Categorizing and understanding collaborative innovation approaches

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Key messages

A changing innovation environment: Today's organizational and societal environment changes are pushing towards a shift in the locus of innovation that is influencing the way actors work, learn and innovate. Problems that need to be solved are getting more complex, commanding the need for the hybridization of knowledge coming from multiple domains. However, approaching innovation processes in a collaborative manner so that multiple actors and collectives get involved, be it actors from multiple industries or users that also want their voices to be heard, comes with new and complex challenges related to knowledge boundaries between all of these stakeholders. Indeed, they all have different but valid concerns, interests, visions and sometimes conflicting values that need to be bridged together, which make it ever more complex to define and frame problems, and develop solutions that respond to these stakeholders' needs.

That is why we provide this knowledge synthesis about collaborative innovation approaches to support organizational and societal adaptation in this evolving context, in order to facilitate new technologies' adoption. Here are the key messages from our synthesis.

Collaborative innovation approaches:

1. ***Have different impacts on knowledge and communities***. Our conceptualization allows to understand and explain the different impacts that collaborative innovation approaches may have on collaborative knowledge development and interdisciplinary learning. Our framework allows a deeper analysis of new approaches and spaces for design, and discusses emerging ways of bridging multiple stakeholders and their specific knowledge. It also takes into account the whole complexity of knowledge sharing between different communities. In this regard, it accounts for experiential knowledge, know-what, know-how, know-who, know-about and multiple ways of knowing. Finally, we tried to provide a richer understanding of the issues and challenges contributing to the design of collaborative learning in collaborative settings and spaces.

2. ***Should be designed to benefit all involved stakeholders***. Most open innovation approaches are designed to support the organization's goals – that is mostly increasing efficiency and profits in private owned firms. However, we showed that these approaches could allow a genuine opening of innovation to further develop stakeholders' knowledge and competence to facilitate technology production, implementation and diffusion for collective good.

3. ***Can impact the whole value chain of innovation***. Collaborative innovation approaches are more than co-creation devices that should be mobilized in the early phases of innovation. They could be useful much earlier, upstream, in the co-definition of issues but also, later, downstream, as co-innovation devices. These approaches can also play all along the innovation process by allowing to progressively work, rework, and hybridize stakeholders' knowledge bases.

4. ***Provide the ability to develop a community and structure an ecosystem for collaborative innovation*****.** We provided a dynamic view of the potential for community development through the mobilization of different sets of collaborative innovation approaches. These approaches should not be considered in silos, but as a process of actors' engagement in a collective body that supports knowledge and capability development. This vision may allow the development of collectives that bridge multiple knowledge domains and organizations.

Executive Summary

Today's innovation challenges are getting more and more complex, commanding the need for a transformation of how we innovate. These challenges are too complex to be solved through closed expert knowledge perspectives, and demand the involvement of multiple actors, while focusing on the benefits for all. It is at the intersection of multiple sectors and knowledge domains that solutions exist. However, bridging multiple knowledge domains is complex since the multiple actors and collectives that want to be involved in the development of services and products have different interests, knowledge and visions. We observed a proliferation of multiple approaches aiming at opening the innovation processes to all concerned actors, managing their collaboration and focusing on user experience, to answer users' specific needs. These modern users are increasingly time constrained, educated, empowered, informed and are willing to participate in the improvement of the products and services based on their experiential knowledge. Finally, today's innovation problems are complex and often ill-formulated, due to confusing information, involving many stakeholders with conflicting values. Multiple systemic ramifications are thoroughly adding to the inherent complexity of current problems. We then need to move toward new ways of innovating, by doing more than "opening to" the crowd of actors coming from multiple domains. We need to "collaborate with" these multiple actors – be it citizens, firms, public organizations and communities - in a meaningful way to develop innovation capabilities and positive outcomes for all.

We provide a literature review and a framework of analysis that allows to specifically address the socialization challenges related to knowledge and innovation in collaborative approaches. We first present three axis of literature review, followed by a conceptualization of collaborative innovation approaches through these three axes. We finally analyze thoroughly three modern collaborative innovation approaches that are gaining traction in management practices.

The first axis focus on *Opening Innovation to Multiple Stakeholders.* In the 20th century, organizations have been working internally to support innovation development, which consequently pushed firms towards the construction of strong bureaucracies and vertical integration (Chandler, 1977). However, the accessibility and the importance of information, and the increasing role of the hybridization of different knowledge domains that are distributed globally have switched the locus of innovation from inside firms to supra-levels of organizations such as inter-organizational networks, communities and ecosystems (Adner and Kapoor, 2010; Baldwin and von Hippel, 2011; Chesbrough, 2003; O'Mahony and Lakhani, 2011). Now, organizations turn to the principles of open innovation, that is "a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology" (Chesbrough, 2003). However, this approach has not yet reached its full potential in bringing together multiple collectives and pushing towards the hybridization of their knowledge in a collaborative manner. Indeed, the literature on open innovation is still centered on the organization's benefits instead of conceptualizing it as a collaborative approach benefiting all involved stakeholders. In addition, the literature has not provided much theorization of approaches and processes to bridging multiple knowledge communities across their knowledge boundaries to push for a co-innovation agenda that considers the various values, visions and interests of involved stakeholders.

The second axis is about *Moving From "Opening To" towards "Collaborating With".* Today's society is marked by a turning point in the place given to the work and values assigned to it. This new ideology comes with a desire of working collectively as a reaction to individualism; open innovation being one of many examples. However, there are different ways of working collectively. As the integration of different and multiple actors during the development process becomes the norm and earn interest from organizations, collective working dynamics need to be understood and conceptualized. To understand them and apply them correctly, the type of reasoning as well as the modes of construction of action and knowledge of these approaches should be understood and defined. Moreover, these modes of action are based on the recognition of stakeholders and user needs.

The third axis deals with *Learning as a Social Activity and Overcoming Knowledge Boundaries*. Studies on communities have emerged strongly in organizational studies in the past 20 years to better explain how knowledge is constructed, shared and transformed with some authors even suggesting that this theoretical focus is more suited to contemporary organizational challenges (O'Mahony and Lakhani, 2011). In this axis, we first theorize knowledge and learning as a social process that is based on a set of structures - such as norms, languages, values - that are socially constructed. This theorization provides an explanation for issues related to sharing knowledge between actors coming from different knowledge domains that are constructed on different sets of structures and that become boundaries to knowledge sharing. Finally, we discuss the puzzles in understanding knowledge construction across these boundaries and the process of building a community that could potentially integrate multiple knowledge domains and collectives.

Based on the puzzling aspects of this literature, that are related to understanding the collective dynamics of innovation, we built a conceptual framework shedding light on the capacities, impact, challenges and practices related to specific collaborative innovation approaches (or spaces). The model – that is presented in figures 1 and 2 – is built on four axes, each of them working as a continuum.

The first axis deals with *the level of engagement of actors in the collective*. This axis of level of engagement move from the level of *crowd* – that is the lowest level of engagement – to *community* – that is the highest level of engagement. We conceptualize the level of *crowd* as a group of individuals with different characteristics (Arolas, Gonzalez Ladron de Guevara, 2011) that do not necessarily know each other and who are loosely bound together by structural social practices (Wexler, 2011). The *community* level of the continuum is built on the literature on communities of practice. Individuals, through a process of peripheral participation (Lave and Wenger, 1990) become members of the collective. They learn from others, observe others, becoming more than participants, but actual members of a collective that is structured around shared practices and identities, artefacts, a joint enterprise and a mutual engagement.

The second axis introduces a categorization of the level of application of knowledge from *theoretical* to *practical.* In one of the poles (*theoretical*), there is the purely abstract knowledge that refers to actions of thoughts (Wacker, 1998) at the conceptual level. At its opposite, there is the *practical* knowledge that engages individuals in the action of doing, in the application of knowledge in their daily actions.

The third axis presents different levels of stickiness of knowledge in practice based on Carlile (2002) characterization. First, "knowledge is *localized* around particular problems faced in a given practice" (Carlile, 2002). Through specialization, individuals become more efficient in solving a specific set of problems in a given context. The knowledge constructed in these practices may be easily transferable from one similar practice to the other. Second, knowledge is *embedded* in practice. "The word embedded suggests an archeological image as to why knowledge is hard to articulate or real, knowledge accumulated in the experiences (Taylor, 1992) and know-how (Harper, 1987) of individuals engaged in a given practice." Individuals in their daily actions build up experiences that become automatic ways of doing and solving problems. So, these individuals may not be able to explain, share and transfer (Carlile, 2004) their knowledge associated with these automatic ways of doing things since the archeological accumulation of this knowledge in their practice is not easily accessible. Third, knowledge is *invested* in the practice. Through successes in solving problems in their daily actions, with specific methods and know-how, knowledge accumulates in the experiences but also gets solidified because of its valorization in practice. Indeed, knowledge becomes valued for its efficiency and other successful attributes pushing individuals to stick with the knowledge they are used to mobilizing.

The fourth axis – *the integration of knowledge domains* – was implied throughout our literature review and model description. This axis is aligned with the level of stickiness of knowledge in practice which increases in complexity as the number of actors coming from different knowledge domains or practices participate and interact. The fourth axis then covers the *number* of actors (organizations, communities, individuals) with different practices and knowledge domains, from a *homogeneous* to *heterogeneous* collective as well as the level of interaction of these different practices in their activities. The integration of a more heterogeneous collective becomes more challenging in terms of knowledge boundaries. However, in some cases, such as at the level of engagement of the crowd, heterogeneous actors do not have to interact even if multiple knowledge domains are represented, meaning that knowledge boundaries become less challenging in managing the collaborative innovation process.

This modelization of the collaborative spaces and their relations to knowledge and engagement with collectives shed light on boundary practices that are facilitated and challenges that occur in these spaces. The visual representation of our framework (figure 2) draws 12 cubes that represent the challenges and practices related to the collaborative innovation approaches mobilized. We present six practices based on Carlile 3-T framework (Carlile, 2004) – *transferring, translating, transforming* – upon which we added three practices - *co-transferring, co-translating and co-transforming* - --where actors mobilize these practices in an interactive and collaborative manner. *Transferring* knowledge occurs between actors sharing localized practices that support the process of sharing knowledge between them. For transferring to occur without complications, stable conditions must exist, such as a common lexicon that represents clearly and thoroughly the knowledge that needs to be transferred. *Translating* is needed when new actors, coming from different practices, do not share the same norms, values, language and visions, creating a sort of fuzziness around the interpretations of situations. In this context, different actors have different interpretations about the same issues, challenges, realities which makes it more complex to share knowledge between them. The process of *transforming* aims at dealing with the different interests of actors. It recognizes that actors are invested in their practices, and so they may face consequences when they need to learn and transform their knowledge. Indeed, new knowledge in one domain may have a negative impact on other actors coming from different knowledge domains. Mirroring these three practices in a “co” perspective means that we keep the same conceptualization of the three practices we just presented, but suggest that these practices may occur in partnership – that is in a collective and interactive relationship rather than in a transmitter-receptor process.

We then present the approaches of *crowdsourcing*, *hackathon,* and *maker/hacker space* to show how our framework allows to understand and conceptualize specific approaches. Actors that are willing to mobilize and/or develop collaborative innovation approaches then can deeply understand what is vested in these approaches, theorize the potential of each of the approach and select what approaches to promote for their own purposes and innovation challenges.

We conclude by presenting how innovation has changed towards collaborative dynamics. Far from being linear and simple, innovation engages complex and interdisciplinary realities with different scopes and various scales. The increasing importance and reliance on collaboration in innovation practices and research shed light on the co-construction issues where many actors with various and sometimes diverging interests and values contribute their knowledge, resources and experiences in the development of common projects. Consequently, it is important to emphasize the relational and dynamic conceptualization of these collaborative innovation approaches. Indeed, considering the various challenges related to knowledge construction and various innovation stages, these approaches are not self-sufficient in regard to capability development and innovative outcomes. These collaborative approaches should be connected and developed relationaly with the contextual challenges that actors are facing in regard to knowledge construction. Collaborative innovation approaches also provide means to opening the evaluation and valuation of innovation across the whole value chain of innovation. Taken together, the benefits of collaborative innovation present major improvements in regard to creating and supporting positive outcomes for organizations, communities and citizens.

However, collective innovation does raise issues related to ownership. It raises questions on how to generate and manage outputs that are co-produced by organizations and the public as well as to whom the Intellectual Property (IP) belongs. Even if we don’t address specifically these issues, we provide a conceptualization allowing the understanding of the negotiations, translations and transformations of each involved actor’s goals, interests and visions. Our analysis then provides a socialization perspective on these issues and highlights practices that may support the management of these key challenges to innovation development. Finally, we did not fully address the topic of technological platforms supporting collaboration. These platforms do play an increasingly important role in collaborating across knowledge boundaries. However, we believe that the theoretical implications of our conceptualization could support the construction of more contextualized technological platforms that answer today’s innovation challenges.

Literature Review

Context: Hybridizing knowledge through collaborative innovation approaches

Today's challenges – be it Grand Challenges such as environmental degradation and climate change (Howard-Grenville et al., 2014), the proliferation of big data (Haas, George & Pentland, 2014), social media and the digital economy, healthcare (Kulik et al., 2014) or many other organizational challenges – demand the hybridization of knowledge from multiple domains that are now interdependent. These problems cannot be solved anymore through closed expert knowledge perspectives, such as the technological, the social, the medical or the finance prisms: it is at the intersection of multiple sectors that solutions exist. The reconfigurations of the innovation processes that have been occurring since the beginning of the 21st century, and that are transforming our ways of working, doing (Lallement, 2015), learning and innovating, aims at addressing this ever-changing and complex world. A systemic vision becomes the norm, and we have to learn to work in such a way. "Systemic vision highlights the commitment of the subject not only in the act of knowledge, connecting the knower to what is known (Morin in Le Moigne, 2004), but also in action, connecting the one who conceives to what is conceived. [...] Thus, a systemic and holistic vision helps [...] to think about the complexity of reality. This shift requires not only a change of logistics but also and above all, a change of mentality which imposes an opening up, a 'decompartmentalization,' of knowledge and spheres of activity." (Alvarez and De Coninck, 2016: 33)

In particular, in the digital economy, that is characterized by complex and interdependent technological systems, an evolving pervasiveness of information technology and a global distribution of knowledge and skills across multiple individuals, groups, and organizations, the locus of innovation is moving towards networks of innovators (Baldwin and von Hippel, 2011; Chesbrough, 2003; Lichtenthaler & Lichtenthaler, 2009), ecosystems, alliances and platforms (Adner and Kapoor, 2010; Nambisan & Baron, 2013; Gawer & Cusumano, 2014; Rohrbeck et al., 2009; Etzkowitz & Leydesdorff, 2000; Faems et al., 2010) that are managed in a collaborative manner (Yoo et al., 2012; Gasco-Hernandez and Torres-Coronas 2004).

