations into their product, this depends on motivating an external supply of innovations (West & Gallagher, 2006). Dahlander and Gann (2010) distinguish between pecuniary and non-pecuniary incentives for obtaining external innovations: user innovation emphasizes the latter while open innovation considers both.

For user innovators, the non-pecuniary benefits include meeting their own needs (personal utility) as well as direct and indirect benefits of sharing their newly developed knowledge in their community (von Hippel, 2007). The prevalence of knowledge sharing can often be explained by the direct benefits users gain from freely revealing their knowledge (Harhoff et al., 2003). Meanwhile, firms create "toolkits" to facilitate the supply of user innovations (Franke & Piller, 2004; von Hippel & Katz, 2002). Users also gain status and reciprocity benefits from belonging to a community and donating their contributions to it (cf. Shah, 2006). Communities more generally offer great potential value for firms seeking for external innovation. These firms thus need to develop a strategy for motivating community members to create and share innovations (Dahlander & Wallin, 2006; Lakhani & Wolf, 2005).

Open innovation also includes non-pecuniary motives. In the case of open source software and game modifications, programmers may donate their innovations to improve their reputation — whether for ego reasons or to signal their skills to the labor market (West & Gallagher, 2006). However, open innovation most typically emphasizes the pecuniary motivations for firms to supply their innovations to other firms (Chesbrough, 2006b). In crowdsourcing, individuals are usually paid directly for their innovation contributions, as with InnoCentive's problem contests (Jeppesen & Lakhani, 2010).

The availability of external innovations from direct competitors is more problematic. Consistent with user firm innovations (cf. de Jong & von Hippel, 2009), firms may freely reveal their innovations because they are complementary to their core business model (Nuvolari, 2004). In other cases, their efforts to block spillovers are unsuccessful, or not economically feasible (e.g., Allen, 1983); in these cases, the unwilling supply of external innovations will likely be unreliable. However, despite the exact drivers, knowledge sharing among firms or organizations more generally, such as in co-creation and cumulative innovation, typically serves ultimate pecuniary motives.

4.3 Appropriating Value from Distributed Innovation

We now explore how firms can capture the value from distributed innovation that is created and shared by external stakeholders in their value network.

4.3.1 Ownership of Distributed Innovation

Ownership of technology is a main driver of who is able to appropriate value within open innovation, as it determines the constraints for knowledge transactions (cf. Arora et al., 2001; Chesbrough, 2003a). Because users typically innovate to solve a need and often do not attempt to draw financial profit from their innovation, ownership of the innovative knowledge is usually not an issue for users and they may even freely distribute their knowledge or innovation, even to producers (de Jong & von Hippel, 2009; Harhoff et al., 2003; Henkel & von Hippel, 2005). In fact, innovation by users typically takes place within communities, which entails the free disclosure of knowledge and innovations (Lakhani & von Hippel, 2003; von Hippel, 2007). When there is a firm (owner by either a producer or user), ownership of the innovation and/or relevant complementary assets is required to appropriate value from the innovation,

such as in the case of communities (Dahlander & Wallin, 2006) or user entrepreneurs (Shah & Tripsas, 2006).

4.3.2 Capturing Innovation Flows

Different mechanisms enable innovation flows to producers. While open innovation considers that strong formal or informal appropriability mechanisms allow firms to profit from innovation (Chesbrough, 2003a; West, 2006), they generally monetize their innovations rather than allowing free spillovers of knowledge (Chesbrough, 2006a). Thus, the management of IP and licensing is a central means to control knowledge flows and determine ownership (cf. Arora et al., 2001; Granstrand, 2000). In general, the distributed production of innovation relies on an IP regime that supports knowledge spillovers and collaborative ownership of innovation. Free spillovers can moreover come from innovation benefactors such as universities (Chesbrough, 2003b). In addition, a producer's internal characteristics and capabilities affect its ability to insource useful knowledge for innovation (cf. Mowery et al., 1996).

4.3.3 Intellectual Property Rights Restricting Flows

There is a stark contrast between open innovation and user innovation and related perspectives in their respective implications for the strength of IP protection — most typically patents but also copyright in the case of software and user-generated content. Outbound open innovation emphasizes strong IP protection (e.g., Chesbrough, 2003a), while inbound open innovation that comes from external firms depends on those firms being able to profit from their innovation, usually via formal appropriability mechanism (Teece, 1986; van de Vrande et al., 2009; West, 2006). Of course, firms are also certainly willing to accept unmonetized inbound spillovers of knowledge and innovation, such as from public universities or research labs (Chesbrough, 2003b).

