

**HEC MONTRÉAL**  
École affiliée à l'Université de Montréal

**“Opening innovation” Across Practices for the Production of Digital  
Health in Montreal**

**par**

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École affiliée à l'Université de Montréal

Cette thèse intitulée:

## **“Opening innovation” Across Practices for the Production of Digital Health in Montreal**

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## Résumé

*Les défis contemporains d'innovation en contexte d'émergence de nouveaux champs exigent la création des capacités nécessaires pour pouvoir accéder et développer une plus grande variété de connaissances et de ressources émanant d'acteurs de disciplines, d'organisations et d'industries différentes. Cette thèse porte sur Hacking Health (HH), une organisation à but non lucratif qui a créé des approches d'innovation ouverte pour aider à produire et soutenir l'innovation numérique en santé. À partir d'une étude qualitative de 42 mois, cette thèse examine la manière dont HH, et les projets qui y ont été initiés, ont généré les flux de ressources et de connaissances permettant de produire des résultats pour la santé numérique. Basée sur une approche de la pratique, cette thèse-par-article vise à jeter un nouvel éclairage sur le "doing" de l'innovation ouverte en mettant l'accent sur les dynamiques relationnelles générées par la production de ces innovations et la construction du champ émergent de la santé numérique qui en résulte.*

*L'Article 1 développe le cadre intégratif de «Opening innovation» et met en évidence les différences et les avantages relatifs de l'open source, de l'innovation ouverte et de la collaboration interorganisationnelle en tant qu'approches pour ouvrir l'innovation. À travers une revue de littérature associée à une analyse de différents cas empiriques tirés de HH, nous montrons comment de nouvelles pratiques répondent aux nouvelles dynamiques relationnelles que l'ouverture de l'innovation génère pour accumuler plus de ressources pour maintenir le progrès des processus d'innovation. L'article 2 met l'accent sur les événements HH tels que les hackathons, les cafés, les ateliers et les bootcamps, et sur leur rôle dans la construction du nouveau champ de santé numérique. Cet article montre la séquence des différents types d'événements que HH a mis au point pour remédier aux défis liés à la création et la pérennisation de projets de santé numérique. Cet article souligne que le séquençage de ces différents types d'événements permet de gérer la nature distribuée, distanciée et dédiée des trajectoires d'acteurs*

*provenant de différents champs. Cette perspective longitudinale permet ainsi de mieux conceptualiser ce qui est impliqué dans l'accumulation de ressources pour l'émergence*

*d'un champ. L'article 3 s'appuie sur une étude de cas comparative du développement de MHcardio et de MHspeech, deux prototypes créés par des groupes interdisciplinaires et interorganisationnels formés lors de hackathons HH. S'appuyant sur le concept d'agencement de la théorie de l'Acteur-réseau, cet article permet de mieux comprendre l'effet performatif des dispositifs liés à la constitution en société, aux accords de propriété intellectuelle et aux subventions de recherche, sur les modèles d'innovation développés par chaque projet. MHcardio, par la mobilisation de dispositifs existants, a reproduit un «modèle d'innovation linéaire» qui repose sur le séquençage des activités d'innovation, de la découverte scientifique à la commercialisation, menant ainsi à la production d'un projet scientifique, tandis que MHspeech a créé un nouveau «modèle d'innovation ouverte et interactif» combinant ces activités de manière dynamique pour produire une nouvelle forme d'agencement de santé numérique.*

*Ces trois articles approfondissent la compréhension du fonctionnement de la production d'une nouvelle forme d'innovation, des transformations qu'elle entraîne et de la construction d'un champ émergent. En illustrant les pratiques spécifiques en jeu dans la production d'innovations de santé numérique et la manière de traiter les différences entre les acteurs impliqués dans ce processus, cette thèse offre un regard pragmatique des processus d'ouverture de l'innovation à la croisée de différentes disciplines, organisations et champs.*

**Mots clés:** Innovation; Innovation ouverte; Santé numérique; Approche fondée sur la pratique; Ouverture de l'innovation; Champ en émergence; Approche relationnelle; Hackathon; Événement d'innovation ouverte.

**Méthodes de recherche:** Recherche qualitative; Approche d'étude de cas; Étude longitudinale; Techniques d'observation participante.

## Abstract

*Innovation challenges in the context of nascent fields are increasingly complex, and require the capacity to opening up innovation in order to access and develop a greater amount and variety of knowledge and resources from actors of different disciplines, organizations and industries. This thesis focuses on Hacking Health (HH), a non-profit organization that created open innovation approaches to help produce digital innovation in health. Using a 42-month qualitative study, this thesis examines how HH and projects it initiated generated a flow of resources and knowledge to produce digital health outcomes. Working from a practice-based approach, this thesis-by-article aims to shed new light into the "doing" of open innovation by focusing on the relational dynamics that the production of these innovations generated.*