These transformations imply new generative dynamics based on diversity (rather than on specialization, as in the previous system) where innovative solutions are based on the continuous knowledge construction across multiple knowledge domains (Carlile, 2002) previously treated as separate silos that were not traditionally connected in the previous innovation paradigms. Increasingly, we are seeing the mobilization of collectives that want to be involved in the development of services and products that will affect them, so that their concerns, interests and knowledge are considered. (Fung & Wright, 2001; Rabeharisoa & Callon, 2002)

Consequently, today's experts need to recontextualize and relocalize their knowledge by focusing on users' needs and by opening to other knowledge domains now interconnected. In addition, modern users, that can be qualified as increasingly time constrained, educated, empowered, informed (Minkiewicz & al., 2014: 39), expert or lead-users (von Hippel, 2005), are willing to participate in the improvement of the products and services affecting their life by contributing to rethinking usages through their experiential knowledge to promote user experience.

This movement towards the involvement of new actors in the innovation processes is exacerbated by the fact that today's organizations and citizens, more than ever, are facing *wicked problems*: "a class of social system problems which are ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values, and where the ramifications in the whole system are thoroughly confusing (Buchanan, 1992)." Indeed, Rowe (1987) argues that the nature of the problem-solving process itself shapes the solution (Kimbell, 2011). In addition, according to Brown and Duguid (1991), "much conventional learning theory [...] tends to endorse the valuation of abstract knowledge over actual practice and as a result to separate learning from working and, more significantly, learners from workers." However, learning theorists have rejected transfer models (Carlile, 2002), which isolate knowledge from practice, and developed a view of learning through social construction approaches (Lave, 1988; Lave and Wenger, 1990), putting knowledge back into the contexts in which it has meaning, that is in their social and physical environments and considering their histories and social relations. In that regard, new forms of cooperation and collaborative initiatives between different knowledge communities are taking shape today and are likely to bring original solutions, generate new dynamics of learning, involve new actors, new configurations of actors and introduce new innovation practices.

Organizations, be it private or public, need to involve their members as innovators, but also, individuals and collective outside their boundaries in meaningful collaborations for all. Consequently, actors that initiate and drive innovation are ready to react to any potential changes and be able to seize opportunities. We observed a proliferation of multiple approaches in management aiming at opening the innovation processes to all concerned actors to better suit their needs and facilitate the diffusion of innovations: open innovation (Chesbrough, 2003b), distributed innovation (Lakhani & Panetta, 2007), user-centered design (Norman, 2002), participatory design (Bjogvisson, Ehn and Hillgren, 2012), open organizations (Boudreau, 2010), open strategy, community involvement (Lakhani et al., 2013;. O'Mahony and Lakhani, 2011), user innovation (von Hippel, 2005), and collective intelligence (Doan et al., 2011). These approaches have in common the mobilization of contributions of multiple actors, such as citizens and users, coming from different knowledge communities (Amin and Cohendet, 2004) to upstream innovation. These "bottom-up" and "outside-in" innovation processes include the ability to capture users' perspectives to better meet their needs by involving them in the political and pragmatic decision-making of the innovation process (Almirall et al., 2014).

We then need to rethink and re-conceptualize innovation in a whole new way focusing on knowledge in its multiple forms – hybrid, contextualized, collective, in continuous development and supporting learning – in order to face our changing environment. Indeed, innovation processes of the 20th century were designed for simple and stable environments. However, today's fast-paced and complex environment demands new ways of organizing innovation through collaborative action.

We turn to four interrelated and complementary literature on *sociology of innovation, open innovation, communities of practice,* and *design thinking* to conceptualize how to open innovation to external communities through *collaborative innovation approaches.* This allows to better understand the scope of collaborative innovation processes to facilitate technologies' appropriation and their usages. These sets of literature agree on the idea that organizations need to involve key actors and stakeholders that were not yet considered in the traditional innovation processes. Sociology of innovation sets the stage by highlighting the need to consider innovation as a process of transformation of social practices, and of appropriation of new technologies that should include all concerned actors throughout the development process. Open innovation put the emphasis on opening organizational boundaries to other organizations (Chesbrough, 2003), communities (O'Mahony and Lakhani, 2011) and lead users (von Hippel, 2005) even if this literature is still stuck in an organization-centric vision and does not shed light on the opening of knowledge boundaries (Carlile, 2002; 2004). Communities of practice allow the conceptualization of learning as a social and shared process that happens relationally through collective structures and individual actions and practices. However, the contribution of this literature needs to be expanded to the analysis of the dynamics of learning and knowledge sharing across communities. Finally, the literature on design sheds light on the co-creation dynamics in open and complex problem-solving processes, involving actors from different knowledge domains (Dorst, 2011), and integrating the final users' perspective. From this literature, we understand that the challenge for innovation and ideation "is no longer just the [creation] of the object; [it is] also [to create] the relationships that this product will have with its environment (physical, social, technical) (Levy 1988)." These sets of literatures together allow us to better conceptualize collaborative innovation approaches as *boundary events,* and boundary practices (Beaupré-Gateau & Simon, 2016) that is, events that have different capacities to support knowledge sharing and transformation across multiple communities of practice.

Even if multiple streams of literature highlight the need to change the way we innovate, organizations still struggles with the collaborative practices allowing to involve, mix and develop external and internal communities of practice. This literature review aims to offer avenues for organizations wishing to open their innovation process to their external communities and to "better" innovate in a creative economy. It also highlights new research streams for researchers interested in emerging innovation processes. Nowadays, organizations do not innovate in a nutshell; they do so by participating with communities in interactive ecosystems to support the development and appropriation of new technologies by users. We shed some light on the processes and the approaches that may support and facilitate communities of practice's members to stand out of their traditional social worlds to integrate new logics of usage and to transform themselves towards actively participating in the innovation processes. This hybridization of communities, its potential and its organizing then need to be analyzed and conceptualized. In that regard, we shed light on the types of impacts in terms of knowledge - that is more than accessing know-what, but also, new know-how, know-about, know-who, know why, and know with - that different collaborative innovation approaches may bring for communities, users, actors and citizens. These approaches are more than co-creation or collaboration approaches, they are spaces and moments facilitating capabilities' development and knowledge transformation to the benefit of the innovation processes. Access to new technologies and mobilization of collaborative innovation approaches cannot be successful if they are only analyzed through the prism of technology and collaborative innovation: we must give way to a more systematic study that deals with social change and collective dynamics (Hermans et al., 2013).

Even if Canada is renowned for its capabilities in knowledge creation and in building novel technologies, it must turn to new understanding of how to ensure that the potential of these new technologies is actualized and used by the public to emancipate its citizens.

Table 1 - Challenges related to the new innovation context

Challenges	**Descriptions**
Need for hybridization of knowledge	Today's innovation problems are too complex to be solved through closed expert knowledge perspectives. It is at the intersection of multiple sectors and knowledge domains that solutions exist. However, bridging multiple knowledge domains is complex.
Mobilization of multiple collectives	Multiple actors and collectives want to be involved in the development of services and products that will affect them, so that their concerns, interests and knowledge are considered. We observed a proliferation of multiple approaches aiming at opening the innovation processes to all concerned actors.
User implication and user experience	Today's solutions need to be user-driven, to answer their specific needs. In addition, modern users are increasingly time constrained, educated, empowered, informed and are willing to participate in the improvement of the products and services based on their experiential knowledge.
Wicked problems	Today's innovation problems are complex and often ill-formulated, due to confusing information, involving many stakeholders with conflicting values. Multiple systemic ramifications are thoroughly adding to the inherent complexity of current problems.

Implications

In response to the new collaborative approaches emerging from open innovation principles, this knowledge synthesis offers an overview of the transformations our modern society is experiencing in terms of innovation development and implementation. These changes bring new ways of "doing", new questions about the impact on participants' knowledge and the innovation process. As a result of this research, an analytical grid to better identify the source of knowledge and understand how it is constructed and diffused according to the initiatives implemented has been developed. This kind of framework or model has many implications for decision makers, professionals, researchers and professors of the Canadian innovation ecosystem.

Governmental implications: This knowledge synthesis brings a whole new perspective on the government 2.0 initiatives. It pushes decision makers to question *who*, *what* and *how* to manage public participation and absorption in the innovation processes, policy development and governmental initiatives for political inclusion. Moreover, the new innovation initiatives are numerous and sometimes difficult to assess when the time comes to distribute budgets. With a better understanding of the implications of collaborative innovation approaches based on our analytical grid, the Government has a unique tool to allocate scholarships and grants according to its objectives in terms of economically and socially impactful innovation.

Organizational implications: This knowledge synthesis gives a constructive and processual approach to the development and structuring of ecosystems of innovations that can benefit all stakeholders. By participating in the collective and interactive development of ecosystem's stakeholders, organizations can grow faster by bridging the initiatives deployed by other firms, organizations, the state, users and communities. Moreover, our analytical tool helps them in choosing the best-suited initiative according to their needs and goals. Thus, organizations can better allocate their resources for more adapted and efficient innovation processes.

Pedagogical implications: This knowledge synthesis allows to develop and understand the potential of new pedagogical approaches to innovation in accordance with our context in regard to the new philosophy of "doing" and the collaborative approaches increasingly present in the workplace. It can then better meet the market's needs by educating future generations of workers accordingly. Finally, it could support the development of pedagogical approaches in collaboration with all stakeholders of our education system.

Approach – Methodology

The synthesis project was divided into four phases: 1) the proposal 2) the launch 3) the preliminary analysis, and 4) the final synthesis. The lead researcher played a supervisory role during each phase to ensure that the literature analysis was carried out rigorously to meet SSHRC's objectives and that students respected the timetable set up. The co-researcher played a supervisory role on the theoretical and conceptual aspects of the report. Both researchers are co-directors of the MOSAIC research-transfer hub on knowledge, creativity, and innovation at HEC Montréal (https://mosaic.hec.ca/).

1) Project Proposal (November and December 2015): We identified with MOSAIC researchers, partners (researchers, organizations, etc.) and in the literature a need for understanding and conceptualizing collaborative innovation approaches. We also systematically reflect on the implications of these new approaches to emphasize the theoretical areas that would support the analysis and contextualization of our object of research. We also highlighted the main authors to consider for each literature.

2) Project launch (March and April 2016): This phase aimed to make an initial review of the literature based on the key authors who have emerged from our preliminary analysis. We selected research topics and research keywords (see Table 2 in the appendix). We focused our reading based on a reading grid (see Table 3 in appendix), and highlighted aspects to analyze further. This systematic analysis allowed a first formatting of the literature review, which was validated during a team meeting. The team developed a research protocol explaining research strategies to be undertaken. In addition to keywords, the search was structured around selected founding texts, and from searching related texts and texts citing the selected founding texts with *Science Direct* and *Google Scholar*. A text bank deposited on a Google Drive folder was built between team members and has been continuously updated during the project. We also carried a backward text selection based on the bibliography of the texts we already had selected. The analyzed texts include scientific articles, books, professional articles, and proceedings from academic conferences.

3) Preliminary analysis (May, June and July 2016): This phase aims to summarize and analyze the observations made during the previous phase. A first version of the synthesis of knowledge has been produced to be presented as part of a scientific conference. Back from the conference, the team met to discuss the comments received, progress, and modifications to address. One of the strong findings was the missing conceptualization of collaborative innovation approaches with stronger linkages to the theories of knowledge. We have produced a conceptual framework that would then categorize, compare, and understand the role of these approaches and produce recommendations for future research practitioners.

4) Final Synthesis (August and September 2016): This phase allowed to format and produce the final synthesis to make it public. The team also began writing an article from this synthesis to submit to a scholarly journal. A synthesis report will also be prepared to be diffused by the MOSAIC hub at HEC Montreal, on its website, on social networks and in a workshop organized by SSHRC.

Results - Outcomes of the Research Synthesis

Our research synthesis and our analysis of the literature is built on three interrelated axis. Together, these axes allow us to conceptualize and understand the potential and implications of the existing collaborative innovation approaches. They also allow us to think of new designs for these approaches in order to open even further the innovation processes to develop all involved stakeholders. More than a literature review, our knowledge synthesis provides a deeper view on knowledge construction across knowledge boundaries and on innovating *with* multiple collectives.

We first present the axis 1 (opening innovation to multiple stakeholders) to highlight the need for more collaborative approaches and for a conceptualization of knowledge boundaries to open innovation. We then present the axis 2 (moving from “opening to” towards “collaborating with”) that support our view on the importance of collaboration during the whole innovation process based on the intersection of theoretical and practical knowledge. Finally, we present the axis 3 (learning as a social activity and overcoming knowledge boundaries) to show the complexities in sharing knowledge across boundaries and the process of community building through and for collaborative innovation.

AXIS 1. OPENING INNOVATION TO MULTIPLE STAKEHOLDERS

In the 20th century, organizations have been working internally to support innovation development, which consequently pushed firms towards the construction of strong bureaucracies and vertical integration (Chandler, 1977). However, the accessibility and the importance of information, and the increasing role of the hybridization of different knowledge domains that are distributed globally have switched the locus of innovation from inside firms to supra-levels of organizations such as inter-organizational networks, communities and ecosystems (Adner and Kapoor, 2010; Baldwin and von Hippel, 2011; Chesbrough, 2003). “Companies link in these innovation networks with people, institutions (universities, government agencies, etc.) and other companies in different countries to solve problems and find ideas.” (De Backer, 2008; 8) Now, organizations turn to the principles of open innovation, that is “a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology” (Chesbrough, 2003). Since Chesbrough (2003) coined the term Open

Innovation, it has gained a lot of momentum with practitioners and in management studies (e.g., Dahlander and Gann 2010; Chesbrough and Bogers 2014; Randhawa, Wilden, and Hohberger 2016).

However, this approach has not yet reached its full potential in bringing together multiple collectiveS and pushing towards the hybridization of their knowledge in a collaborative manner. Indeed, the literature on open innovation is still centered on the organization's point of view and benefits instead of conceptualizing it as a collaborative approach benefiting to all the involved stakeholders. In addition, the literature has not provided much theorization of approaches and processes to bridging multiple knowledge communities across their knowledge boundaries to push for a co-innovation agenda.