Conversely, user innovation researchers typically view strong IP protection — specifically between producers and their customers — as retarding user innovation (von Hippel, 2005). Unlike open innovation, the normative assumptions of this research do not emphasize firm success.

5 Discussion

In this paper, we presented an overview of different perspectives that provide a critique to the traditional model of the vertically integrated innovation process.

We showed the strategic implications of the research on distributed innovation by discussing the nature and sources of distributed innovation, how firms can increase the supply of such innovation, and how they can capture the value that is created as such.

5.1 Implications

This paper has identified the important commonalities within research on distributed innovation spanning largely disjoint bodies of theory and empirical evidence. It suggests that careful examination of the convergent and conflicting predictions and proscriptions of these streams will improve our understanding of both the constituent streams, and more broadly how innovation can and should take place outside the boundaries of the firm.

These streams share a common critique of the long-accepted integrated model of industrial innovation as represented by Chandler (1977), Freeman (1982) and others. Such research on distributed innovation assumes that knowledge, as enabler of innovation, is dispersed beyond the boundaries of any one firm, and thus that important innovation activities take place outside or across the boundaries of the firm. These perspectives consequently offer congruent (if not parallel) normative proscriptions for 21st century innovation processes, about the importance to firms of searching outside

their boundaries to obtain crucial knowledge (if not complete solutions) both for creating and commercializing innovations.

Similarities aside, the important differences between these perspectives suggest a family of related research rather than commensurable theories awaiting unification under some grand unified theory. At their core, they make different assumptions where and how such external sources of innovation occur, assumptions that are subject to empirical verification through, for example, a test of competing hypotheses. Prior research in distributed innovation either focuses on one perspective while ignoring the others, or blurs the definitions of each perspective (or sub stream) at the expense of accuracy — thus minimizing the ability to draw upon the insights of these multiple research perspectives.

More significantly, these distributed innovation perspectives diverge in their emphasis of the key stakeholders. Concomitantly, they differ in their consideration of motivations for creating innovation and their definitions of the desired success outcome. In this regard, open innovation is in some ways more similar to vertical integration and thus different from the other perspectives in emphasizing firm success.[7] A critique that remains unique to user innovation is the (empirical) emphasis on extra-organizational innovation that (largely) originates with individuals rather than inside the boundaries of other organizations.

There are also crucial normative and policy fault lines within these distributed innovation perspectives. For example, open innovation is generally dependent on the

---

[7] The earliest, exploratory phase of user entrepreneurship parallels other user innovation processes, but the latter stages — after firm creation — are more similar to those of open innovation in which firms seek to commercialize external sources of innovation. Cumulative innovation assumes profit-maximizing corporate actors but does not seek to optimize their results.

strong IP provisions that are anathema to user innovation researchers as well as those in many auxiliary perspectives. This thus puts open innovation at odds with other distributed innovation research that recommends policy regimes of weaker IP enforcement (e.g., Scotchmer, 2004; von Hippel, 2005).

5.2 Opportunities for Future Research

A more integrated view of the distributed innovation process suggests numerous opportunities for future research, both to build upon the existing streams and to identify new distributed innovation mechanisms and phenomena outside these streams.

Those cases of overlapping phenomena and causal mechanisms offer opportunities for testing competing hypotheses between open innovation and user innovation as well as the other perspectives on distributed innovation. This would allow evaluating a range of contemporary phenomena such as user-generated content, crowdsourcing and even user entrepreneurship. At the same time, other perspectives on collaboration such as open science (Merton, 1973; David, 2002), social production (Weber, 2004; Benkler, 2006) and free culture (Lessig, 2004) are neither fully distinct from nor fully coincident with any of the major perspectives. Identifying boundaries of these (and other) areas of distributed innovation research would allow better bounding both the managerial and public policy proscriptions offered by each.

The overlaps also suggest opportunities for attempting integrated tests of one or more streams. For example, the various perspectives might be ideal for modeling the problem of joint maximization of innovation success criteria for the various actors in a value network. Moreover, an exploration of different types and levels of openness could bring forward how the optimal degree of openness differs across the value network (cf.