*Article 1 develops the practice-based integrative framework of "opening innovation" and highlights the differences and relative strengths of open source, open innovation and interorganizational collaboration as approaches to opening innovation. Through a literature review paired with an analysis of different empirical cases from HH, this article shows how specific new relational practices address the new relational dynamics these connections bring to accumulate more resources for innovation to keep progressing. Article 2 emphasizes HH events such as hackathons, cafés, workshops and bootcamps, and their role in the construction and configuration of the new field of digital health. This article shows the sequence of different types of events HH eventually developed to address a lack of progress in generating and sustaining digital health projects. This chapter highlights that the sequencing of these different types of events addressed the distributed, distanced and dedicated nature of the trajectories of resources that need to be accumulated from actors across existing fields. This longitudinal view of how a sequence of events addressed these relational dimensions help better conceptualize what is involved in field emergence. Article 3 builds on a comparative case study of the longitudinal development of MHcardio and MHspeech, two prototypes created by interdisciplinary and interorganizational groups formed in*



*HH hackathons. Building on the concept of agencement taken from Actor-Network Theory, this article generates a deeper understanding of the performative effect of devices related to company incorporation, intellectual property agreements and research grants on the innovation approaches of each project. MHcardio ended up reproducing a “linear model of innovation” that is built on the sequencing of innovation activities, from scientific discovery to commercialization, generating a scientific project, while MHspeech created a new “open and interactive model of innovation” that dynamically combined these activities into a new form of agencement for the production of a digital health project.*

*These three articles provide important insights into the inner workings of the production of a new form of innovation, the transformations it entails and the construction of an emerging field. By illustrating the specific practices at play in the production of digital health innovation, and the ways to deal with differences between actors that this process brings to light, this thesis offers a pragmatic understanding of the processes of opening innovation at the intersection of different disciplines, organizations and fields.*

**Keywords:** Innovation; Open innovation; Digital Health; Practice-based approach; Opening innovation; Field emergence; Relational approach; Hackathon; Open innovation events.

**Research methods:** Qualitative research; Case study approach; Longitudinal study; Participant observation techniques.

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## Abbreviation List

FCE	Field-Configuring event
HH	Hacking Health

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# **CHAPTER ONE**

## **Introduction**

### **1.1 Preface**

The overarching goal of this thesis is to shed new light on the “doing” of open and distributed innovation approaches in the context of field emergence. This goal unfolds from the tacit assumptions underlying this thesis, namely that contemporary innovation challenges are becoming increasingly complex, that they involve higher stakes in that they may generate a profound impact for great numbers of individuals, sometimes resulting in the transformation of existing fields and the development of new ones (Zietsma et al., 2017), for instance in the case of climate change, population health and the aging population (Kulik, Ryan, Harper and George, 2014; Howard-Grenville et al., 2014), and that the processes to resolve these challenges are consequential to the outcomes that are produced. Solutions to such challenges require the mobilization of a variety of knowledge and resources from multiple actors who come from different organizations, disciplines and industries that have been built on distinct language, methods, activities and values. These complex innovation challenges sometimes juxtapose distinct and difficult to reconcile interests such as environmental, social and commercial values. Therefore, when brought together to tackle innovation challenges, actors coming from these different social arenas may face difficulties in collaborating because of their relative difference (Carlile, 2002; 2004; Bechky, 2003). Furthermore, the variety of actors to involve in such processes, the distance between their differences and the novelty these challenges bring to bear are often unknown at the outset, and evolve as innovations get developed, because solutions to today’s challenges can require moving into uncharted territories.



Scholars from the open and distributed innovation literature have suggested that knowledge and resources can be shared to produce innovations with distributed actors across disciplinary and organizational boundaries (von Hippel, 2005; Chesbrough, 2003; Benkler, 2006). This creates situations where actors coming from different disciplines, organizations and industries come together to share knowledge and resources in pursuit of shared innovative goals. Open and distributed innovation processes, according to both the open source model (e.g. von Hippel and von Krogh, 2003) and Chesbrough's open innovation paradigms (e.g. Chesbrough, 2003), therefore aim at increasing the sources of knowledge and resources actors use to improve their innovation capabilities. However, this means that actors participating in such processes have to deal with their differences in terms of language, methods, interpretations and interests that are embedded in their respective practices (Carlile, 2002; Levina and Vaast, 2005). To do so, they develop sufficient redundancy of shared knowledge to help reach an optimal zone of cognitive distance that is essential in co-constructing new valuable knowledge (Nonaka, 1994; Carlile, 2004; Nooteboom, 2006).

Organizations (e.g. Puranam et al., 2014), disciplines (e.g. Carlile, 2002; Bechky, 2003) and fields (e.g. Barley and Tolbert, 1997), among other social spaces, have been shown to provide structuring contexts that orient actors' activities and interests. Despite the generative potential of combining knowledge and resources from different organizations and disciplines (Carlile, 2004), opening up innovation appears to be a hazardous undertaking that could lead to serious confrontations and struggles related to actors' different practices. In addition to exploring the challenges regarding intersecting disciplines and organizations, this thesis investigates the much more complex process of opening up innovation to a variety of actors in the context of field emergence (Meyer et al., 2005). This context of field emergence creates a greater additional source of uncertainty and complexity than that of collaborating across organizational and disciplinary boundaries (Levina and Orlikowski, 2009). Field emergence can drive major innovative changes, but also requires a profound understanding of the social changes it involves. Studying the "doing" of open innovation in such contexts highlights the unique challenges actors face in practice when innovating outside their traditional

approaches in ill-defined contexts characterized by increasing sources of novelty that actors must address when solving their innovation challenges. Studying such initiatives also shows the resulting outcomes from these new interactions in terms of constructing new fields of practices.