Open Innovation, an Organization-Centric Perspective on Openness

According to Chesbrough (2006), open innovation aims at using "purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation" (Chesbrough, 2006: 1). This perspective on open innovation clearly position open innovation as an organization-centric vision, that is, it is centered on the firm's interests and benefits. This vision has been reflected on the theory development, research and practical uses of open innovation that mostly have been focusing on the inbound flows of knowledge and resources that firms use to commercialize their ideas and even replace internal R&D activities (West & Bogers, 2014)

For example, open innovation recognizes the importance of the activities and knowledge of individual users in the innovation process as a continuously growing source of external knowledge (von Hippel, de Jong, and Flowers 2012; Laursen and Salter 2006; Piller and West 2014). However, these stakeholders have mostly been presented has a source of ideation that firms can *draw upon* in the pursuit of their organizational goals (Bogers and al., 2016). For example, Piller & Walcher (2006) showed that firms are specifically looking to collect novel ideas from customers when launching idea competitions. Attached to other sets of literature focusing on the users as potential innovators, such as lead users (von Hippel 1986), creative consumers (Berthon et al. 2007), hackers (Lakhani and Wolf 2005) and online pirates (Choi and Perez 2007), open innovation presents great research opportunities to better understand how to truly collaborate with these stakeholders.

Indeed, we need to learn more on how to tap and develop the knowledge-base of these individuals to support innovation. It has been shown that these users develop innovations because they enjoy the process of doing so (West and Gallagher 2006), and because they look to benefit from using the solutions in their daily activities (von Hippel, 1982). To accelerate innovation *with* the user innovators, and other stakeholders, firms might need and want to turn towards a more collaborative vision in order to develop users and stakeholders innovation capabilities to the benefit of all. By doing so, firms open themselves to receiving experiential knowledge from users – such as contextual "information on how products or services are used and what limitations exist in the available product (Rohrbeck et al., 2009)" - who communicate their needs who can also suggest and co-construct firms' products by (re)contextualizing them to new usages (von Hippel 1988, 2005; Bogers, Afuah, and Bastian 2010), and getting supported by communities and organizations in the development of standards (Tushman and Rosenkopf, 1992; Rosenkopf and Tushman, 1998; Rosenkopf and Nerkar, 2001).

There is a growing recognition that we need to turn to other units of analysis than the firm in order to better understand the processes related to open innovation (West et al., 2014). Chesbrough and Bogers (2014) presented an interesting multi-level framework shedding light on the emerging perspectives on open innovation related to the processes and outcomes outside of the organization, in broader context such as the industries, innovation systems, and societies. We believe that we can resolve this conundrum by reaching to other sets of literature that already have somewhat been connected to the open innovation literature, such as as users as innovators (Bogers, Afuah, and Bastian 2010; Piller and West 2014), innovation communities (Fleming and Waguespack 2007; West and Lakhani 2008) and communities outside the firm's boundaries (O'Mahony & Lakhani, 2011), as well as other sets of literature coming from the sociology of innovation and design literature since they did not necessarily consider the firm as the focal point of analysis (Bogers and al., 2016).

Towards a Collaboration Perspective of Opening Innovation

Even though the open innovation literature has maintained an organization centric vision, it still address the potential for organizations of outflowing knowledge to facilitate the expansion of their market by supporting external use of innovation (Chesbrough 2006). However, we follow Boger and al. (2016) call for research on "research questions that span across collaborative innovation concepts and across levels of analysis that have so far developed in parallel." In that regard, we believe that researchers should focus more on the collaborative aspects behind open innovation that may facilitate innovation development and diffusion. Researchers on open innovation are now recognizing the need for firms to actively participate in innovation ecosystems that are built on a set of various actors that are part of an innovation process (West and Bogers, 2014). These interrelated actors coming from multiple domains (O'Mahony and Lakhani, 2011), which together have the needed skills and resources to bring an idea to its commercial use (Karnøe 1996), can collectively create novel and useful solutions (Iansiti and Levien 2002; Radziwon, Bogers, and Bilberg 2016) and resolve innovation uncertainty (Adner and Kapoor 2010). Indeed, this active involvement of the multiple stakeholders in the innovation process, through an open approach, facilitates the development of innovation, be it at the early stages of innovation such as ideation or development, or at the stages of validation and valuation, or for implementation and diffusion (Bogers and al., 2016; Dahlander and Gann 2010; Huizingh 2011; Chesbrough and Bogers 2014).

In that regard, Bogers and al. (2016) suggest looking at the involvement of multiple communities of practice in the innovation processes in order to "tap into a very specialized and often tacit topic knowledge" (Bogers and al., 2016). We follow this call for research and look for the integration of multiple communities and stakeholders beyond the ideation stages. However, to do so, we need to better understand how to work and innovate with these other stakeholders – such as the userS-innovators – to access and support the co-sharing and co-construction of sticky knowledge (von Hippel, 1998) by involving these multiple actors so that they are inclined at sharing it (von Hippel & von Krogh, 2006), and thus at contributing to innovation development (Lettl et al., 2006).

Looking for a Better Processual Conceptualization of Collaboration Across Knowledge Boundaries

Even if the first case studies of open innovation have highlighted some of the open innovation instrument organizations mobilize, such as spin-in, spin-outs, outsourcing R&D, technology in-sourcing (Chesbrough, 2003a; Chesbrough, 2003c; Chesbrough, 2006), user integration kits (Piller & Walcher, 2006), open innovation can still move forward in the understanding of the processes and dynamics of collaborative approaches. According to Bogers and al. (2016), "the role played by external stakeholders in the innovation process is largely conditioned by the type of knowledge creation process, its outcomes, and its further absorption". We then believe that we need to better understand these processes, outcomes and absorption so that collaborative approaches' potential can be better conceptualized and mobilized in practice.

The mobilization and involvement of external stakeholders are usually more relevant when organizations need to access users' needs and preferences or expert knowledge in the definition of problems and solutions and less relevant when the needed knowledge is mostly tacit and contextualized internally to organizations or externally to communities in their practices, social networks and cultures (Bogers and al., 2016). The contextualization of knowledge in practice may indeed form knowledge boundaries between practitioners coming from different domains and traditions (Carlile, 2004). However, we believe that there is a strong potential in making these boundaries more permeable. Nonetheless, the relevance of this knowledge intersection has yet to be proven in the open innovation (OI) literature because researchers did not focus sufficiently on the collaborative processes that may support and facilitate co-innovation between these sometimes distant collectives. As Hargadon and Sutton (1997) suggested, "ideas from one group might solve the problems of another, but only if connections between existing solutions and problems can be made across the boundaries between them. When such connections are made, existing ideas often appear new and creative as they change form, combining with other ideas to meet the needs of new users. These new combinations are objectively new concepts or objects because they are built from existing but previously unconnected ideas (1997: 716).”

We then turn towards the importance of knowledge in collaborative innovation processes, following Chesbrough and Bogers (2014) new definition of open innovation: open innovation is “a distributed innovation process based on purposively managed knowledge flows across organizational boundaries” (p. 17). To do so, we need to consider knowledge as being more complex than how it is usually conceptualized in the open innovation literature – as it is shown in the mobilization of words such as “flows” (Piller and West, 2014), inbound and outbound (Chesbrough, 2003) – to move towards the understanding of the stickiness of knowledge (von Hippel, 1998). Considering the complexity of knowledge will be our first step into understanding the implications of different collaborative innovation processes. As Bogers and al. (2016) presented, “it is clear that the relationships between various types of extra-organizational individuals and different types of knowledge creation and innovation processes stand out as an interesting area of future research, especially in the context of explaining the effectiveness of OI.”

Concluding Remarks

“The problem with existing methods and practices is that none of them fosters collaboration among involved parties” (Bretshneider and al., 2008). Indeed, open innovation approaches do not fully “open” their innovation process in a collaborative manner, but do it for the sole purpose of reaching their organizational goals with no intentions of contributing to the development of other stakeholders. For example, in crowdsourcing contests and idea competitions, competition is induced between every participant which may prevent collaboration amongst contributors even if collaboration has been identified as a great potential for stakeholder integration (Gasco-Hernandez and Torres-Coronas 2004). Multiple authors agree on the idea that innovations are co-constructed in collaboration processes where many actors contribute their knowledge, resources and experiences (Gasco-Hernandez and Torres-Coronas 2004; Franke and Shah 2003; Sawhney et al. 2005). Furthermore, collaborative methods coming from the open innovation literature mostly facilitate the early stages of the innovation process where ideas for innovations are generated when we believe that collaboration could influence the whole innovation process. We then propose to reflect on the innovation spaces and platforms that we need to design (Bullinger, 2012) such as hackathons, to allow innovators to co-create and co-innovate in a collaborative manner with all involved stakeholders.

AXIS 2. MOVING FROM “OPENING TO” TOWARDS “COLLABORATING WITH”

The new century marks a turning point in the place given to the work and values assigned to it. Not only is it possible to note a revaluation of manual intelligence of workers, but also the desire to return to the basis of a work that carries a meaning; a job that is free of obligations, free of imposed deadlines and objectives. This philosophical change transforms practices and results in a reconfiguration of the collective report relationship to work (Lallement, 2015). It is the desire to break away from the constraints imposed by the organizations and dictated by the market that pushes people to seek business or work areas where they feel free to exercise their profession or their passion to their liking. In other words, they are looking for a space that allows them to return to the basis of their profession that brought them to choose it initially or, simply, to practice a passion that they love. At the heart of this philosophy is thus the currency to keep the work as an end in itself. "The time for organizations, businesses, unique work or home locations and time of activities ‘monochronic’ is gone. The boundaries between work and leisure become porous."(Gwiazdzinski, 2015: 470)

This new ideology also comes with a desire of working collectively as a reaction to individualism; open innovation being one of many examples. However, there are different ways of working collectively. As the integration of different and multiple actors during the development process becomes the norm and earns interest from organizations, collective working dynamics need to be understood and conceptualized. To understand them and applied them correctly, the type of reasoning as well as the modes of construction of action and knowledge of these approaches should be understood and defined. Moreover, these modes of action are based on the recognition of stakeholders and user needs.

Collective Dynamics for Problem-Solving

There are different levels of dynamics within the project development. Collaboration is the most collective dynamic (Huxham & Vangen, 2005). It requires a mutual commitment from all stakeholders so that they coordinate their efforts together to solve the problem. Cooperation, in turn, requires individuals to take responsibility for a specific part of the project and, subsequently, coordinate the integration of their piece of the puzzle with the rest of the group members. In other words, collaboration and cooperation are "links built by agents to voluntarily perform a common task." (Dejours 1993: 41) The bonds that are built are symbolic in nature and their construction assumes that actors take initiatives to mobilize and engage in the process. Cooperation therefore calls for transparency and confidence between the actors of the collectivity, an agreement on the internal rules that regulate and mediate the actions taken, as well as a space for communication that allows everyone to express themselves and listen to each other.

A collaborative innovation approach puts in motion an abductive process. Practical knowledge sharing across disciplinary boundaries is more complex than “transferring” explicit knowledge (Carlile, 2004). Actors participating in the collaborative process need to mobilize approaches facilitating the use of tacit knowledge, so that the fundamental skills and practices needed for the construction of solutions come into play in the innovation process (Bjogvisson, Ehn and Hillgren, 2012). Inspired by the way designers work, Dorst (2011) suggests a conceptualization of the types of abductive work (Cross, 2011) done to solve problems of different level of complexity. The first type is *Abduction-1* and is associated with conventional problem solving that is usually done in any organization (Dorst, 2006). At this level of complexity, actors know how a problematic should be solved to reach the aspired value of the solution. Then, the designers and their teammates only need, in this type of problem, to solve the “what” of the problem, that is constructing the artifact, the service or the system materializing the working principle (how) behind the solution. The other type of abductive work, *Abduction-2*, is more complex since the only factor in the problem-solving equation that can be reached and assessed at the beginning of the process is the potential end-value (Dorst, 2011). The team would then need to move backward to determine the working principle and the object to be designed.

To do so, the design activities would aim at linking “what designers do, know, and say, with what end users and other stakeholders do, know, and say, acknowledging the materials and objects involved in practices and at the same time attending to the discursive practices that make possible particular ways of doing, knowing, and saying (Kimbell, 2012).” This type of conceptualization of design work shifts the analysis from the individual designers (Dunne and Martin, 2006; Razzouk and Shute, 2012; Efeoglu and al., 2013) to the practices. This analysis aims at understanding social structures having a relational interaction with individual actions in their daily activities.

Design always has been, at its core, a discipline that is about integrating useful knowledge to develop solutions to present-time problems (Buchanan, 1992). Design thinking has then always been focused on the technological culture and on the integration of multiple knowledge for new productive purposes (Churchman, 1967). This literature allows to shed light on some innovation and collaboration practices that are LESS explored in organization studies and management theories. Indeed, as Dunne and Martin (2006) suggest, “We teach a very narrow form of collaboration, which is to find somebody who thinks like you and then work together. I don’t think we teach students to really dig deep and to understand somebody else. We don’t understand users; we don’t understand clients; we don’t understand other people really well. We don’t teach students about visualizing and imagining something that does not now exist that would take care of users’ needs. We don’t teach them about prototyping, giving the product to the consumer and then improving it and improving it some more. We don’t do any of that.” All of these principles, that is, the opening to other knowledge perspectives, the deep understanding of problematic, the user-centered design, the understanding of stakeholders’ visions, and the pushing for the unknown is fundamental in the mobilization of collaborative innovation approaches.

To facilitate users’ understanding of an innovation and, therefore, their capacity of absorption so that new practices get diffused, authors from the co-design literature believe that all relevant stakeholders of the development process should be included from the beginning to the end. Sociology of innovation also offers a different way of looking at innovation from the perspective of appropriation in and transformation of social practices. "Innovation is neither good nor bad. It depends on where one speaks and the people talked about [...]" (Gaglio, 2011: 4) Innovation can therefore not only be seen as the economic consequences of an object, a method or a process, but should be understood in regard to its social impact. Instead of focusing innovation on the producers or inventors, sociology of innovation focuses on the whole network of involved stakeholders in the innovation endeavor, which includes direct and indirect users. (Von Hippel, 2005) In other words, understanding the sociology of innovation means understanding the social structures that influence the process and the product of innovative activities as well as the transformations of that social structure following the innovation process.

Collaborate "with" and "in" a network of practices and actors

This vision of the innovation process allows the development of a theory accounting for social practices instead of studying the innovation as a reified and objectified thing or process. From this point of view, sociologists study the cultural, social, economic and political changes rather than organizational processes allowing the firm to yield profitable results in the context of their technological developments. "[...] Innovation here doesn't mean new objects - such as information and communications technology – but a complex process based on new objects that transforms modes of interactions and relationships between actors. (Choplin, 2002; 1) Moreover, innovation should be regarded in interaction with the existing social structures and networks of practices that interacts with the innovation process. "The fundamental sociological insight - that social structure influences behaviors - can help explain at multiple levels and at different stages of the innovation process." (Hill, 2010: 2) For example, since innovation is understood as a social process, users appropriation becomes a very important phase to study. For sociologists, appropriation is indeed what determines the transformation of an invention into a fully actualized innovation (Alter, 2002). Innovation is powerful because it is adopted in the user practices meaning that a technology is not intrinsically powerful (Coutant, 2015). Indeed, appropriation, that is a whole process in itself included in the innovation process, may take different turns depending on the population concerned. The underlying principles of a technology may, for example, get discovered during this phase in which users determine and define its usage (Pinch and Bijker, 1984) which may lean towards multiple forms and sometimes unforeseen uses.