Almirall & Casadesus-Masanell, 2010, Laursen & Salter, 2006; Vanhaverbeke & Cloodt, 2006).

As this paper reviews the different perspectives in the light of managing or profiting from distributed sources of innovation — which is beyond the focus of user innovation and other utility-based innovation research — future research should further develop models for the strategic utilization of distributed innovation. While such an attempt will benefit from contrasting and integrating the boundary conditions as put forward by the different perspectives, it is especially important to identify causal mechanisms linking managerial decisions to identifying and achieving a continuous supply of external innovations, and finding a way to appropriate value from those innovations for superior performance. In this vein, the work on open innovation — open business models in particular — is currently most directly relevant to supporting such research (Chesbrough, 2006b; Chesbrough & Rosenbloom, 2002), while more attention to the possible costs of distributed innovation processes is also needed (Faems et al., 2010).

This work also suggests a broader, more general examination of the scope of knowledge and innovation that spans or resides outside organizational boundaries. In considering firm commercialization of external innovations, both Murray and O'Mahony (2007: 1009) and Shah and Tripsas (2007: 132) identify the importance of know-why and know-what, in addition to know-how, suggesting an opportunity to apply Garud's (1997) typology of these three types of knowledge to the process of creating and commercializing distributed innovations.

Finally, the distributed view suggests a potential broadening of our understanding about the interaction between internal absorptive capacity, external knowledge stores and the boundaries of the firm (Veugelers & Cassiman, 1999; Laursen & Salter, 2006;

Spithoven et al., 2010). Developing technical skills not to create innovations but to evaluate external innovations is already an established part of the open innovation process (Chesbrough, 2006a). A distributed perspective could help address a crucial question raised by Brusoni et al. (2001): When (and why) is there a value for a firm to acquire knowledge or innovations beyond those that it sells.

6 References

Abernathy, W. J., & Utterback, J. M. 1978. Patterns of industrial innovation. *Technology Review*, 80: 40-47.

Allen, R. C. 1983. Collective invention. *Journal of Economic Behavior & Organization*, 4: 1-24.

Almirall, E., & Casadesus-Masanell, R. 2010. Open versus closed innovation: A model of discovery and divergence. *Academy of Management Review*, 35: 27-47.

Archak, N. 2010. *Money, glory and cheap talk: analyzing strategic behavior of contestants in simultaneous crowdsourcing contests on TopCoder.com*. WWW '10 Proceedings of the 19th international conference on World Wide Web, Raleigh, NC: April, 2010.

Armour, H. O., & Teece, D. J. 1980. Vertical integration and technological innovation. *Review of Economics and Statistics*, 62: 470-474.

Arora, A., Fosfuri, A., & Gambardella, A. 2001. *Markets for Technology: The Economics of Innovation and Corporate Strategy*. Cambridge, MA: MIT Press.

Baldwin, C. Y., Hienerth, C., & von Hippel, E. 2006. How user innovations become commercial products: A theoretical investigation and case study. *Research Policy*, 35: 1291-1313.

Baldwin, C. Y., & von Hippel, E. forthcoming. Modeling a paradigm shift: From producer innovation to user and open collaborative innovation. Organization Science, published online, March 11, 2011, DOI: 10.1287/orsc.1100.0618.

Balka, K., Raasch, C., & Herstatt, C. 2010. How open is open source? Software and beyond. *Creativity and Innovation Management*, 19: 248-256.

Benkler, Y. 2006. *The Wealth of Networks: How Social Production Transforms Markets and Freedom*. New Haven, CT: Yale University Press.

Bogers, M., Afuah, A., & Bastian, B. 2010. Users as innovators: A review, critique, and future research directions. *Journal of Management*, 36: 857-875.

Brusoni, S., Prencipe, A., & Pavitt, K. 2001. Knowledge specialization, organizational coupling, and the boundaries of the firm: Why do firms know more than they make? *Administrative Science Quarterly*, 46: 597-621.

Chandler, A. D., Jr. 1977. *The Visible Hand: The Managerial Revolution in American Business*. Cambridge, MA: Harvard University Press.

Chandler, A. D., Jr. 1990. *Scale and Scope: The Dynamics of Industrial Capitalism*. Cambridge, MA: Harvard University Press.