Although recent studies have examined processes involving plural organizations or distributed individuals for innovation (e.g. von Krogh and von Hippel, 2003; Chesbrough, 2003), they have mostly been conducted in contexts that have already been materialized and institutionalized with clear social structures (such as existing markets, established online communities and organizational hierarchies), and a set of artifacts that provide the means to deal with actors' differences (Dalhander and Fredericksen, 2012). These considerations offer a good way to better understand today's organizational challenges. However, they cannot fully account for the distributed, dynamic, fuzzy, constantly unfolding and uncertain nature of contemporary organizing for innovation. As we collectively move from firm-centric and market-centric organizing toward network-based (Benkler, 2006), ecosystem-based (Adner, 2006) and field-based organizing (Zietsma et al., 2017), we need to engage more with what such changes truly mean for innovation processes, for practitioners within these processes, and for management as a discipline. This means that the assumptions underlying previous research on organizations' internal innovation processes in a single industry built on its own system of values have to be revisited to allow for a better collective understanding of the profound challenges we face in increasing our capabilities to deal with the complexity of contemporary innovation challenges.

Although a plethora of scholars have chosen to conduct studies building on some of these considerations, only a few have considered the whole portrait presented above. For instance, a new stream of research on Grand Challenges has emerged and blossomed in organization theories (e.g. Eisenhardt et al., 2016; George et al., 2016) during my research project, and focuses on issues similar to the ones I will address in this thesis. Yet innovation scholars' efforts are still scattered and don't provide a clear empirical and theoretical picture of the "doing" of open innovation in such contexts. For example, although open source and user innovation scholars have drawn an optimistic picture of



the potential of openness for reaching and transforming any socioeconomic sector for the better (von Hippel and von Krogh, 2006; O'Mahony, 2007), they have yet to explore the deeper dynamics and consequences at play in more complex settings than those related to software, which explains why these new models of innovation have not successfully expanded beyond the software world. Furthermore, while open innovation researchers have built their arguments on permeable organizational boundaries for sharing knowledge and resources (Chesbrough, 2003; Chesbrough and Vanhaverbeke, 2014), they have not fully accounted for the challenges of such organizing principles on existing social structures to solidify the theoretical underpinnings that could help us understand the deeper underlying consequences of the phenomena that are observed in contexts of open innovation (Randhawa et al., 2016). Whereas some interorganizational scholars, building on institutionalism, have attempted to understand the outcomes of interorganizational collaboration on field structuration (e.g. Lawrence et al., 2002; Marchington et al., 2004), they did not sufficiently focus on the actual “doing” of such phenomena, in a dynamic fashion, by examining actors’ micro-activities that constitute and reconstitute fields and their institutions.

As I began researching this topic and carrying out the fieldwork, I wondered: “Why is that the case?” Is it because the empirical settings and research designs of previous studies could not account for this depiction of the “doing” of open innovation? Or is it because the background of the open innovation paradigms in the discipline of business economics and strategy (Tucci et al., 2016), and the conceptual apparatus of interorganizational studies have not provided a sufficient theoretical framework for understanding such issues? Is it because, on the one hand, open innovation and open-source traditions predominantly aim at connecting researchers with practitioners, and, on the other hand, they are still focused on the phenomenological underpinning of their research contexts without focusing on their deeper conceptual implications? Or is it because scholars did not actually revisit the theoretical and fundamental differences between the “doing” of innovation in traditional innovation contexts and the “doing” of open innovation?

From the beginning of this thesis research, these are the personal questions and

considerations that led me to develop a longitudinal and inductive research design (the research design will be presented in more detail in the following sections) to account for the complexity of the “doing” of open innovation and of its consequences. The case I observed for this thesis (see section 1.5 for more details), however, also pertains to these profound questions. As I engaged with the processes of producing digital solutions to health challenges, I began observing the complexity of connecting actors who were new to each other, who came from different disciplines, organizations and industries, given that these social contexts generated profound differences in terms of language, methods and interests. Digital health, as a now stabilized form of innovation, builds on the convergence of digital technologies with health, healthcare and society to enhance the user-friendliness and efficiency of healthcare delivery while providing more personalized and precise services. Digital health therefore involves the development and use of information and communication technologies to help address the population’s health challenges. Yet driving the development of such digital health solutions required the construction and solidification of new relations that cut across existing configurations of practices, reshuffling the accepted norms for the construction of a new field of practices with its own rules and ways of doing. This transformation was even more challenging because the health sector, which was built on mature configurations of practices, stabilized in a dispersed sociotechnical network of administrative (e.g. budgetary rules), legal (e.g. regulations and responsibility issues), political (e.g. public health system) and scientific (e.g. evidence-based medicine) devices, intersected with the field of digital technologies, which was built on its own bundles of practices that involved interests diverging from those of actors in the field of health.