This point of view on the importance of user appropriation processes allows to identify users' needs and better understand their behavioral patterns, lowering the potential risks of non-relevance of solutions for users' practices. Indeed, in these processes, more importance is given to personalized interactions between actors, as well as on the whole experience rather than focusing on the product (Prahalad et Ramaswamy, 2004) which facilitate the adaptation of the product under development to personal experiences and users' typical practices. It ensures that the needs of all stakeholders of the project are considered. To do so, actors face challenges to build a shared understanding and communication channels between them (Kleinsmann et Valkenburg, 2008). Consequently, actors accept that controversies across boundaries are to be expected (Bjogvisson, Ehn and Hillgren, 2012), and that, even if they seem irreconcilable (Dorst, 2011), they may be managed by satisfying the sometimes diverging considerations, interpretations and interests of those affected by an innovation.

In a context of complex problems, characterized as wicked problems (Buchanan, 1992) commanding the involvement of multiple communities of practice (Lave and Wenger, 1991), that are each mediated and constructed on a variety of signs and artifacts (Kimbell, 2011), designers and design practices becomes increasingly important as cultural intermediaries (Julier, 2013) to attach these networks of actors, even if they come from different knowledge domains (Kelley and Van Patter, 2005). There is a need for this form of cultural work – or as we shall present in the Axis 3, boundary work across knowledge boundaries – since designers and individuals' creative problem solving abilities is always determined by their tradition (Louridas, 1999) and the past combinations of ideas, artefacts and actors. Indeed, tradition determines the problematic, the means to solve it, the space of creativity around the problematic, as well as the material and social agencies to put forward. All in all, tradition is a socially shared structure determining individual actions and how one perceives and solves a problem (Louridas, 1999). These socially shared traditions are what hold together members of communities of practice, but what may reduce novelty creation as well (Carlile, 2004).

Designers and their “way of doing” then play an important role into breaking down these traditions to facilitate the understanding and solving a problem.

Moreover, every actor plays a crucial role in the innovation process. «Since the outcome of a project depends on the alliances, which it allows for, and the interests which it mobilizes, no criteria, no algorithm, can ensure success a priori. Rather than speak of the rationality of decisions, we need to speak of the aggregation of interests which decisions are capable or incapable of producing. Innovation is the art of interesting an increasing number of allies who will make you stronger and stronger.» (Akrich and al., 2002: 205) Besides, the number of actors (human and nonhuman) involved as well as their relative importance may increase or decrease and their identity can change over the innovation process. (Akrich and al., 2006) Since sociologists rather focus their understanding of innovation on the association process in which innovators are engaged, innovators are denied any favorable position. Therefore, innovators don’t have any privileged contact with reality, they are never in front of their future users, but only are meeting with mediators which can be either good or bad mediators (Akrich, 1987: 30). Innovators’ actions rather represent a constellation of simple tasks (Alter, 2002), through which innovators manage to create associations between new actors to give life to their innovation. Innovators are then constrained to engage many different actors in their process; actors coming from a plurality of communities.

It is through common actions (Alter, 2002) of communications and everyday actions, accumulations (Tarde, 1900; Gilfillan, 1935) of historical structures, combinations of ideas (Arthur, 2006) and associations of actors (Akrich et al., 2006) that traditions, customs and ideas are transformed. It is through imitation (which in Tarde’s language is equivalent to appropriation for sociologists of innovation) of new behaviors and new uses that social structures and practices get stabilized in the collective histories. Tarde (1900) actually suggests that social transformations are the result of individual initiatives, which are imitated by collective, thus transforming their social structures.

Concluding Remarks

In conclusion, we have shown that binding multiple actors, practices and ideas together in a collaborative process is instrumental to an innovation success. Furthermore, by considering the role of innovators, authors of the sociology of inventions and sociology of innovation reach beyond the heroic explanation of genius inventor. They rather turn to the study of innovation as a process of social transformation, which involves the reorganization of social structures. To transform an idea based on new practices, different skills and knowledge are required from the ideation phase to the implementation. A single individual may transform his or her practices to face the daily constraints, but if he doesn’t quickly surround himself with actors from diverse fields and backgrounds, the idea coming from the transformation of his/her practice will not get used by others. Therefore, innovation is a collective process; it is not the result of a single individual’s work. It requires a good understanding of how practical and conceptual knowledge are constructed and deployed to ensure that all stakeholders are considered, involved and put in interaction in the development process.

AXIS 3. LEARNING AS A SOCIAL ACTIVITY AND OVERCOMING KNOWLEDGE BOUNDARIES

Studies on communities have emerged strongly in organizational studies in the past 20 years to better explain how knowledge is constructed, shared and transformed with some authors even suggesting that this theoretical focus is more suited to contemporary organizational challenges (O’Mahony and Lakhani, 2011). In this axis, we first theorize knowledge and learning as a social process and phenomenon that is based on a set of structures - such as norms, languages, values - that are socially constructed. This theorization provides an explanation for issues related to sharing knowledge between actors coming from different knowledge domains that are constructed on different sets of structures that become boundaries to knowledge sharing. Finally, we discuss the puzzles in understanding knowledge construction across these boundaries and the process of building a community that could potentially integrate multiple knowledge domains and collectives.

Knowledge as a Social Phenomenon and a Social Boundary

The literature on communities has been focusing on the social structures such as traditions (Louridas, 1999) that influence how individuals act and think in their daily life and on how knowledge is collectively constructed. In turns, individuals sharing the same contexts, that is the same practices (Wenger, 1998; Brown and Duguid, 1991; 2001), or occupations (Van Maanen and Barley, 1982; Bechky, 2003), through socialization with each other, can share knowledge – both tacit and explicit (Brown and Duguid, 2001) - between one another. Lave and Wenger (1991) first used the term communities of practice to describe learning through practice and participation based on a set of norms, shared language and identities. The term "community of practice" refers to a collective who share a common interest and a desire to learn from and contribute to the community, commit to the community domain, and therefore have a shared competence that distinguishes members from other people (Lave & Wenger 1991). Most research on communities have focused on the inside functioning of the community (Bechky, 2003), allowing deep understanding of learning and knowledge creation in a localized context, but black boxed how knowledge creation across boundaries works (Carlile, 2004).

Knowledge, when understood through this social perspective, becomes a vehicle as much as a constraint to knowledge building – mostly when knowledge should be shared across knowledge boundaries (Carlile, 2002). Communities of practice may become static in regard to their knowledge base and resist the adoption of new practices that challenge their predispositions, such as the identity of their members (Robert, 2006). Members would rather tend to adopt knowledge that does fit with their actual practices that are more comforting to their identity. Members of these collectives may be tightly bonded (Barley, 1996), to the point of constraining innovation across boundaries. In these perspectives, knowledge emerges and exists (Choo, 1998) in the participative communal context, and becomes more and more “sticky” (Brown and Duguid, 1991) to that particular community context. But what happens when one needs to translate and/or transform his/her current knowledge to bridge it and construct a project with individuals coming from different communities (Carlile, 2004)?

In a context where innovation is built on the hybridization of knowledge coming from multiple expertizes and domains, one has to understand how to create knowledge and share meaning across knowledge boundaries. That is particularly the case for projects entering innovation systems in which actors from multiple domains are bound together and all should understand, value and co-produce the innovation. In that regard, authors of the literature on epistemic communities have explained how knowledge may become public across scientists (Ziman, 1967) in a network of practice (Brown and Duguid, 2001). According to Nicolini et al. (2003), knowledge is embodied in actions situated in historical, social and cultural contexts – what they labeled knowledge as a social expertise. This shared culture is the vehicle for integrating a collective and share knowledge (Lazaric and Thomas, 2006).

Building and Developing a Community to Facilitate Innovation Across Boundaries

Lave and Wenger (1991) were interested in understanding how, through daily actions, apprentices learn by entering a collective. They shed light on the process through which these newcomers learn from observing others and performing simple tasks while trying to understand and learn how the community works and how they can fit in and participate in it to develop their individual identities (Wenger et al. 2002). This process was labeled legitimate peripheral participation. Then, a community of practice is a group of individuals participating in communal activities, experiencing and (re)creating their shared identity through engaging in and contributing to the practices of their communities. According to Brown and Duguid (2001), even if humans do all share sociohistorical elements that support their identity, “much of the practice that forms identity and gets work done is more local and more dynamic”, pointing towards the need of supporting a local context for identity development.

There has been a growing interest within organizations and researchers to encourage, support, and sponsor communities of practice in order to better share tacit knowledge that is not easily articulated (Wenger, 2000). According to Lesser and Storck (2001), communities of practice have an impact on organizational performance by, among other things, 1) decreasing the learning curve of new employees, 2) reducing rework and preventing "reinvention of the wheel" and 3) spawning new ideas for products and services. We believe that communities of practice may also impact stakeholders outside of organizations sponsoring the communities by decreasing their learning curve of new technology usages, reducing rework when lead users (von Hippel, 1996) are willing to transform a product's identity and to develop new ideas that are fitting their needs.

This perspective does fit with our inquiry, that is, understanding how we can develop people's competences towards the appropriate practices in regard to the appropriation of new technologies. To do so, we believe that one may need to create a context (epistemic, social, cultural) that facilitates knowledge construction (Choo and Neto, 2010) by supporting the elaboration of basic shared language, norms and values. By mobilizing collaborative approaches such as innovation events, organizers are reproducing the peripheral participation process and the communal socialization so that participants – that can be understood as potential new community members - may learn new practices related to developing technologies. This, in turn, may also have an impact on individual's identity so that they take part in innovation processes. This approach also fits specifically with two of the seven actions that can be taken in order to cultivate communities of practice. According to Wenger, McDermott and Snyder (2002), 1) one needs to find and nurture a regular rhythm for the community by coordinating a thriving cycle of activities and events that allow for the members to regularly meet, reflect, and evolve and 2) create opportunities for open dialog within and with outside perspectives so that members understand the different possibilities for achieving their learning goals.

To understand how knowledge creation happens across boundaries, studies have looked at individual actions in moving practices from one community to another, termed brokering (Wenger, 2000), or boundary work supported by boundary objects (Carlile, 2002). Chua (2002) suggests that social interaction is one of the main drivers of knowledge creation, and that cooperation is one of the strongest way to support knowledge diffusion. Through these social interactions, individuals coming from different communities need to learn how to learn together before learning from one another (Mishra and Bhaskar, 2011). Other scholars argue for approaches of knowledge spreading based on contributing to knowledge through cooperation and adopting new patterns of behaviors (Mughai, 2010), highlighting the relevance of collaboration for knowledge diffusion and construction.

However, these studies did not focus on how one may create a community at the intersection of multiple communities through the mobilization of collaborative approaches. If we consider knowledge to exist and emerge in social interactions, we then need to acknowledge and support the replication of the actions and practice shown to have an impact on the re-creation of knowledge. We need not to focus only on the characteristics of a crowd or community event, but on the context creation it supports and the practices mobilized to facilitate knowledge construction, creation and transformation.

Concluding Remarks

Learning is a complex phenomenon that needs to be conceptualized as a social phenomenon to allow a deeper understanding of the challenges related to knowledge construction across multiple knowledge domains and of the ways to overcome these challenges. Communities are built on a set of artefacts, norms and values that structure individual actions through shared practices. These practices may then become boundaries to knowledge sharing when actors are part of communities built around distant practices. However, we believe that by constructing a new repertoire of artefacts, norms and values, based on shared interests and missions, actors may reconstruct their practices and identities around these new social structures which would allow the construction of new communication, translations and transformation channels across multiple knowledge domains.

CATEGORIZING COLLABORATIVE INNOVATION APPROACHES

Multiple types of approach exist in order to reach and access the so-called crowd's knowledge (Boudreau and Lakhani, 2013), with each of them having different characteristics that are suited to specific challenges and issues related to distinct knowledge boundaries (Carlile, 2004). "These co-creation challenges within innovation highlight how co-creation is not simply a matter of bringing together those who co-create, but rather how the boundaries are necessary to enable innovation in the co-creation process." (Degnegaard, 2014: 104)

Our Model: Categorizing and Understanding Collaborative Innovation Approaches

We developed an integrative framework that allows comparing, contrasting, and integrating the collaborative innovation approaches. This framework should be understood dynamically, with no clear boundaries between the different practices and continuum levels. To facilitate the reading and understanding of the figure, knowledge typologies have been defined by presenting them through clear boxes. However, in practice, many nuances exist and should be mentioned in between the crowd and the community (1), between the source of knowledge (2), the different levels of stickiness of knowledge (3) and integration of knowledge domains (4).

Our continuum on the first axis goes from *crowd* to *community*. First, the collaborative innovation approaches always bring together multiple individuals but with different degrees of engagement to the participating collective. The less engaged level is labeled the *crowd* level, which can be understood as a large, generic and undefined network of self-selected individuals/contributors (Howe, 2006b; Afuah & Tucci, 2012; Arolas, Gonzalez Ladron de Guevara, 2011). We refer to the *crowd* as a group of individuals with different characteristics (Arolas, Gonzalez Ladron de Guevara, 2011) that do not necessarily know each other and who are loosely bound together by structural social practices (Wexler, 2011). They only have in common the contest, the problem or the challenge that they are trying to solve separately and so they do not form a bounded collective that carries knowledge in its social structures.

However, the level of crowd is a continuum, evolving depending on the mode of organization of the crowd. For example, Viscusi & Tucci (2016) argue that there are two different types of crowds, that is the "open crowd" which is permeable to new members, and the "closed crowd" that has boundaries limiting access for certain participants or new members. In the latter case, individuals may build an engagement to the collective, yet don't share structural aspects characterizing the level of engagement that we define as *community.* One of these exceptions of a crowd forming an engagement is the online community such as those built by crowdsourcing platform like Innocentive (see additional resources), where there is a greater possibility of the people knowing each other (Whitla, 2009). However in the cases of online communities that are constructed without peer-to-peer interactions, the collective does not foster a sense of belonging or identity and thus, a community-like engagement for members (e.g. Jeppesen and Lakhani, 2010).

The passage from the level of engagement of crowd to community implies a transformation of the way knowledge is transmitted, integrated and applied between people, individually and collectively. Knowledge sharing at the community level goes from a transmitter-receiver relationship to a partnership relationship (co-) - meaning that knowledge sharing becomes mutual and interactive. But as the individual's engagement shifts, different types of partnershipS can occur.