Chesbrough, H. W. 2003a. *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston, MA: Harvard Business School Press.

Chesbrough, H. W. 2003b. The era of open innovation. *MIT Sloan Management Review*, 44: 35-41.

Chesbrough, H. W. 2006a. Open innovation: A new paradigm for understanding industrial innovation. In H. W. Chesbrough, W. Vanhaverbeke, & J. West (Eds.), *Open Innovation: Researching a New Paradigm*: 1-12. Oxford: Oxford University Press.

Chesbrough, H. W. 2006b. *Open Business Models: How to Thrive in the New Innovation Landscape*. Boston, MA: Harvard Business School Press.

Chesbrough, H. W., & Prencipe, A. 2008. Networks of innovation and modularity: A dynamic perspective. *International Journal of Technology Management*, 42: 414-425.

Chesbrough, H. W., & Rosenbloom, R. S. 2002. The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change*, 11: 529-555.

Christensen, C. M. 1997. *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Boston, MA: Harvard Business School Press.

Christensen, J. F., Olesen, M. H., & Kjær, J. S. 2005. The industrial dynamics of open innovation: Evidence from the transformation of consumer electronics. *Research Policy*, 34: 1533-1549.

Cooper, R. G. 2001. *Winning at New Products: Accelerating the Process from Idea to Launch* (3rd ed.). Cambridge, MA: Perseus Publishing.

Dahlander, L., & Gann, D. M. 2010. How open is innovation? *Research Policy*, 39: 699-709.

Dahlander, L., & Wallin, M. W. 2006. A man on the inside: Unlocking communities as complementary assets. *Research Policy*, 35: 1243-1259.

David, P. A. 1998. Common agency contracting and the emergence of 'open science' institutions. *American Economic Review*, 88: 15-21.

David, P. A. 2002. The political economy of public science: A contribution to the regulation of science and technology. In H. Lawton Smith (Ed.), *The Regulation of Science and Technology*: 33-57. London: Palgrave.

de Jong, J. P. J., & von Hippel, E. 2009. Transfers of user process innovations to process equipment producers: A study of Dutch high-tech firms. *Research Policy*, 38: 1181-1191.

Dedrick, J., & Kraemer, K. L. 1998. *Asia's Computer Challenge: Threat or Opportunity for the United States and the World?* New York: Oxford University Press.

Dodgson, M., Gann, D., & Salter, A. 2006. The role of technology in the shift towards open innovation: The case of Procter & Gamble. *R&D Management*, 36: 333-346.

Enkel, E., Gassmann, O., & Chesbrough, H. W. 2009. Open R&D and open innovation: Exploring the phenomenon. *R&D Management*, 39: 311-316.

Fabrizio, K. R., & Di Minin, A. 2008. Commercializing the laboratory: Faculty patenting and the open science environment. *Research Policy* 37: 914-931.

Faems, D., de Visser, M., Andries, P., & van Looy, B. 2010. Technology alliance portfolios and financial performance: Value-enhancing and cost-increasing effects of open innovation. *Journal of Product Innovation Management*, 27: 785-796.

Franke, N., & Piller, F. T. 2004. Value creation by toolkits for user innovation and design: The case of the watch market. *Journal of Product Innovation Management*, 21: 401-415.

Franke, N., & Shah, S. 2003. How communities support innovative activities: An exploration of assistance and sharing among end-users. *Research Policy*, 32: 157-178.

Franke, N., & von Hippel, E. 2003. Satisfying heterogeneous user needs via innovation toolkits: The case of Apache security software. *Research Policy*, 32: 1199-1215.

Freeman, C. 1982. *The Economics of Industrial Innovation* (2nd ed.). Cambridge, MA: MIT Press.

Galunic, D. C., & Rodan, S. 1998. Resource recombinations in the firm: Knowledge structures and the potential for Schumpeterian innovation. *Strategic Management Journal*, 19: 1193-1201.

Garud, R. 1997. On the distinction between know-how, know-what, and know-why. *Advances in Strategic Management*, 14: 81-102.

Granstrand, O. 2000. *The Economics and Management of Intellectual Property: Towards Intellectual Capitalism*. Cheltenham: Edward Elgar Publishing.

Hagedoorn, J. 2002. Inter-firm R&D partnerships: An overview of major trends and patterns since 1960. *Research Policy*, 31: 477-492.