I then realized that developing new forms of organizing through open innovation principles in such a context had the potential to generate profound tensions given that open innovation is built on new sets of organizing principles that have the performative effect of reshaping who participates in an innovation process, how actors interact and what rules and interests structure their activities. As an organizing principle, openness fundamentally revisits what actors and organizations are, as well as their relations to other actors and their environments, how they work, how they innovate and how they



interact. I consequently assert that appreciating this complexity of the “doing” of open innovation requires an understanding of the processes of “opening innovation” to shed light on empirical phenomena that are profoundly different from traditional approaches to innovation. Although this concept of *opening innovation* will be explored in more detail in the following section of the thesis, I present its generic definition taken from article 1 (chapter 2) of the present thesis:

*“Opening innovation is a practice-based framework that views opening up for innovation as a set of activities that increases the number and variety of actors and resources that can be applied to the problem at hand. This process can reshuffle existing relations among actors and their practices, creating the need to change existing practices and develop new relational practices (Ness, 2009; Manning, 2010) to manage the relational boundaries associated in developing innovative outcomes (Carlile, 2002; 2004; Kaplan et al., 2017). Without such efforts to develop new relational practices, opening up for innovation will lack progress and can also generate negative outcomes.”*

Structural changes in existing practices are then needed to improve actors’ ability to accommodate and bridge these increasing sources of novelty in order to create solutions that build on knowledge and resources coming from different organizations, disciplines, communities, industries and fields. Ultimately, resolving these issues is key to addressing contemporary innovation challenges such as climate change, the aging population, population migrations and global healthcare. To make these structural changes, we collectively need to learn how to progressively access, accumulate and develop a variety of resources, knowledge, methods and perspectives so that solutions to these challenges become consequential in the world (Lundvall, 2017). The generic and overarching research question of this thesis is therefore:

*How does the “open innovation” of actors in the context of field emergence increase the number of new contributors and resources to be applied to their evolving innovation challenges, and what does this process produce in terms of relations and interactions?*

This question aims to provide an overview of the remaining questions that will be addressed in each article of the thesis. This question also takes into consideration the costs of opening innovation, in terms of changing existing configurations of practices and relations and the benefits of intersecting different disciplines, organizations and fields (Leonard-Barton, 1995; Carlile, 2004; Furnari, 2014). In that sense, this thesis uses resources as a term that encompasses the personal (knowledge and time), social (relations and connections) and financial capital that actors bring to bear to produce an outcome.

## **1.2 Thesis Overview**

This thesis-by-article is organized into six sections. In Chapter One, I introduce the study's overarching goal, provide a summary of the three articles and make some general comments on methods, keeping in mind that each article of the thesis is built on its own methodological underpinnings. In Chapter Two, I provide a comprehensive, critical and conceptual literature review, which is rooted in a conceptualization of the empirical setting of the thesis, highlighting the interactions between three different sets of literature, namely open-source and user innovation (Lakhani and von Hippel, 2004; von Hippel, 2005), open innovation (Chesbrough, 2003) and interorganizational collaboration (Sharfman and Gray, 1991) that are now, more than ever, addressing overlapping issues (Sydow et al., 2015). I argue that the lack of consideration of the interactions that occur across these streams of literature hinders our collective understanding of processes of opening up innovation, the challenges related to it, its downsides and upsides and its outcomes. This critical analysis of the literature underscores the need to be fully aware of the deeper nature of the processes involved in opening innovation before introducing the research inquiries that are explored in the remaining parts of the thesis.

Chapters Two, Three and Four consist of the three articles that form the corpus of the thesis. Chapter Five bridges these three articles to clarify their interrelations and the contributions of the thesis. I revisit the central concept of *opening innovation*, using it as a framework for integrating and synthesizing the study's overall findings and

highlighting how it expands our current understanding of innovation to create an integrative theoretical framework and research program that needs further collective investigation. In Chapter Six, I conclude the thesis by briefly highlighting its main contributions and limitations, together with my concluding remarks.

### **1.3 One Generic Question, Three Supporting Analyses**

The three articles of the thesis create a deep yet broad conceptual understanding of the processes of *opening innovation* in order to examine the thesis's overarching research questions in detail:

*How does the “open innovation” of actors in the context of field emergence increase the number of new contributors and resources to be applied to their evolving innovation challenges, and what does this process produce in terms of relations and interactions?*

Article 1 conceptualizes the process of creating the means and capacities of opening up for innovation to access and develop a greater amount and variety of knowledge and resources. Building on perspectives on open source, open innovation and interorganizational collaboration that have explored such capacities from different origins and scopes of analysis, this article presents a practice-based integrative framework of what we label “opening innovation” that highlights these differences and connects their relative strengths.

Through a critical literature review paired with an analysis of different empirical cases from Hacking Health, a non-profit organization that helps drive digital health innovation, this paper bridges the user-centric, firm-centric and field-centric approaches to opening innovation that are progressively connecting a greater variety of actors and resources. We show how new relational practices and the artifacts they produce address the new relational dynamics these connections create, which is essential for allowing actors to continue accumulating more resources for their innovation process to keep progressing. This article lays the groundwork for further detailed analysis of the struggles that occur at different layers of practice to produce digital health innovation



and of the way actors manage to move across these layers. These considerations are the seeds of the following articles, which provide a deeper and more detailed analysis of these challenges and of ways to resolve them.