The *community* level of the continuum is built on the literature on communities of practice. Individuals, through a process of peripheral participation (Lave and Wenger, 1990) become members of the collective participating in the event or the already existing collective. They learn from others, observe others, becoming more than participants, but actual members of a collective. Through the collaborative innovation approaches, members of the collective develop artifacts, epistemic objects (...), shared practices (...), norms and identities (...), a mutual engagement, a joint enterprise and a shared repertoire (Wenger, 1998). Once these social structures are constructed, individuals of the crowd become members of community, that is, they become socially engaged and structured in the community. The collective in itself, through its members' social associations, becomes a carrier of knowledge that supports a collective cognition project (Lave, 1988) through a reflexive and praxeological process of knowledge development in action.

The community level can also be understood as a continuum in itself. At its lower degree, community members are not necessarily attached by traditions, cultural aspects and a shared repertoire such as strong communities of practice. Communities of interest come together to get informed on a shared topic of interest and is open to whomever is interested in that topic. Individuals engaging in these forms of communities do not share a joint enterprise or a mutual engagement (Wenger, 1998) but may build a shared repertoire to exchange knowledge together, which is facilitated by the construction of shared identity (Hsu and Hannan, 2005) related to the collective community interest.

The second axis is the source of knowledge. Indeed, knowledge is deployed differently depending on the individual who possesses it, the context within which he finds himself and why he uses it (Who, How, What and Why). This axis proposes a categorization of the level of application of knowledge from *theoretical* to *practical* passing through a transmission of knowledge from theoretical to theoretical, theoretical to practical and practical to practical. In one of the poles there is the purely abstract knowledge that refers to actions of thoughts. (Wacker, 1998) This knowledge is learned by individuals and applied conceptually. At its opposite, there is the practical knowledge that engages individuals in the action of doing. There is no ontologically superiority of one knowledge over the other, but a differentiation to make.

The *theoretical source* of knowledge considers all the notions, ideas, laws or hypotheses generated by observation or experience. "A theory implies a set of concepts and their relations (i.e., "ontological commitment")" (Hjørland, 2015: 21). It is an accumulation of facts that, analyzed and synthesized, are used to improve the understanding of a reality. The creation and sharing of this type of knowledge stays in a conceptual and abstract realm. Theoretical knowledge provides a framework for analysis, an efficient method for field development and clear explanations for a pragmatic world. (Wacker, 1998) "Theories carefully outline the precise definitions in a specific domain to explain why and how the relationships are logically tied so that the theory gives specific predictions." (Wacker, 1998: 363) Therefore, this source of knowledge emphasizes specifically the understanding and interpretation of why and how specific phenomena occurs. (Hunt, 1991)

However, "[...] learning *how* is different from learning *that*: the former involves, as the latter does not, inculcation : i.e. persistent, impressive repetition." (Nyiri, 1992: 47) The *practical source* of knowledge, therefore, refers to a concrete and experiential frame of action in *praxis*. It emphasizes on the capacity of discerning what action to take in a given situation. Behaviors, activities, habits, skills and processes are all entities that put in motion the practical knowledge. (Catinaud, 2015)

There is a form of thinking as well as acting on problems simultaneously in a global perspective. It is mainly deploying to find and realize creative and innovative solutions. In the design field, it is known as the reflexive practitioner. (Schön, 1993) It allows those who practice it, first, to open up and reflect on the various issues of a problem and lead to dialogue between actors of different disciplinary backgrounds and, secondly, to take an active mode in achieving a viable solution to the problem. These two roles do not go one without the other: the thinking and practice feed one another constantly. "Theory, for theory's sake, can easily degenerate into an uninteresting art form. Yet, practice without theory can quickly become a dull and dangerous occupation." (Shubik, 1987).

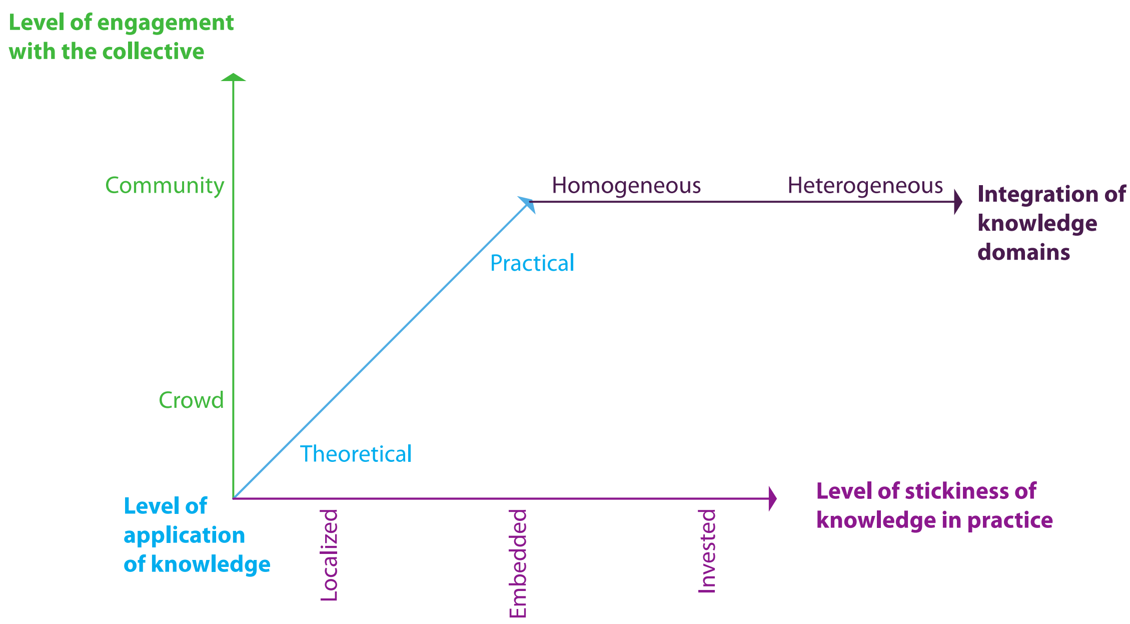
The third axis present different levels of stickiness of knowledge in practice based on Carlile (2002) characterization. First, "knowledge is *localized* around particular problems faced in a given practice" (Carlile, 2002). Through specialization, individuals become more efficient in solving a specific set of problems in a given context. The knowledge constructed in these practices may be easily transferable from one similar practice to the other. With the complexification of problematic, and the openness to collaboration, these localized knowledge is useful to others, since multiple organizations or actors face similar problematic. For example, a programmer may use one coding language at his work in the aeronautic industry that could also be useful in the development of digital solutions in the healthcare system. The challenge here lies in getting access to such individuals with localized knowledge that could transfer it to another practice around a similar set of problems. This challenge that can be related to the *know-who* (Lundvall and Johnson, 1994) becomes ever more important now that problems command the mobilization of knowledge coming from different fields of expertise (Pavitt, 1998).

Second, knowledge is embedded in practice. "The word embedded suggests an archeological image as to why knowledge is hard to articulate or real, knowledge accumulated in the experiences (Taylor, 1993) and know-how (Harper, 1987) of individuals engaged in a given practice. Knowledge is also embedded in the technologies, methods, and rules of thumb used by individuals in a given practice (Carlile, 2002)." Individuals in their daily actions build up experiences that become automatic ways of doing and solving problems. So, these individuals may not be able to explain, share and transfer (Carlile, 2004) their knowledge associated with these automatic ways of doing things since the archeological accumulation of this knowledge in their practice is not easily accessible. The challenge occurs when individual who do not share practices need to go to the bottom of things - that is understanding all accumulated knowledge - to be able to access the other's knowledge or on the other side, to communicate it. This situation becomes even more challenging when the practices are distant from one another (Carlile, 2002).

Third, knowledge is invested in the practice, a characteristic that is usually not considered in the complexity of knowledge creation and construction. Other literature understand this phenomenon as resistance to change (Coch and French, 1948) without fully developing on why it is the case. Through successes in solving problems in their daily actions - with specific methods and know-how, knowledge accumulates in the experiences but also gets solidified because of its valorization in practice. Indeed, knowledge becomes valued for its efficiency and other successful attributes pushing individuals to stick with the knowledge they are used to mobilizing. "In this way, individuals are less able and willing to change their knowledge to accommodate the knowledge developed by another group that they are dependent on. Changing their knowledge means an individual will have to face the cost of altering what they do to develop new ways of dealing with the problems they face (Carlile, 2002)." The challenge is then to provide means for individuals to recognize the value of other ways of doing and solving problems so that they may understand that the benefits of changing their knowledge is higher than the cost of altering what they usually do.

The fourth axis – *the integration of knowledge domains* – was implied throughout our literature review and model description. This axis is aligned with the level of stickiness of knowledge in practice which increases in complexity as the number of actors coming from different knowledge domains or practices participate and interact together. The fourth axis then covers the *number* of actors (organizations, communities, individuals) with different practices and knowledge domains, from a *homogeneous* to *heterogeneous* collective as well as the level of interaction of these different practices in their activities. The integration of a more heterogeneous collective becomes more challenging in terms of knowledge boundaries. However, in some cases, such as at the level of engagement of the crowd, heterogeneous actors do not have to interact together even if multiple knowledge domains are represented, meaning that knowledge boundaries become less challenging in managing the collaborative innovation process. At its highest degree of heterogeneity, coupled with a high level of engagement of actors in the collective (level of community), individuals coming from multiple communities of practice bind together as one collective, by sharing a macroculture (Borgh, Cloodt and Romme, 2012; Abrahamson and Fombrun, 1994), interests and missions that act as structures for the collective, moving towards a collective that can be understood as a community of communities (Amin and Cohendet, 2004). This aggregation of communities becomes more and more necessary in the development of complex innovations.

Figure 1 - Categorizing collaborative innovation approaches



The visual representation of our conceptualization highlights the practices that are necessary to solve challenges specific to knowledge boundaries that arise contextually. These practices can occur during certain forms of collaborative innovation approaches. The six practices presented in the figure – *transferring, translating, transforming, co-transferring, co-translating and co-transforming* – are based on Carlile's 3 T framework (Carlile, 2004) upon which we added three practices where actors mobilize these practices in an interactive and collaborative manner. For our purpose, we will define the first three practices – transferring, translating and transforming – and provide a simple principle for expanding these definitions to explaining the latter three practices.

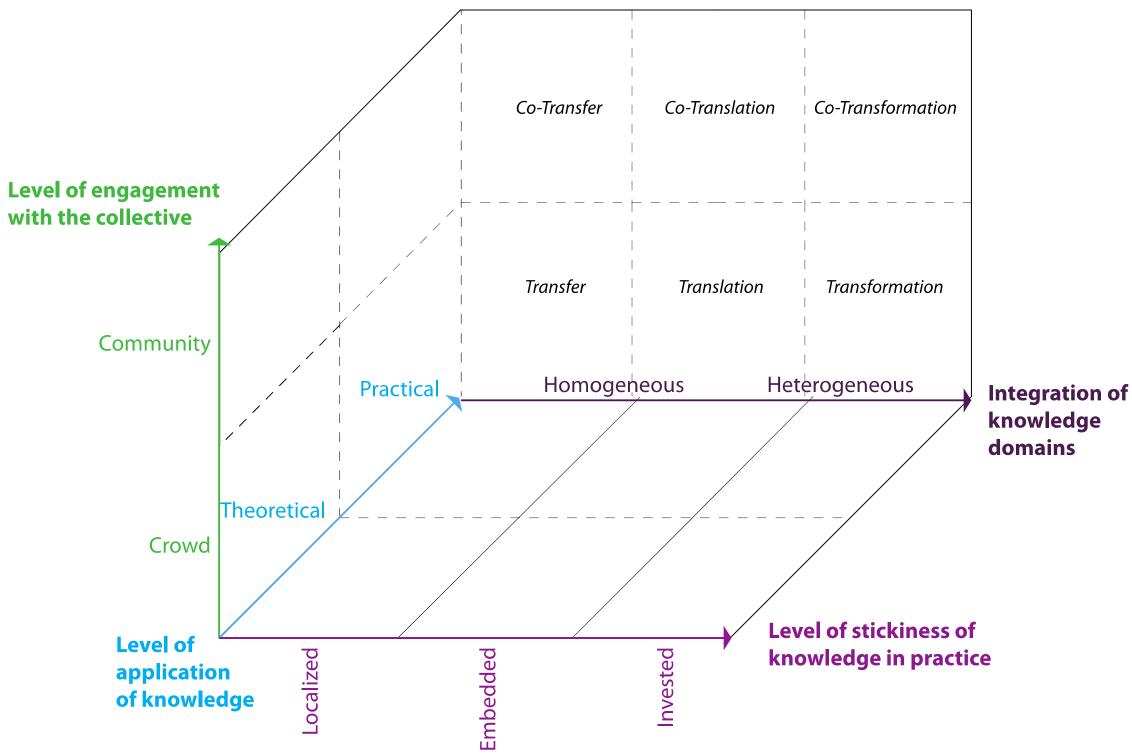
Transferring knowledge occurs between actors sharing localized practices that support the process of sharing knowledge between them. For transferring to occur without complications, stable conditions must exist, such as a common lexicon that represents clearly and thoroughly the knowledge that needs to be transferred. However, failure to transfer knowledge may occur when the existing lexicon is not sufficient to represent the differences between actors and the novelty that needs to be accounted for.

There is a need for *translating* when new actors, coming from different practices, do not share the same norms, values, language and visions, creating a sort of fuzziness around the interpretations of meaning. In this context, different actors have different interpretations about the same issues, challenges, realities which makes it more complex to share knowledge between them. Actors then need to figure out what are the different interpretations by translating the meaning they attach to a situation so that other actors may understand their perspectives and develop a common meaning "to address interpretive differences across boundaries (Carlile, 2004)." However, issues related to effective knowledge sharing do not always emerge from diverging interpretations. They may also come from diverging political interests different actors hold.

The process of *transforming* aims at dealing with the different interests of actors. It recognizes that actors are invested in their practices, and so they may face consequences when they need to learn and transform their knowledge. Indeed, new knowledge in one domain may have a negative impact on other actors coming from different knowledge domains. "What is required is a process in which actors negotiate and are willing to change the knowledge and interests from their own domain" by recognizing the potential consequences of the novelty on their practices in order to "transform their domain- specific knowledge accordingly (Carlile, 2004)."

Mirroring these three practices in a "co" perspective means that we keep the same conceptualization of the three practices we just presented, but suggest that these practices may occur in partnership – that is a collective and interactive relationship, and not only in a transmitter-receptor process. We suggest that *transferring, translating and transforming* can occur to all actors participating in a knowledge construction process at the same time or around the same knowledge boundary issues. For example, when recognizing that novelty in one knowledge domain may have consequences in another actor's knowledge domain, we suggest that the transformation of knowledge may occur for both participating actors. Indeed, they could both change their knowledge base in a negotiation process to benefit a shared purpose.