Harhoff, D., Henkel, J., & von Hippel, E. 2003. Profiting from voluntary information spillovers: How users benefit by freely revealing their innovations. *Research Policy*, 32: 1753-1769.

Henkel, J. 2009. Champions of revealing: The role of open source developers in commercial firms. *Industrial and Corporate Change*, 18: 435-447.

Henkel, J., & von Hippel, E. 2005. Welfare implications of user innovation. *Journal of Technology Transfer*, 30: 73 - 87.

Howe, J. 2006. The Rise of Crowdsourcing. *Wired Magazine*: 14.06.

Howe, J. 2008. *Crowdsourcing: Why the Power of the Crowd Is Driving the Future of Business*. New York, NY: Random House.

Huston, L., & Sakkab, N. 2006. Connect and Develop: Inside Procter and Gamble's new model for innovation. *Harvard Business Review*, 84: 58-66.

Jeppesen, L. B., & Frederiksen, L. 2006. Why do users contribute to firm-hosted user communities? The case of computer-controlled music instruments. *Organization Science*, 17: 45-63.

Jeppesen, L. B., & Lakhani, K. M. 2010. Marginality and problem solving effectiveness in broadcast search. *Organization Science*, 21: 1016-1033.

Kogut, B., & Zander, U. 1992. Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science*, 3: 383-397.

Lakhani, K. M., & Wolf, R. G. 2005. Why hackers do what they do: Understanding motivation and effort in Free/Open Source software projects. In J. Feller, B. Fitzgerlad, S. A. Hissam, & K. M. Lakhani (Eds.), *Perspectives on Free and Open Source Software*: 3-21. Cambridge, MA: MIT Press.

Lakhani, K. R., & Panetta, J. A. 2007. The principles of distributed innovation. *Innovations: Technology, Governance, Globalization*, 2: 97-112.

Lakhani, K. R., & von Hippel, E. 2003. How open source software works: 'Free' user-to-user assistance. *Research Policy*, 32: 923-943.

Laursen, K., & Salter, A. 2006. Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal*, 27: 131-150.

Leifer, R., McDermott, C. M., O'Connor, G. C., Peters, L. S., Rice, M., & Veryzer, R. W. 2000. *Radical Innovation: How Mature Companies Can Outsmart Upstarts*. Boston, MA: Harvard Business School Press.

Lessig, L. 2004. *Free Culture: How Big Media Uses Technology and the Law to Lock Down Culture and Control Creativity*. New York, NY: The Penguin Press.

Lettl, C., Herstatt, C., & Gemuenden, H. G. 2006. Learning from users for radical innovation. *International Journal of Technology Management*, 33: 25-45.

Lichtenthaler, U., & Ernst, H. 2007. External technology commercialization in large firms: Results of a quantitative benchmarking study. *R&D Management*, 37: 383-397.

Lilien, G. L., Morrison, P. D., Searls, K., Sonnack, M., & von Hippel, E. 2002. Performance assessment of the lead user idea-generation process for new product development. *Management Science*, 48: 1042-1059.

Lüthje, C., Herstatt, C., & von Hippel, E. 2005. User-innovators and 'local' information: The case of mountain biking. *Research Policy*, 34: 951-965.

Merton, R. K. 1973. *The Sociology of Science*. Chicago: University of Chicago Press.

Mowery, D. C., Oxley, J. E., & Silverman, B. S. 1996. Strategic alliances and interfirm knowledge transfer. *Strategic Management Journal*, 17: 77-91.

Murray, F., & O'Mahony, S. 2007. Exploring the foundations of cumulative innovation: Implications for organization science. *Organization Science*, 18: 1006-1021.

Nuvolari, A. 2004. Collective invention during the British Industrial Revolution: The case of the Cornish pumping engine. *Cambridge Journal of Economics*, 28: 347-363.

O'Mahony, S. 2007. The governance of open source initiatives: What does it mean to be community managed? *Journal of Management and Governance*, 11: 139-150.

Ogawa, S. 1998. Does sticky information affect the locus of innovation? Evidence from the Japanese convenience-store industry. *Research Policy*, 26: 777-790.

Ogawa, S., & Piller, F. T. 2006. Reducing the risks of new product development. *MIT Sloan Management Review*, 47: 65-71.