Article 2, titled “The sequencing of field-configuring events in the emergence of the field of digital health: collecting different resource trajectories,” focuses on the consequential role Hacking Health’s series of events played in the construction of the emerging field of digital health from the intersection of existing fields. The article sheds light on the individual and cumulative impact of Hacking Health “open innovation” events – cafés, workshops, hackathons and bootcamps - that are conceptualized as a series of field-configuring events (FCE) (Meyer et al., 2005; Lampel and Meyer, 2008). We pair these open innovation events with the conceptualization of field-configuring events (which has not yet been done) to explore, from an earlier standpoint and in more detail, the processes related to field emergence that occur at the intersection of different existing fields. We therefore aimed at identifying *how different field-configuring events contribute to the process of field emergence taking place across existing fields*.

This longitudinal study of different types of open innovation events that had yet to be considered for their field-configuring capacity significantly improves our understanding of the role of FCEs in the context of an emerging field. Whereas scholars contributing to the FCE literature have mostly focused on single events and on already institutionalized events, such as conferences, award shows and Olympic games, representing existing fields, our findings are constructed on the observation of a series of events with few to no entry barriers and fuzzy field boundaries, which allow a better viewpoint of field emergence. Our longitudinal view allowed us to see how these different types of events addressed a lack of progress in generating and sustaining hackathon outcomes, and how the sequencing of these different types of events helped address the three relational dimensions of trajectories (distributed, distanced and dedicated) that arise in field emergence among actors when trying to accumulate resources from different existing fields. This relational and longitudinal perspective on the dynamics of resource accumulation allows us to better theorize the notion of field emergence and to track the accumulation of resources across a sequence of different types of events to understand



their cumulative impact on field emergence.

Article 3, titled “*Transforming configurations of practices for the production of a digital health agencement*,” explores the longer-term negotiations and transformations related to the production of a digital health project. These digital technologies are indeed reorganizing the way healthcare services are produced and delivered by generating connections between actors new to each other, intersecting different practices and value systems, and revisiting existing configurations of knowledge, resources and devices. Building on a comparative case study of the post-hackathon longitudinal development of MHcardio and MHspeech, two prototypes that were created by interdisciplinary and interorganizational groups, we explore the local negotiations that occur when devices like those related to company incorporation, intellectual property agreements and research grants were introduced. To better address the deeper dynamics of these negotiations and their consequences, we adopt a practice-based approach built on the concept of agencement taken from Actor-Network Theory.

This perspective helps us highlight the contrasting innovation approaches of each project, with MHcardio reproducing a “linear model of innovation” that is built on the sequencing of innovation activities, from scientific discovery to commercialization, and MHspeech creating a new “open model of innovation” that combines these activities into a new form of agencement for digital health. We show that producing MHspeech as a digital health project involved profound transformations in actors’ practices and identities, whereas MHcardio reproduced actors’ differences, which led to the project becoming purely scientific and research-oriented. We thus unpack the performative effect of the underlying devices that sustain these models of innovation to explain the observed projects’ outcomes.

#### **1.4 A Note on Methods**

This section briefly presents the overarching methodological considerations of the thesis. However, each thesis article includes its own methodological section and considerations, given that their conceptual implications require slightly different methodological approaches. To understand the full story of Hacking Health’s work,

each article focuses on different parts of the collected data. The following subsection provides an overview of the research design and explains the reasoning underlying my methodological choices. The overarching research design of the thesis is presented in Figure A below.

*Choice of method and design: from practice-based approach to qualitative study*

This research is built on a practice-based approach, considering innovation as something people do (Lundvall, 2017), with a focus on knowledge and resources as being embedded, reconstructed and transformed in practice, that is, in actors' daily activities (Cook and Brown, 1999; Carlile, 2004; Nicolini, 2012). However, for the purpose of this thesis, the practice-based approach is not only a methodological choice but also an ontological and epistemological assumption, meaning that I consider practices as "the primary building blocks of social reality (Feldman and Orlikowski, 2011)." I therefore go beyond observing the detailed quotidian activities of actors in their innovation processes. I engage profoundly with the "strong program" (Nicolini, 2012) of practice theory that strives to explain social matters such as disciplines, organizations and society, and their organizing in terms of practices, what they produce and reproduce, what they change and maintain, and how this happens. Practice theory encompasses an array of different scholars' work, such as Bourdieu (1990), and also includes work by the Actor-Network Theory's authors, and other sociologists (e.g. Giddens, Taylor) and philosophers (e.g. Wittgenstein, Heidegger). Despite their differences, these theories share commonalities regarding the foundational role of practice in social reality. I then build on this view to explain the deeper social processes related to opening innovation, the challenges they entail and their broader outcomes.

In the present research, I see a practice as "an organised constellation of different people's activities (Schatzki, 2012)" that go beyond the local, meaning that this constellation takes into consideration the whole scene of action unfolding through actors' doing (Nicolini, 2017). Furthermore, I consider that practices do not consist solely of human activities, but are constituted and are enacted with material entities. Human activities are therefore relationally rooted in complex sociotechnical networks



that give them meaning and action. As organized constellations of sociomaterial activities, practices are seen as the concrete building blocks of social life, and, as such, are the unit of analysis (Nicolini, 2012) that drove this research. The conceptualization of this practice-based approach, briefly presented here, is further developed and recontextualized for each article in keeping with their different objectives.