Figure 2 – Sorting practices and challenges related to collaborative approaches



Our framework provides a deeper vision into the practices that are supported in different collaborative innovation approaches and issues related to knowledge construction when mobilizing specific approaches instead of others. It then sheds light on knowledge construction processes that support innovation and learning in different contexts and social structures. (see Table 4, in the appendices) For example, we can analyze lectures as a knowledge diffusion approach that is categorized in the level of engagement of the crowd, where localized knowledge and theoretical is shared through the practice of transferring. Indeed, in lectures, a professor – who is generally an expert in a localized (specialized) field of knowledge (Bennis et O'Toole, 2005) – transmits theoretical knowledge to a collective of individuals who are not engaged in the collective of the classroom. Our framework then allows to understand the underlying issues of a knowledge sharing approach. Indeed, the downsides of lectures are 1) the potential of knowledge receptors (e.g. students) to consolidate theoretical knowledge in their practice, 2) the difficulty of transmitting such knowledge to actors who are not part of the localized practice of the professor – that is they do not share necessary codes and language, and 3) the capacity of such approaches to bind actors together in a collective to facilitate knowledge co-construction.

For the latter issues, new pedagogical approaches have been developed to reduce the gap existing between employers, students and other stakeholders' needs in the education system (Johnson et al., 2007). For example, experiences have been attempted in developing more active form of learning (Tsay et Brady, 2012) such as cooperative learning which focuses on group work organized through shared goals and social interdependence between students (Johnson et al., 1998; Johnson et al., 2007) and other approaches based on the community of practice principles (Barczyk and Duncan, 2013). In addition, some other pedagogical approaches even mobilize open innovation and project management principles to promote collaborative competences in the classrooms (Oganisjana, 2015). These new approaches then focus on managing the issues of lectures by creating a bond between students, and by moving towards the mobilization of theoretical knowledge in practice.

In the next sections, we present in a more detailed manner three new collaborative approaches that have been mobilized as open innovation devices in recent years: *crowdsourcing, hackathon, and maker/hacker space.* Based on our conceptualization, we provide an understanding of the potential benefits of moving towards such collaborative innovation approaches for the development of individuals and collectives, and diffusion of new technologies across multiple knowledge domains.

Crowdsourcing

Open innovation has recently turned towards the "wisdom of crowds" (Surowiecki, 2005), through collaborative innovation approaches that fall under the umbrella of crowdsourcing Crowdsourcing is defined as "the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call" (Howe, 2006b) built for individuals external to the organization's boundaries. The process usually includes a contributor (the crowd), a sponsoring organization (or other actors) soliciting these contributions and some form of sourcing process. Indeed, crowds are seen by organizations as a major knowledge resources for innovations (Enkel 2005, Kristensson 2002). Crowdsourcing allows tapping into diverse, and distant knowledge to provide solutions to *local* problems (Jeppesen and Lakhani 2010; Afuah and Tucci 2012; Poetz and Schreier 2012). The principle of "collective intelligence" is the underlying assumption of this idea (Surowiecki, 2005, Bonabeau, 2009). Indeed, crowdsourcing builds on the principles that a large group of individuals have more pieces of information and insights than any one individual (Surowiecki, 2005) since it builds on a larger participant pool who may explore in parallel different solutions (Terwiesch and Xu 2008) and that a large number of people performing small tasks can collectively perform a large task (Benkler, 2006). We present the visual categorization of crowdsourcing as a collaborative innovation approach based on our conceptual framework (see figure 3 in the appendices).

These crowd-related activities are usually built as contests (Boudreau and Lakhani, 2013) such as tournaments, idea competitions (Bertshneider and al., 2008) and innovation contests (Afuah & Tucci, 2012; Diener & Piller, 2013) that are shared and hosted via an Internet platform and in which individuals or teams generally compete for a cash prize. Contests have proven their effectiveness as platforms for innovation (Terwiesch and Xu 2008, Terwiesch and Ulrich 2009). In crowdsourcing contests, the sponsor organization identify a specific problematic that needs to be addressed (sometimes for societal purposes, sometimes for purposes related to their own business), and offers a cash prize that is coherent with the complexity of the challenge (Zheng et al. 2011). Depending on the problematic the organization is trying to resolve, there are different levels of task complexity related to the types of task and the nature of the problem-solving process (Schenk and Guittard, 2011).

Organizations, through crowdsourcing platforms, promote and invite individuals or teams to submit solutions answering the problematic description (Zheng et al. 2011). Individuals unaffiliated with the contest sponsor and on a voluntary basis (Majchrzak and Malhotra, 2013), select a problem they want to solve, work and propose their solutions to the contest. These participants, that may be localized all across the globe, are autonomous third party independent agents who are competing for a monetary award, for recognition, and because they are interested in the tasks at hand (Lakhani and von Hippel, 2003; Murray and O'Mahony, 2007; von Hippel, 2005; von Hippel and von Krogh, 2003). After submitting their ideas, every participant solutions are assessed and winners are selected to receive the prize offered by the sponsor organization in exchange for the right to use and exploit the solution (Mortara et al., 2013).

Multiple platforms such as Innocentive now provide intermediary services for organizations willing to launch a challenge (sponsor organization) and reach an important crowd. Some firms such as Procter and Gamble even built their own crowdsourcing platforms and made this approach one of their main problem-solving processes (Dodgson et al., 2006; Huston & Sakkab, 2006). These platforms allow to reach, mobilize and maintain members, facilitate payment, and manage intellectual property worldwide (Boudreau and Lakhani, 2013).

However, such an approach to opening innovation has limitations in regard to knowledge construction. First, these platforms do not allow to manage the widely diverse knowledge, skills, and perspectives (Boudreau and Lakhani, 2013), coming from a wide range of individuals. Indeed, firms may gain more interesting ideas for innovations (Lakhani and Thusman, 2012). However, this increased variance may also have a negative impact on the innovation process. For example, organizations usually struggle to combine distant knowledge with their knowledge base (Kotha et al., 2013) because of the novelty they have to manage (Carlile, 2004).

We believe that the crowdsourcing approach does not allow to manage *embedded and invested* knowledge and interpretations of a heterogeneous collective in the innovation process. Indeed, crowdsourcing facilitate the organizing of the collective and of geographically distributed contributions of members of a particular community (Plattner, 2012). However, it does not allow the crossing of multiple communities and development of the member's capacities.

Second, crowdsourcing is more of an organization centric approach for idea generation when we look to better understand how to make new technologies accessible for the citizens/users through collaboration across the whole innovation process. Indeed, most studies in the crowdsourcing literature did not address the development of the crowd itself but focused on the benefits for the sponsor organizations (Howe, 2006b; West & O'Mahony, 2008), the way to mobilize the crowd (Schenk & Guittard, 2009) and on intermediary platforms (Chanal & Caron-Fasan, 2010). We would then qualify crowdsourcing as a restricted collaborative approach. Organizations who initiate this method determine the participants' roles and tasks. Accordingly, organizations and experts from this organization search for some specific localized expertise, knowledge or specific products. This creates a temporary relationship, a « […] one-time act from the participants' side aimed at responding to a task » (Aitamurto, 2013: 230). This approach puts forward the final product, not the innovation process that may have a greater impact on the implementation of innovations in traditional environment. Crowdsourcing then becomes more a matter of inbounding knowledge from outside the firm's boundaries and of motivating participants to submit ideas instead of managing knowledge boundaries for a deeper collaboration. A more collaborative approach, according to our categorization, is an approach that underlies a process built jointly between the organization and the players that are invited to participate in the creative process. This approach would involve interactive communication between consumers and result in a shared experience; personal and professional. To the contrary, the creation of new ideas does not change the user in a crowdsourcing process, but basically allows the firm to create a new product without influencing the knowledge of the contributor from the crowd.

Third, much of the early literature has studied contests through the lens of static, single-submission contests. However, more and more contests now mobilize an iterative approach of evaluation and scoring through multiple entries (Wooten and Ulrich, 2015). For example, the Netflix Prize, 99Designs, and the NASA's Asteroid Challenge Series mobilized a more complex approach to crowdsourcing contests. Such dynamic contests, with changing information structures facilitate learning through these iterations but do not address the need to crossing knowledge boundaries in collaborations involving individuals from different domains. Still, this is a further step into engaging the collective in a more bounded crowd by supporting collective learning.

Finally, one issue with this method is that it was not built to foster collaboration among involved parties. In the crowdsourcing contests, a situation of competition is produced which may prevent individuals to collectively create together and then form a collective Bretschneider and al. (2008). We then need to move towards more cooperative approaches in order to foster the construction of shared identities which may facilitate knowledge co-construction across the different stages of innovation. That is why we turn to a more engaging approach of opening innovation to the outside communities, an approach that better suits the goals of managing multiple types of knowledge and making accessible new technologies to users and citizens.

Hackathon

Since the 2000s, hackathons have been increasingly mobilized for multiple purposes by different types of organizations such as NGOs (Linnell & al., 2014), tech firms (Briscoe, 2014), public organizations (Juell-Skielse & al., 2014) and governments (Baraniuk, 2013). Ingrained into the very essence of coding, but given a formal name only fairly recently, today's version of a hackathon emerged during the late 1990s. Hackathons famously gained traction in the 2000s when Facebook and Google started promoting that its internal hackathons were held regularly. In 2011, more than 400 hackathons were reported to have been held worldwide (Leckart, 2012). We present the visual categorization of the hackathon as a collaborative innovation approach based on our conceptual framework (see figure 4 in the appendices).

Depending on the focus of the hackathon, this approach has been defined in plural ways. Briscoe (2014) define it as "a problem-focused *computer programming event*, as well as a contest to pitch, *program*, and present instances of prototype *digital innovation* (e.g. a prototype mobile application)". This definition focus mostly on the technological and digital innovation aspect of the hackathon. Calco and Veek (2013) define it as "an event where *computer programmers, developers, and designers collaborate intensively in teams*, at a specified venue, under tight timelines, with the aim of solving complex software-related problems or producing innovative technologies" which is indeed focused on the technological innovation as well, but mostly centered on the social and collaborative aspect of the event. It also put forward the operational side of the hackathon that is built as a time restricted event. This social focus is amplified in Briscoe's (2014) perspective that points on cross-pollination of "a diverse set of thinkers in a "meeting of the minds" [encouraging] participation from a wide spectrum of disciplines, and highlight the importance of representation of all stakeholders, from clinicians to engineer to entrepreneurs to end-user. As a result, non-traditional expertise and perspectives contribute to the conversation." However, this perspective goes even further on the social aspect by also highlighting the importance of knowledge and expertise. Depass et al. (2014) emphasize the competitive aspect of the hackathons when defining it as "competitive events, ending in a final pitch contest with judges who may include healthcare leaders, technologists, entrepreneurs and venture investors. Winning teams convince the judges and fellow attendees of the problem, potential solution and a sustainable business model." Johnson et al. (2014) promote and studied "civic hackathons", shedding light on the purpose of the hackathon and on the multiple stakeholders (whom may have multiple interests) of that purpose. They define it as "a time-limited (typically hours or days) event, launched at a specific venue, where *enthusiasts*, *government workers*, *interested citizens*, and the *private sector* meet in a collaborative environment to access government open data (Johnson et al., 2014)." Finally, and emphasizing even more the purpose of a hackathon, Zapico et al. (2013) call to mind that the reference to "hack" in the hackathon "is not to hacking as in computer crime, but to the original meaning of a hacker as someone who "programs enthusiastically", who believes that computing and information sharing is a positive good and who believes it is an ethical duty to facilitate access to computers and computing resources."

Despite the fact that hackathons and its variants are increasingly emerging in the literature (Briscoe, 2014), there are still multiple questions that need to be answered in regard to their outcomes (Johnson and Robinson, 2014**)** and their impacts on organization-user relationships even if assumptions are that these approaches should support the development of digital solutions fitting users and citizens' needs (Johnson and Robinson, 2014). By reaching to the crowds and communities, organization may better find real-life problems that need to be addressed to improve users' quality of life (Sarasvathy, 2001).

Hackathons are still understudied and undertheorized. However, based on the definitions that we assembled, it seems that hackathons move towards a greater engagement of individuals into a collective. By bringing together multiple stakeholders of the innovation process and making them work together, this approach allows for a deeper engagement with the teams that get formed. In addition, through the problem-solving and prototyping activities, team members get to co-create solutions, and then, to translate their own practice into a shared understanding within the team. Indeed, by building prototypes, actors co develop cultural artefacts that support knowledge sharing across knowledge boundaries - artefacts that can then be called boundary objects (Star and Greiseimer, 1989; Carlile; 2002). In addition, through this co-creation process, actors get to build a shared language to support knowledge transfer through these knowledge boundaries.

Sure, hackathons are also built as competitive processes (see example of Hacking Health in additional resources). However, they allow to bring together actors and individuals coming from multiple collectives and knowledge domains. In addition, by focusing on a specific purpose, this approach allows to create a sense of "joint enterprise" (Wenger, 1998) increasing the sense of belonging into the collective. Finally, by focusing on experiential knowledge through artefact construction, hackathons support the dis-embedding process of knowledge in practice so that actors may co-translate their knowledge to the benefit of the collective in which they are now engaging.

Hacker/Maker space

As the "do it" philosophy grows stronger and people's need to engage in the development process of objects and services making them more than consumers but full participants, the maker and hacker movement and initiatives gain popularity. (Dougherty, 2012) Innovation, as seen by this movement, is not something that can be "domesticated" by schools or universities, but at the contrary, something "wild" that comes from experimentation and collective thinking. Therefore, people with common interests for craft, art, sciences and engineering meet, socialize and wishing to experiment and develop innovative solutions come together in labs to work collectively. "Today's makers enjoy a level of interconnectedness that has helped to build a movement out of what in the past would have been simply a series of microcommunities defined by a particular hobby or activity." (Dougherty, 2012: 12) These communities, to function, put forward values of collaboration, cooperation and interpersonal support "build around a productively negotiated ideology between a traditional "hacker ethic", foregrounding autonomy, and care, foregrounding interdependence". (Toombs, Bardzell, and Bardzell, 2015: 629) The labs shared by these communities have been thought in consequence offering a community-operated workplace to work freely and collectively. We present the visual categorization of the hacker/maker space as a collaborative innovation approach based on our conceptual framework (see figure 5 in the appendices).