Perkmann, M., & Walsh, K. 2007. University-industry relationships and open innovation: Towards a research agenda. *International Journal of Management Reviews*, 9: 259-280.

Poetz, M. K., & Schreier, M. forthcoming. The value of crowdsourcing: Can users really compete with professionals in generating new product ideas? *Journal of Product Innovation Management*.

Prahalad, C. K., & Ramaswamy, V. 2003. *The Future of Competition: Co-Creating Unique Value with Customers*. Boston, MA: Harvard Business School Press.

Rai, A. K. 2001. Fostering cumulative innovation in the biopharmaceutical industry: The role of patents and antitrust. *Berkeley Technology Law Journal*, 16: 813-853.

Raymond, E. S. 2001. *The Cathedral and the Bazaar: Musings on Linux and Open Source by an Accidental Revolutionary*. Sebastopol, CA: O'Reilly.

Ren, Y. and Levina, N. 2010. *The rising of crowdsourcing in management research: How to attract, motivate, and organize the crowd*. Paper presented at Academy of Management Meeting, Montreal, August 2010.

Roberts, E. B. 1988. Managing invention and innovation. *Research Technology Management*, 31: 11-29.

Robertson, P. L., & Langlois, R. N. 1995. Innovation, networks, and vertical integration. *Research Policy*, 24: 543-562.

Rogers, E. M. 1995. *Diffusion of Innovations* (4th ed.). New York: The Free Press.

Sawhney, M., Verona, G., & Prandelli, E. 2005. Collaborating to create: The Internet as a platform for customer engagement in product innovation. *Journal of Interactive Marketing*, 19: 4-17.

Schumpeter, J. A. 1934. *The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle*. Cambridge, MA: Harvard University Press.

Scotchmer, S. 2004. *Innovation and Incentives*. Cambridge, MA: MIT Press.

Shah, S. K. 2006. Motivation, governance, and the viability of hybrid forms in open source software development. *Management Science*, 52: 1000-1014.

Shah, S. K., & Tripsas, M. 2007. The accidental entrepreneur: The emergent and collective process of user entrepreneurship. *Strategic Entrepreneurship Journal*, 1: 123-140.

Spithoven, A., Clarysse, B., & Knockaert, M. 2010. Building absorptive capacity to organise inbound open innovation in traditional industries. *Technovation*, 30: 130-141.

Teece, D. J. 1986. Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy*, 15: 285-305.

Tushman, M. L., & Anderson, P. 1986. Technological discontinuities and organizational environments. *Administrative Science Quarterly*, 31: 439-465.

Utterback, J. M. 1994. *Mastering the Dynamics of Innovation*. Boston, MA: Harvard Business School Press.

Utterback, J. M., & Suárez, F. F. 1993. Innovation, competition, and industry structure. *Research Policy*, 22: 1-21.

van de Vrande, V., de Jong, J. P. J., Vanhaverbeke, W., & de Rochemont, M. 2009. Open innovation in SMEs: Trends, motives and management challenges. *Technovation*, 29: 423-437.

VanderWerf, P. A. 1992. Explaining downstream innovation by commodity suppliers with expected innovation benefit. *Research Policy*, 21: 315-333.

Vanhaverbeke, W. 2006. The inter-organizational context of open innovation. In H. W. Chesbrough, W. Vanhaverbeke, & J. West (Eds.), *Open Innovation: Researching a New Paradigm*: 205-219. Oxford: Oxford University Press.

Vanhaverbeke, W., & Cloodt, M. 2006. Open innovation in value networks. In H. W. Chesbrough, W. Vanhaverbeke, & J. West (Eds.), *Open Innovation: Researching a New Paradigm*: 258-281. Oxford: Oxford University Press.

Vanhaverbeke, W., van de Vrande, V., & Chesbrough, H. W. 2008. Understanding the advantages of open innovation practices in corporate venturing in terms of real options. *Creativity and Innovation Management*, 17: 251-258.

Vargo, S. L., & Lusch, R. F. 2004. Evolving to a new dominant logic for marketing. *Journal of Marketing*, 68: 1-17.