This practice-based approach guides the empirical focus on activities (Langley and Abdallah, 2011; Nicolini, 2017), their consequences and interrelations. It prompts the mobilization of specific methodological approaches, such as an observation orientation (Nicolini, 2012), to capture what people do, but more importantly, it relies on a “sensitivity not just to surface activity but to the skills and competencies that underlie it (Langley and Abdallah, 2011),” and the context that gives practices meaning (Schatzki, 2002). The underlying knowledge and resources can be vested in deeper social structures that were and continue to be accumulated across time and space (Carlile, 2002; Carlile and Dionne, 2018). Such a consideration demands the mobilization of a longitudinal design to be able to dig beneath the surface of actors’ activities to understand the complexities related to actors’ different practices.

In addition, the practice-based approach of this thesis considers practice as sociomaterial, highlighting the importance of considering both the social and the material in collecting and analyzing data. The study of materiality is of particular importance for this thesis because it aims at exploring multiple and conflicting visions along with different and interacting interpretations (Hodder, 1994) in the construction and evolution of innovations, firms and fields. Focusing on the materiality of practice allows me to track what is conflicting, what is accumulated throughout actors’ activities (Carlile and Dionne, 2018) and what is stabilized as shared social structures that become the guiding principles of subsequent activities (Langley and Abdallah, 2011). The recursive nature of practice implies that activities are constrained and enabled by these social structures, while simultaneously solidifying, reproducing and transforming them. This latter consideration is especially important for my research inquiry because I aim to understand, in practice, the construction and evolution of digital health innovations and of the resulting emergent field of digital health, which intersects different existing fields.

Qualitative research suits this purpose because it allows me to gain an in-depth understanding of human activities and interactions with materiality (Patton, 2005), together with the reasons that govern such interactions and actions. Qualitative approaches investigate the “why” and “how” that are specifically related to a processual and temporal understanding of evolving relational dynamics in rich detail (Langley and Abdallah 2011). Qualitative data offer the means to investigate social and human problems by focusing on informants’ activities while providing a rich contextual understanding of such phenomena (Diaz Andrade, 2009). This qualitative approach has allowed me to gradually move from the data to the theorization of the phenomena under observation through emerging patterns. For instance, the early and generic objective of this research was to understand actors’ ability to collaborate across organizational and knowledge boundaries in the context of hackathons. The fieldwork, however, gradually directed the research toward the much more complex research problem of tracking the accumulations that occur longitudinally across time and space from the orientation of producing specific digital solutions that will transform firms and fields. Such emerging patterns come from the thesis goal of understanding the multiple interactions, struggles and changes that occur during the fieldwork, without being constrained by prior hypotheses (Patton, 2005).

This focus on detailing human activities while allowing the emergence of patterns from the field, and tracking accumulations across space and time, required the longitudinal study of a single case. Such a longitudinal design aims at tracking the same people, their activities, challenges and actions to observe differences, not between a great number of different people, but rather arising from the interacting and evolving factors of the environment under investigation. Longitudinal studies thus make observing changes, outcomes and accumulations more accurate. Because of the repeated observations of the same cases, informants and interactions, my longitudinal approach allowed me to observe the temporal sequence of events, and therefore the way actors evolved, why they evolved, what changed in their context and what stayed the same (Carlile and Dionne, 2018).



## **1.5 The Case Study Approach to Exploring the Processes of Opening Innovation**

This qualitative research is built on an in-depth single case study approach (Yin, 2017; 2013) with embedded case studies. This research approach suits my research objectives of exploring the processes of opening innovation in a flexible, evolving and contextualized manner:

*“A case study is an empirical inquiry that investigates a contemporary phenomenon (the case) in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident (Yin, 2017, p. 16).”*

The case study approach allows one to focus on the interactions both inside and around the studied case, and to take into account the complexity of a single case (Patton, 2005). This approach was essential in capturing the whole picture of the phenomenon under investigation to devise an integrative framework of opening innovation that cuts across multiple layers of analysis (Carlile and Dionne, 2018) and thus extends boundaries of existing research approaches. The qualitative approach of this research was especially helpful in developing strong and insightful conceptual contributions and addressing the complexity of solving innovation challenges in healthcare (Eisenhardt et al., 2016).

### **1.5.1 The Selected Case: Hacking Health**

This thesis builds on the study of Hacking Health, a non-profit organization founded in 2012 in Montreal and Toronto that is dedicated to stimulating innovation in healthcare by combining knowledge and resources from a diversity of actors who have the capabilities to develop digital solutions to healthcare issues. Hacking Health’s approach to stimulating innovation primarily involves organizing a variety of events to facilitate connections between actors who come from different organizations and disciplines that did not traditionally work together. Hacking Health gradually brought together 1) healthcare clinicians, researchers, patients and hospitals, 2) coders, 3) designers, 4) entrepreneurs, investors and financial organizations, 5) health-related companies and technology firms, and 6) governmental bodies. The construction of connections among

this variety of actors opens up new spaces of exchange, allowing them to benefit from the generative power of sharing their knowledge and resources to produce digital health innovations.

Hacking Health is structured as a global entity (Hacking Health Global) with multiple active Hacking Health Chapters under its umbrella in different cities. These chapters act as quasi-autonomous franchises in charge of organizing events in their cities to create their own local fields of digital health. This structure has allowed Hacking Health to quickly expand from three cities at the beginning of the research project to more than 50 chapters on five continents. We focused on one of these chapters, the Hacking Health Montreal chapter, which is a founding chapter and one of the most active. Accordingly, the thesis research occurred in the context of the publicly funded single-payer Quebec healthcare system during a period of budget cuts and systemic reform overseen by the Philippe Couillard-led Liberal Party that was in power at the time.