These collaborative spaces are very inclusive (see examples such as Helios or District 3 in additional resources). The facilities provide infrastructure similar to workshops and laboratories. In the majority of these spaces, machines and tools are available so individuals can experiment as much as they wish. Some individuals also bring their own tools and share them with others. (Lallement, 2015) Hackerspaces and makerspaces also propose social activities, lectures and games. People who subscribe and decide to participate come on their own free will. The rules and laws applied to the space is determined by the members that compose it. Some of them have boards of elected members but their democratic power of action is limited to what the community let them do. The members have the freedom to work on their projects or join a project or existing team. Exchanges and mutual assistance between individuals are encouraged. However, the greatest wealth of these areas is the development of knowledge and skills of individuals within the community. Indeed, through impromptu and organized meetings, people exchange and share their knowledge with each other.

Thus, people who participate and form these communities make this shared experience an educational one (Toombs et al., 2015) by transferring, translating and transforming their knowledge collectively. Thus, maker and hacker spaces present an "alternative networks of knowledge production and sharing, offering a more resilient and pragmatic response to various challenges" (Kera, 2012: 1) They become sites of opportunities to transfer and translate scientific knowledge to everyday interests, practices and problems of ordinary people in a large diversity of contexts. However, hackerspaces and makerspaces present some limitations. These workspaces with few constraints become development areas in which projects can be spread over long periods of time and even may never materialize. These experimental areas are oriented towards learning and knowledge sharing rather than results.

State of Knowledge – Knowledge Strengths and Knowledge Gaps

The knowledge synthesis presents the state of the literature based on three interrelated axis that are bridged together in our framework of analysis. Both the individual analysis of the axis and their combination in the framework provides us with a promising research agenda.

The first axis labeled *Opening innovation to multiple stakeholders* mostly builds on the open innovation literature that has recently focused on opening organizations' boundaries to the benefit of the firms' innovation processes. This literature successfully draw attention to the principles related to openness in the innovation processes so that organizations move apart from the 20th century paradigms of innovation that were centered on bureaucracy, vertical integration, regulation of opportunism and protection of intellectual property. In addition, this literature provided fruitful analysis of the involvement of stakeholders in the early phases of innovation to support the creation of novel solutions. Finally, open innovation is a paradigm that fits with multiple other literature that, when combined, provides even deeper and richer explanations of the innovation principles.

The second axis labeled *Moving from "opening to" towards "collaborating with"* was grounded in the sociology of innovation and the design literature. These literature shed light on the innovation process as interacting with and transforming the existing social structures and networks of actors. It then opens up to considering the innovation process as a whole, including the appropriation phases. Innovation, in that sense, becomes innovation when a solution is appropriated in the collective practices. By focusing on the appropriation of new solutions, these literatures provide an important view on the end-users and on involving every actor in the network of a solution to solidify it as an innovation. Several design principles, that are, the opening to other knowledge perspectives, the deep understanding of problematic, the user-centered design, the understanding of stakeholders' visions, and the pushing for the unknown are fundamental in the mobilization of collaborative innovation approaches, provides a great way into understanding how to bind actors together.

The third axis labeled *Learning as a social activity and overcoming knowledge boundaries* was grounded in the literature of knowledge communities and knowledge in practice. In this section, we provided a conceptualization of knowledge as a collective phenomenon and of the complexities of sharing knowledge between actors coming from different domains and backgrounds. We also discussed the process of building a community through the development of a social structure that supports knowledge sharing between individuals.

However, there are still puzzling aspects that need to be addressed in regard to these literatures.

Moving from the level of analysis of organization towards macro-levels of communities. Open innovation positions the opening of innovation processes as an organization-centric vision, that is, it is centered on the firm benefits. This vision impacted theory development in the field with research and practical uses of open innovation mostly focusing on the inbound flows of knowledge and resources that firms use to commercialize their ideas and even replace internal R&D activities (West & Bogers, 2014). There is a growing recognition that we need to turn to other units of analysis than the firm in order to better understand the processes related to Open innovation (West et al. 2014). We suggest an analytical perspective focusing on the level of communities (O'Mahony and Lakhani, 2011) instead of focusing on the point of view of single organizations in understanding the principles of open innovation and how it works. For example, we suggested bridging other sets of literature with the open innovation perspective such as as users as innovators (Bogers, Afuah, and Bastian 2010; Piller and West 2014), innovation communities (Fleming and Waguespack 2007; West and Lakhani 2008) and communities outside the firm's boundaries (O'Mahony & Lakhani, 2011), lead users (von Hippel 1986), creative consumers (Berthon et al. 2007), hackers (Lakhani and Wolf 2005) and online pirates (Choi and Perez 2007) as well as other sets of literature coming from the sociology of innovation and design literature since they did not necessarily consider the firm as the focal point of analysis (Bogers and al., 2016).

From open to collaborative. Boger and al. (2016) call for research on "research questions that span across collaborative innovation concepts and across levels of analysis that have so far developed in parallel." In that regard, we believe that researchers should focus more on the collaborative aspects behind open innovation that may facilitate innovation development and diffusion. Researchers on open innovation are now recognizing the need for firms to actively participate in innovation ecosystems that are built on a set of the various actors that are part of an innovation process (West and Bogers, 2014). In addition, we suggest that the active involvement of multiple stakeholders in the innovation process facilitate more than the early stages of innovation. They also support the stages of implementation and diffusion (Bogers and al., 2016; Dahlander and Gann 2010; Huizingh 2011; Chesbrough and Bogers 2014). However, the sociology of innovation literature presented the potential challenges in bridging multiple actors with sometimes diverging interests in an innovation network. Literature on knowledge communities also comes short at explaining knowledge creation across boundaries works (Carlile, 2004) since most research on communities have focused on the inside functioning of the community (Bechky, 2003). But what happens when one needs to translate and/or transform his/her current knowledge to bridge it and construct a project with individuals coming from different communities (Carlile, 2004)? To better understand how to bridge actors and their interests towards shared goals, we need to shift the analysis from the individual designers (e.g. Dunn and Martin, 2006; Razzouk and Shute, 2012; Efeoglu and al., 2013) to the practices. This analysis aims at understanding the relational interactions between social structures and individual actions in the innovation processes.

Moving towards a processual understanding of managing knowledge boundaries through collective structuration. Open innovation can still move forward in the understanding of the processes and dynamics of collaborative approaches. According to Bogers and al. (2016), "the role played by external stakeholders in the innovation process is largely conditioned by the type of knowledge creation process, its outcomes, and its further absorption". We then believe that we need to better understand these processes, outcomes and absorption so that collaborative approaches' potential can be better conceptualized and mobilized in practice. Research has shown that external stakeholders are usually less relevant when the needed knowledge is mostly tacit and contextualized internally to organizations or externally to communities in their practices, social networks and cultures. The contextualization of knowledge in practice may indeed form knowledge boundaries between practitioners coming from different domains and traditions (Carlile, 2004). However, we believe that there is a strong potential in crossing these boundaries, and that the relevance of this knowledge intersection has yet to be proven in the open innovation literature because researchers did not focus sufficiently on the collaborative processes that may support and facilitate co-innovation between these sometimes distant collectives. In a context where innovation is built on the hybridization of knowledge coming from multiple expertizes and domains, one has to understand how to create knowledge and share meaning across knowledge boundaries. As Bogers and al. (2016) presented, "it is clear that the relationships between various types of extra-organizational individuals and different types of knowledge creation and innovation processes stand out as an interesting area of future research, especially in the context of explaining the effectiveness of OI." Indeed, we need to learn more on how to tap and develop the knowledge-base of these individuals to support innovation. To do so, we need to consider knowledge as being more complex than how it is usually conceptualized in the open innovation literature. Lave and Wenger (1991) were interested in understanding how, through daily actions, apprentices learn by entering a collective, a process that they labeled legitimate peripheral participation that gradually facilitate sharing tacit knowledge between members of the community. According to Brown and Duguid (2001), "much of the practice that forms identity and gets work done is more local and more dynamic", pointing towards the need of supporting a local context for identity development. However, these studies did not focus on how one may create a community at the intersection of multiple communities through the mobilization of collaborative approaches. Then, we believe that to cross and manage knowledge boundaries efficiently, one may need to create a context (epistemic, social, cultural) that facilitates knowledge construction (Choo and Neto, 2010) by supporting the elaboration of basic shared language, norms and values. By mobilizing collaborative approaches such as innovation events, organizers are reproducing the peripheral participation process and the communal socialization.

Additional Resources

Mosaic – https://mosaic.hec.ca/
Hacking Health – www.hackinghealth.ca ; Videos [https://www.youtube.com/user/hackinghealth]
Startup weekend - https://startupweekend.org/
Montréal Ville Intelligente - http://villeintelligente.montreal.ca/en
Living Lab SAT (Société des arts technologiques) - http://sat.qc.ca/
Helios - http://heliosmakerspace.ca/
District 3 - http://d3center.ca/
Adicode - http://www.univ-catholille.fr/documents/Dossier%20de%20presse%20ADICODE%20Euratechnologies_OK.pdf
La maison de Justin (CHU Ste-Justine + SAT) : https://www.chusj.org/fr/soins-services/T/Traumatologie/La-maison-de-Justin
Innocité :http://innocitemtl.ca/en/
Innocentive - https://www.innocentive.com/

Knowledge mobilization - implementation of your plan

The knowledge mobilization activities will be integrated into the existing MOSAIC research hub activities at HEC Montreal in order to benefit the public and all MOSAIC's partner organization (including Ubisoft, Bell Canada, Desjardins, Cirque du Soleil, the Research Institute of Hydro-Québec, Emploi Québec, Aero-Montreal, the City of Montreal, Hacking Health, Living Lab SAT, CHU Ste-Justine, etc.) that are particularly interested in the research results of our report. Indeed, these organizations all mobilized and / or expressed their interest to set up collaborative innovation approaches. Collectively, these organizations are in contact with hundreds of thousands of users / Canadian citizens. They will benefit from the knowledge generated in this synthesis of knowledge to better understand how to involve external knowledge communities inside their organizational boundaries to benefit while stimulating the development of the involved actors. Through these approaches, MOSAIC partner organizations will be able to create and strengthen collaborations with actors from multiple fields and sometimes hybridize different industries to increase their innovation capabilities to benefit Canadian citizens-users.

The knowledge generated in this research project will be included in disseminated through a multi-level and multi-platform process, supported by Mosaic's network of partners. It will build on the intersection of academics with actors outside of the academic world through 1) targeted research and training activities, mainly for public researchers and students, but which will also be integrated by representatives of the private and public sectors, and 2) open and cross-boundary activities around a common transfer, exchange and networking platform. All activities will be supported and reinforced by a strong online presence, which will communicate about the progress of the project, to announce large-scale events related to the project, but also to provide the publications (if the copyright allows it). See table 5 in the appendix for a list of the knowledge diffusion activities. This distribution will be organized in four forms:

1) *Monthly MOSAIC Seminar*: One of the monthly MOSAIC seminars that bring together academics, students and professionals coming from different spectrums and industries will deal specifically with the thematic of our knowledge synthesis. As part of this event, some industry partners that already mobilized such approaches will thus be invited to present their experiences to complement our presentation, and then will react to our research results. These events usually attract 80 to 120 persons.

2) *Training for partners*: MOSAIC is regularly invited to train managers and employees at different levels in regards to the innovation process. The data gathered in this synthesis will be mobilized as part of multiple training. In particular, workshops will be organized to reflect on collaborative innovation approaches with the with higher management levels and innovation professionals of specific partner organizations such as the City of Montreal, Ste-Justine Mother-Child Hospital, Desjardins, CIUSSS de l'est-de-l'Île-de-Montréal and Hacking Health. These organizations are already engaged in a partnership for the development and dissemination of new technologies through collaborative innovation approaches to benefit Canadian citizens.

3) *Best practices guide to collaborative innovation practices*: A guide will be made available on the website of MOSAIC and will be distributed to all partner organizations. This guide will discuss best practices to mobilize in order to develop organizations' capacities to develop and participate in collaborative innovation approaches to transform their practices towards new technologies while fostering citizens' involvement.

4) *Assessment of collaborative innovation approaches and validation of our conceptualization*: MOSAIC, as Hacking Health, the City of Montreal, Desjardins and the Living Lab SAT partner, will be invited to assess to the development and mobilization of a new collaborative innovation approach in a participant observation held by one of the students contributing to the knowledge synthesis. Thus, the results of the knowledge synthesis will enable the validation of this new approach facilitating the appropriation of new technologies by Canadian citizens and the development of empirical research to keep developing best practices for innovation management. We will also validate our framework based on our observations.

The knowledge synthesis will also be presented in academic channels. A first draft has already been presented in the EGOS conference in July 2016 in Naples, Italy, in preparation for a scientific publication. The final report will also be submitted in January 2017 to AOM annual meeting to be held in Atlanta in August 2017. The report will be eventually turned into a manuscript to be submitted to a renowned academic journal in February 2017. The diffusion to the academic community will allow to engage in an additional communication channel to reach a larger part of the population. By interesting other researchers to our research directions, they will develop further our conceptual and intellectual project to propose new practical and academic avenues.

The report will also be proposed for presentation to the Council on Information and Knowledge Management of the Conference Board of Canada in first quarter 2017.

Ultimately, this work aims to engage all sectors of society to stimulate a public dialogue for innovation in Canada. MOSAIC's partners will also mobilize the approaches presented to experiment new ways of opening innovation through collaborative efforts, which will also strengthen the collaborative network of MOSAIC around this collaborative vision. The ambition is to develop methods that support the development collaborative approaches that are inclusive to all Canadian citizens, and to translate them into training modules for policy makers, managers and public organizations. These modules will also enable the development of new course material to be disseminated to management students in credit programs and training. This educational vision will ultimately prepare tomorrow's managers and decision makers to better engage citizens - users and stakeholders - in their innovation processes.

Finally, we aim at pushing further this research perspective to better understand collaboration for innovation in complex ecosystems. To do so, we will present an application to the SSHRC Partnership Development Grants on November 30 2016.

Conclusion

The complexification of societal, economic, technological, and environmental issues and challenges has changed the way we innovate. Far from being linear and simple, innovation now engages with complex and interdisciplinary realities, at different scopes and various scales. The increasing importance and reliance on collaboration in innovation practices and research shed light on the co-construction issues where many actors with various and sometimes diverging interests and values contribute their knowledge, resources and experiences in the development of common projects. Innovation then needs to be understood as a complex social, technical, and organizational process, that moves across multiple social worlds and structures, and in which a variety of knowledge and competencies are required, and should be developed accordingly. Within the collective dynamics of innovation, four axes are particularly relevant: the level of engagement of the actors, the source of knowledge utilized, the level of stickiness of knowledge as well as the integration of knowledge domains. Collaborative innovation approaches can be categorized and understood through these four axes in regard to their structures, internal dynamics, challenges and potential of association.