Veugelers, R., & Cassiman, B. 1999. Make and buy in innovation strategies: Evidence from Belgian manufacturing firms. *Research Policy*, 28: 63-80.

von Hippel, E. 1976. The dominant role of users in the scientific instrument innovation process. *Research Policy*, 5: 212-239.

von Hippel, E. 1988. *The Sources of Innovation*. New York, NY: Oxford University Press.

von Hippel, E. 1994. 'Sticky information' and the locus of problem solving: Implications for innovation. *Management Science*, 40: 429-439.

von Hippel, E. 2005. *Democratizing Innovation*. Cambridge, MA: MIT Press.

von Hippel, E. 2007. Horizontal innovation networks--by and for users. *Industrial and Corporate Change*, 16: 293-315.

von Hippel, E., & Katz, R. 2002. Shifting innovation to users via toolkits. *Management Science*, 48: 821-833.

von Hippel, E., & von Krogh, G. 2003. Open source software and the 'private-collective' innovation model: Issues for organization science. *Organization Science*, 14: 209-223.

von Krogh, G., & von Hippel, E. 2006. The promise of research on open source software. *Management Science*, 52: 975-983.

Weber, S. 2004. *The Success of Open Source Software*. Cambridge, MA: Harvard University Press.

West, J. 2006. Does appropriability enable or retard open innovation? In H. W. Chesbrough, W. Vanhaverbeke, & J. West (Eds.), *Open Innovation: Researching a New Paradigm*: 109-133. Oxford: Oxford University Press.

West, J., & Gallagher, S. 2006. Challenges of open innovation: The paradox of firm investment in open-source software. *R&D Management*, 36: 319-331.

West, J., & Lakhani, K. R. 2008. Getting clear about communities in open innovation. *Industry & Innovation*, 15: 223-261.

West, J., & O'Mahony, S. 2008. The role of participation architecture in growing sponsored open source communities. *Industry & Innovation*, 15: 145-168.

West, J., Vanhaverbeke, W., & Chesbrough, H. W. 2006. Open innovation: A research agenda. In H. W. Chesbrough, W. Vanhaverbeke, & J. West (Eds.), *Open Innovation: Researching a New Paradigm*: 285-307. Oxford: Oxford University Press.

7 Tables and Figures

Attribute	Vertical integration	Open innovation	User innovation
Main research question	How do firms control end-to-end innovation process?	How can firms maximize innovation effectiveness?	How can users be supported to become innovators?
Key stakeholder	Firm	Firm	User
Other stakeholders	-	Other firms in value network	Producers
Level of analysis	Firm	Firm	Innovation
Key success measures	Profit	Profit	Quantity of (significant) innovations
Locus of innovation/knowledge	Within firm	Outside firm	Within users
Type of innovator	Organizational	Organizational	Individual†
Assumed motivations	Pecuniary	Pecuniary	Utility
Innovation mode	Internally controlled	Best of breed	Cumulative
Norms	Managerial hierarchy	Market exchange	Cooperation
Relationship with other innovators	None	Exchange	Cooperate
Spillovers	Blocked	Paid	Free
Representative works	Chandler (1977, 1990)	Chesbrough (2003a, 2006a)	von Hippel (1988, 2005)

† A limited amount of research considers innovations by user firms.

Table 1: Contrasting integrated and distributed innovation research

		Locus of innovation	
		Individuals	**Organizations**
Motive	**Pecuniary**	Open innovation Co-creation	Vertical integration Open innovation Co-creation Cumulative innovation
	Non-pecuniary	User innovation Social production	User innovation

Table 2: Motives and locus of innovation

Type of innovation flows (revealing)	**Distributed innovation perspectives (and selected phenomena)**
Blocked	User entrepreneurship Vertical integration
Unintended spillover	Cumulative innovation Free culture
Free revealing	User innovation Social production Co-creation Open innovation (knowledge benefactor) Open source software Open science
Paid revealing	Open innovation Crowdsourcing