### ***Stage 1: Exploratory Case Study***

I first entered the field as a participant observer in December 2013, trying to understand what to explore and capture for the research project. I participated in the organizing committee of the 2014 Hacking Health Montreal hackathon held in February to observe every committee meeting, along with online discussions and email interactions. I thus gained privileged access to the principal organizers in my investigation of Hacking Health's mission, challenges and activities. Throughout this two months exploratory fieldwork, I noted what was occurring, and tried to arrive at a definition of the research problem and the methodological procedures to follow in order to understand this problem. As Yin (2013) suggests, "You may have started your exploratory work because you were initially uncertain about some major aspect of your anticipated case study—the questions to be asked, the hypotheses of study, the data collection methods, the access to the data, or the data analytic methods—and, therefore, needed to investigate one or more of these issues." Indeed, this two-month exploratory stage helped me select what to look for and what to track during the more extensive data collection phase. This exploratory stage of the research was particularly revealing



regarding Hacking Health's mission: its aim was much greater than organizing a single hackathon; rather it aspired to have a profound impact on healthcare institutions by fundamentally revisiting the way innovation challenges were tackled through opening the door of the field of healthcare to other potential contributors.

During this exploratory stage, I legitimized my presence on the field, clarified the type of data that I could access and gained a better understanding of the problems to be addressed and what practices to track to better represent what Hacking Health was producing. Indeed, following this exploratory stage, because I was "no longer caught up in adjustments to the newness of the field setting, [I began] to really *see* what [was] going on instead of just looking around (Patton, 2005)."

### ***Stage 2: Case study and its nested units of analysis***

Our case study of Hacking Health meets the revelatory case criteria (Yin, 2017; Langley and Abdallah, 2011) because it is one of the first organizations to try to open healthcare institutions to other external sources of knowledge and resources with actors such as coders, venture capitalists and entrepreneurs. According to Yin (2017), a single-case study can be analyzed through the incorporation of subunits of analysis, or layered and nested case studies (Patton, 2005) that can "add a significant opportunity for extensive analysis, enhancing the insights into the single case (Yin, 2017, p. 56)." To understand this case and provide in-depth explanations of Hacking Health's approach, I specifically focused on actors' real-time practices across the three nested cases of (1) the Hacking Health Chapter of Montreal, (2) Hacking Health events and (3) projects created during these events. Altogether, these intersecting nested case studies constitute the overall case study (Patton, 2005), and provide more details about the story of opening innovation to contribute to the creation of the emerging field of digital health for the production of digital health innovation. This case study design suits the practice-based approach in that it allows me to track multiple practices involved in the production of digital health.

### ***Sampling Criteria***

In this section, I briefly address how the nested cases and boundaries of this research

were selected and created to respond to the overarching research question of the thesis.

Hacking Health Chapter. The Montreal chapter was selected because of its easy geographical access and its central role for Hacking Health. This chapter was one of the two founding chapters (Montreal and Toronto); Hacking Health Global headquarters are based in Montreal. The Montreal chapter was therefore the scene of ample experimentation, and fundamental negotiations and activities. In the course of the research, I interviewed chapter leaders from several other chapters. These chapters were selected due to their different degrees of maturity, in order to tackle specific questions and test my abductive reasoning in the development of the conceptualization of Hacking Health's work.

Hacking Health Events. I observed four types of events organized by Hacking Health: hackathons, cafés, workshops and bootcamps. These four types of events were developed by Hacking Health while the research project was under way. Because of the many events that were organized starting in 2014 (on average there was one event per month), I selected a representative set of events for each type of event. About seven cafés, five workshops, one hackathon and one bootcamp (which started in 2016) were organized per year in the Montreal chapter. I therefore chose to observe 10 cafés, 7 workshops, 4 hackathons and 2 bootcamps to collect data representative of HH activities. Cafés were organized in different types of settings, such as hospitals, private firms and communities. I therefore observed cafés taking place in a variety of settings to account for their differences and create better comparative analytical material. I also observed different types of workshops –from pitch to design to coding– to be able to represent this variety in my analysis. Finally, I specifically observed Montreal events to better track the longitudinal outcomes of each event, and to maintain my observation period following the hackathons with the project groups that were selected to be observed from their creation.

Projects emerging from Hacking Health hackathons. I longitudinally observed four projects from their creation in their respective hackathons: MHspeech (from 2014 to 2018), Star-Kart (from 2014 to 2016), Mon Menu (from 2015 to 2016) and MHcardio



(from 2016 to 2018). I selected the projects to be studied based on specific criteria. First, a healthcare clinician had to lead the project as a lead user (Urban and von Hippel, 1988). Second, projects were not designed prior to the event, allowing the longitudinal observation of how actors move from a problem to an idea, a prototype, a project and its implementation. Projects were entirely designed and developed by project groups created during a Hacking Health hackathon. Third, the implementation of the projects had to go through a hospital innovation funnel, meaning that projects were presented by a healthcare clinician working in a hospital in which the project would be implemented. Fourth, I selected groups based on their interdisciplinarity. At a minimum, groups were made up of healthcare clinicians, coders and designers. Group members also came from different organizations, which helped to better understand the challenges related to organizational boundaries. Fifth, groups had to agree to be observed throughout the process of their project's development or until they failed in their attempts.