The collaborative innovation approaches all serve different challenges and potentialities in developing, managing and supporting learning, creating, ideating, developing and innovating capabilities. Together, these approaches allows to proactively work and rework the knowledge bases of actors ahead of the innovation processes to support the development of the needed capabilities. Consequently, it is important to emphasize the relational and dynamic conceptualization of these collaborative innovation approaches. Indeed, considering the various challenges related to knowledge construction and various innovation stages, these approaches are not self-sufficient in regard to capability development and innovative outcomes. These collaborative approaches should be connected and developed relationally with the contextual challenges that actors are facing in regard to knowledge construction. By doing so, innovation ecosystems and communities are activated, engaged, and kept in line with the innovation challenges since various collaborative innovation approaches support knowledge construction in diverse ways, scales and scopes. For example, some approaches such as *Hackathons* can support knowledge sharing, collective creation and knowledge boundary opening in a short-term perspective. However, the *Makerspace* is more suited to maintain a momentum in knowledge sharing, increase the level of engagement in the collective, support knowledge transformation, and facilitate the structuration of shared identities and joint enterprise in the long run. Taken together, these collaborative innovation approaches have a multiplier effect for the development of innovation and collaboration capabilities of organization and communities as well.

In addition, these collaborative innovation approaches allow to move further in the opening of organizational boundaries towards an agenda of collaborating with the various stake-holders participating in an innovation ecosystem. Indeed, these approaches allow to develop and increase everyone’s innovation capabilities for the betterment of all. Our analysis aims at rethinking and reinterpreting the value chain of innovation in that regard. At the core of this value chain are the valuation processes, which traditionally have been reserved to experts. Collaborative innovation approaches provide means to opening creation and innovation as well as the evaluation and valuation of the products, outputs and outcomes of these processes. Gradually, by collaborating with involved actors, they are given the freedom to make value assumptions and the power to participate in the innovation proposition as well as the innovation valuation, in terms of relevance and performance.

Taken together, the benefits of collaborative innovation present major improvements in regard to creating and supporting positive outcomes for organizations, communities and citizens. These approaches move a big step forward in supporting meaningful participation and collaboration to develop innovation capabilities that benefit all citizens. By taking into account every actor’s perspectives, interests and knowledge, it becomes possible to push for meaningful innovations that solve societal challenges that are highly relevant to Canadian citizens.

However, collective innovation does come with issues related to ownership. It raises questions on how to generate and manage outputs that are co-produced by organizations and the public as well as to whom the Intellectual Property (IP) belongs. Our own purpose in this knowledge synthesis was to understand the collective dynamics taking place in these collaborative innovation approaches. Doing so, we did provide a conceptualization allowing the understanding of the negotiations, translations and transformations of each involved actor’s goals, interests and visions. Our analysis then provides a socialization perspective on these issues and highlights practices that may support the management of these key challenges to innovation development.

Finally, we did not fully address the topic of technological platforms supporting collaboration. These platforms do play an increasingly important role in collaborating across knowledge boundaries. However, these platforms act as tools in a relational perspective of knowledge construction since we further focuses on the socialization aspects and the connection between actors as a way to innovate. Indeed, our objective was to provide a conceptual understanding of the social structures vested in the collaborative innovation approaches. We believe that the theoretical implications of our conceptualization could support the construction of deeper and more contextualized technological platforms that answer today's innovation challenges. Although technological solutions are important parts of today's innovation processes, they are no more than means, bridges, and tools that allow stake-holders to create, build, and implement innovation, and to enjoy its different benefits.

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Appendixes

Table 2 – Research keywords

Themes	Keywords
Collaborative innovation approaches	Crowdsourcing, innovation contest, design contest, hackathon, crowdsourcing contest, crowdsourcing platform
Theories of knowledge	Community, Community of practice, knowledge boundaries, professional community, crowd
Design practices	Design thinking, participatory design, collaborative design
Open innovation	Open innovation, user innovation, lead user, user communities
Sociology of innovation	Innovation, Inventions, Sociology of innovation, Sociology of uses, Sociology of technology, Sociology of invention

Table 3 – Reading Analysis Grid

References	
Key concepts	
Empirical support	
Arguments	
Results	
Other sources	
Notes	
Significant quotes	

Table 4 – Reading of the model: Understanding Knowledge construction practices

		Homogeneous		Heterogeneous
		Localized	Embedded	Invested
Crowd	Open crowd	Pool of specialized theoretical knowledge where individuals share and learn from others singularly by **transfer**.	Decoding and **translating** theoretical knowledge knowledge from a knowledge domain and translating it to another.	Construction of new knowledge individually by understanding and experimentation and **transforming** of theoretical knowledge in one knowledge domain to respond to novelty in another knowledge domain.
	Closed crowd	Pool of specialized practical knowledge where actors share and learn from others singularly by **transfer**.	Decoding and **translating** practical knowledge knowledge from a knowledge domain and translating it to another.	Construction of new knowledge individually by understanding and experimentation and **transforming** of theoretical and practical knowledge in one knowledge domain to respond to novelty in another knowledge domain.
Community	Community of interest	Specialized theoretical knowledge co-**transferred** in a partnership mode in between actors that share a common goal.	Decoding and co-**translating** theoretical knowledge between a knowledge domain and another.	Construction of new knowledge together by understanding, experimenting and co-**transforming** theoretical knowledge in one or more knowledge domain to respond to novelty and reduce the consequences of learning
	Community of practice	Specialized practical knowledge co-**transferred** in a partnership mode in between actors that share a common goal	Decoding and co-**translating** theoretical and practical knowledge between a knowledge domain and another.	Construction of new knowledge together by understanding, experimenting and co-**transforming** theoretical and practical knowledge in one or more knowledge domain to respond to novelty in a complex and shared situation and reduce the consequences of learning

Figure 3 – Categorizing Crowdsourcing

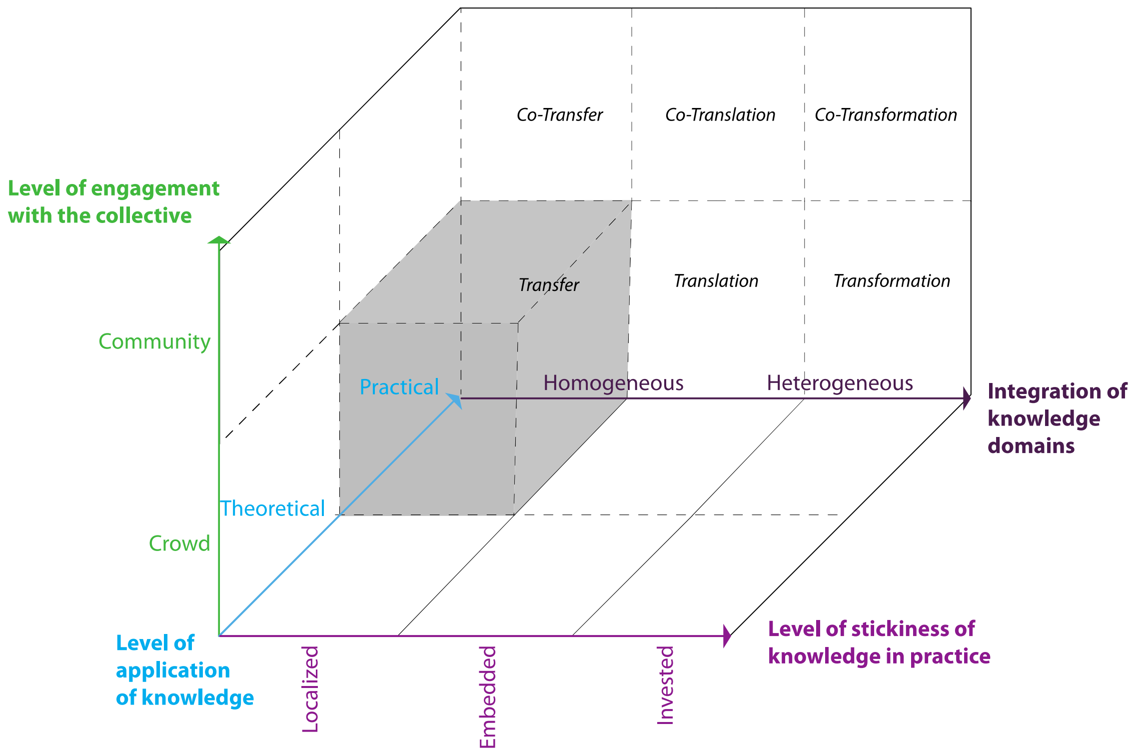

Figure 4 - Categorizing Hackathon

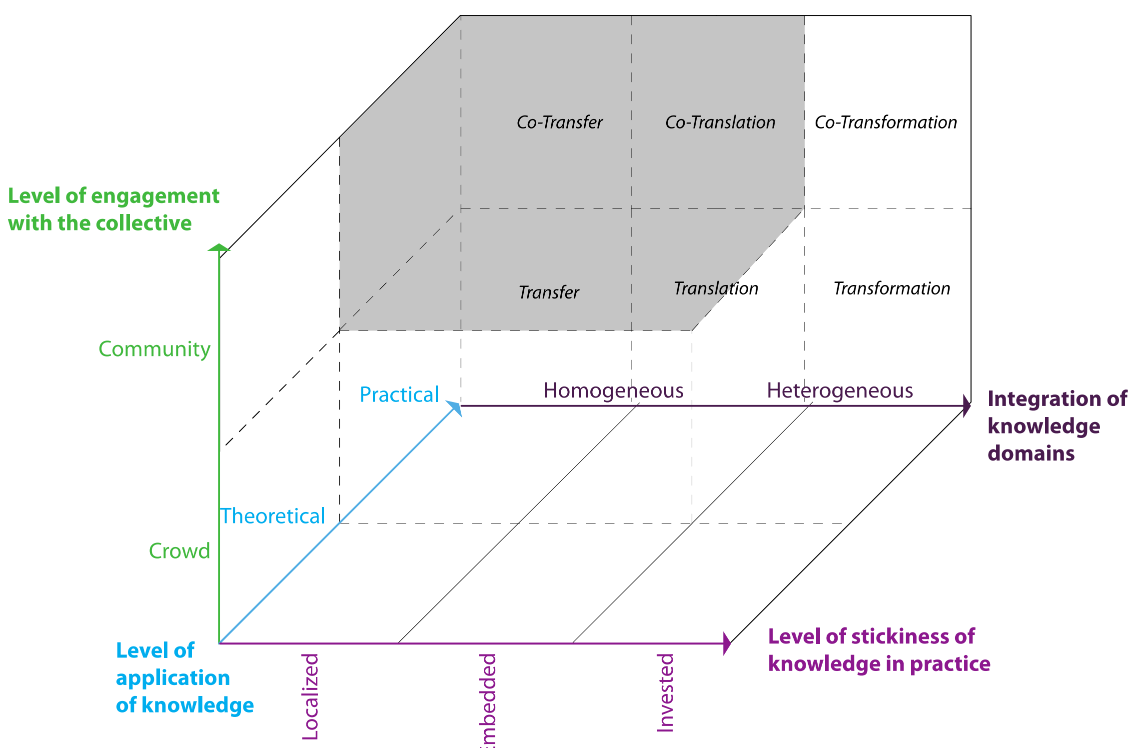

Figure 5 - Categorizing Hackerspace, Makerspace

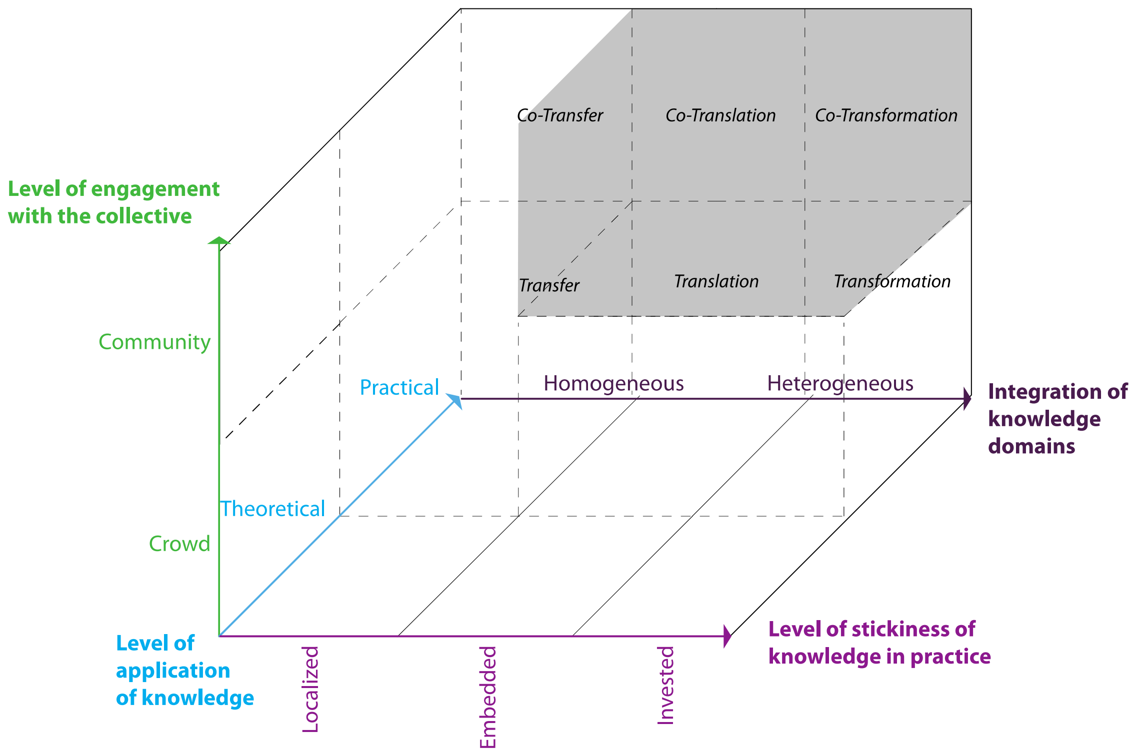

Table 5 – Activities of knowledge mobilization for the knowledge synthesis

Activities	July 2016	October 2016	November 2016	December 2016	January	February
Diffusion	Academic conference EGOS2016		Final workshop of SSHRC knowledge mobilization Presentation of the knowledge synthesis at the fall school of creativity management in Strasbourg (http://creasxb.unistra.fr) Application to the SSHRC Partnership Development Grants	Production of a guide for best practices to collaborative innovation	Submission to the academic conference AOM 2017 Launching event at MOSAIC for our guide for best practices to collaborative innovation	Submission to an academic journal
Training			Training for MOSAIC partners on collaborative innovation tools methods	Training for MOSAIC partners on collaborative innovation tools methods		
Evaluation		Assessment of a new collaborative innovation approach	Assessment of a hackathon approach			