Table 3: Classification of use and restrictions on innovation flows

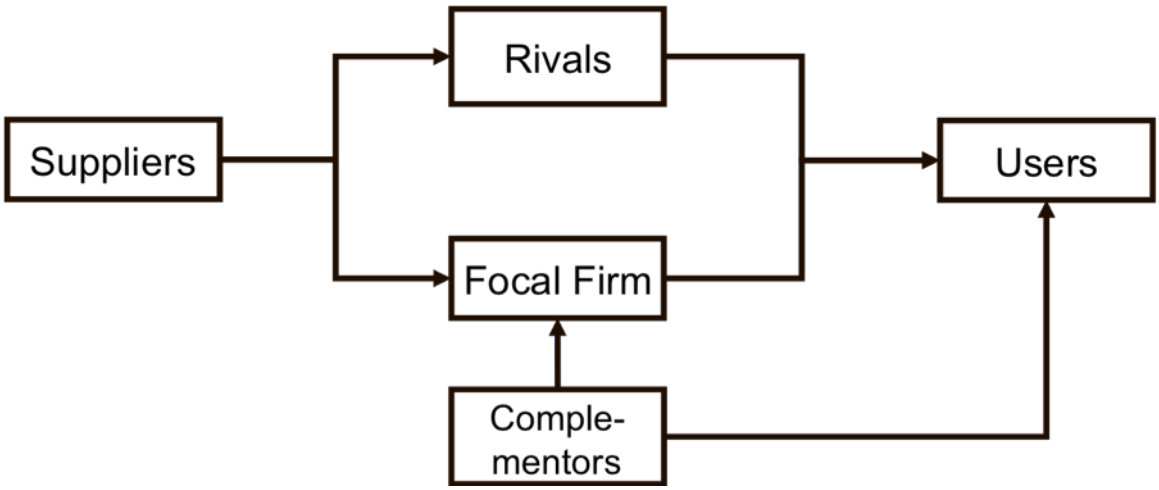

Figure 1: Stakeholders in a focal firm's value network

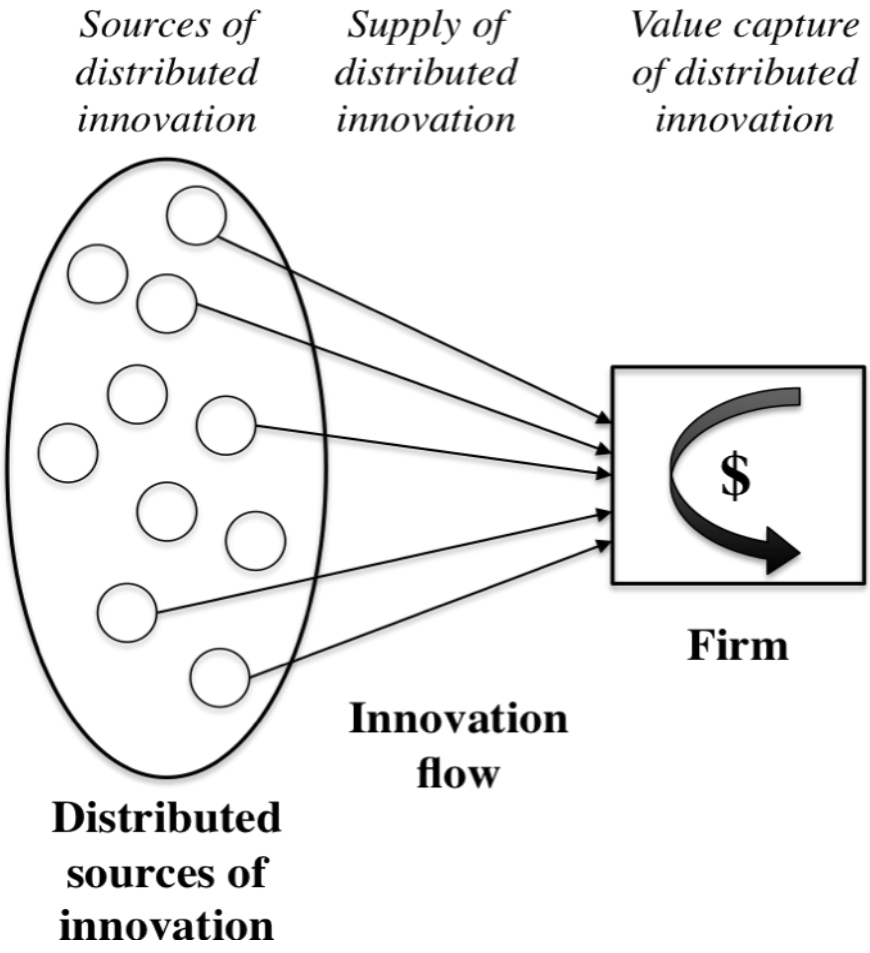

Figure 2: Strategic management of distributed innovation