### ***Research Site Access***

Although Hacking Health as an organization was generally open to my research inquiries, I faced challenges in observing the evolving context that needed to be tracked in order to fulfill the purpose of the thesis, and its practice-based orientation, related to understanding processes of opening innovation. First, because Hacking Health is a global and volunteer-based organization, I found it difficult to keep track of the constant changes occurring in the organizer team. For example, all members of the organizing committee from the first observed hackathon are no more active with Hacking Health anymore. The support from the Global Leaders of Hacking Health was essential in maintaining my legitimacy to continue tracking the evolution of the organization within and across its organizational boundaries. In addition, Hacking Health did not have a physical location, which made it harder to observe their activities. This resulted in extensive coordination efforts and a need to participate in what were sometimes last-minute meetings, in varying locations, to conduct interviews with organizers, and to observe Hacking Health members' activities.

Further, given my goal of tracking interactions occurring within Hacking Health's

events, I needed to convince event participants to be part of my research project. This proved to be particularly challenging during hackathons, when I aimed to observe group members' interactions for the entire duration of their hackathon experience. This participation in the research project also required the participants to agree to be observed and interviewed for the remainder of the project groups' innovation process, if projects were kept alive after hackathons, through good times and bad, for months and even years. This resulted in research participants labeling me "the friendly spy within our group" and "the shadow," and describing themselves as being my "laboratory rats." Keeping my research project alive was even more difficult because of the lack of organizational and disciplinary ties between project group members who were not obligated to continue participating in the research project, and who did not have underlying interests to do so. I therefore had to constantly manage the tension between legitimizing my presence in the project groups and observing participants without interfering in their activities.

Finally, observing the processes of opening innovation meant keeping track of a constantly evolving research context. As presented in previous sections, the practice-based framework of opening innovation involves increasing the number of contributors in response to the problems that gradually come up when innovating. This means that my research had to account for a constantly growing number of research participants and had to describe their input in the innovation processes at different points in time. These participants, however, did not belong to the same organization because the research context of the thesis cut across several organizations, communities and industries. Such an unconventional research approach created major challenges with regard to staying in contact with project groups as they developed while respecting the boundaries created by research ethics considerations.

### **1.5.2 Research Data**

The thesis data were gathered through participant observation techniques: observations, both virtual (email exchanges, virtual communications, etc.) and in person, interviews, and documentation. The data were mostly collected in "real-time," but in some cases



were also collected retroactively (via interviews and documentation). This approach suited the practice-based approach driving the longitudinal and processual case-study design of this thesis (Langley and Abdallah, 2011; Yin, 2017). These participant observation techniques were particularly suited to the research problem addressed in this thesis by accounting for the contextualized nature of situations under observation while allowing me to track actors' activities.

By digging into these three sources of data (observation, interview and documentation), looking at the interrelations across the three observed nested cases, and collecting data from various informants who had different views of the same situations, I was able to validate and crosscheck findings (Patton, 2005). Using various data types has strengthened my findings because the strengths of one data source (e.g. interview) can often compensate for the weaknesses of another data source (e.g. observation). For example, when observing actors working on the development of a prototype during a hackathon, I could not access their interpretations of the situation without conducting interviews. Observations, on the other hand, provided live, contextualized and unbiased (at least not by the informants' visions) information about what happens on the field. Each set of data provided a piece of the puzzle to answer the research problem. Below I briefly describe each participant observation technique used in the course of this research.

1. Observation. Observations were at the foundation of the data collection approach. I conducted observations of (1) the Montreal chapter of Hacking Health (organizing committee), (2) Hacking Health events and (3) project groups created during hackathons. However, I had to adapt my observation techniques into a "virtual" ethnography (Hine 2000) because actors from these different localizations of practices predominantly used virtual communication technologies for their group interactions. This methodological consideration was particularly important in my research context given that Hacking Health was built on volunteer participation, with no physical work location, while project groups comprised members coming from distinct organizations who did not yet have a physical space to work from. Therefore, most interactions occurred virtually, via videoconference software such as *Skype* and *Zoom*, the chatroom

application *Slack* and continuous email exchanges. This research therefore combined virtual observation techniques with traditional techniques of being physically present during actors' interactions during Hacking Health events and some project group meetings.

- 1) Building on these techniques, I conducted a 22-month participant observation with the Montreal chapter during which I participated in regular committee meetings, was part of the email exchanges of the committee, and conducted ethnographic interviews with the main representatives. I observed the biweekly two to three-hour meetings of the organizing committee. These meetings were more frequent during the pre-hackathon crunch-time periods. For all of these events, I participated in organizing committee meetings to understand the challenges related to organizing such events and how they were resolved. I also captured why these events were organized that way and how HH connected with specific event participants, collaborators and partners. I also observed eight virtual meetings between chapter leaders from different cities (Hacking Health monthly leader calls). During these interactions, I grasped the challenges that different chapters faced and observed discussions about how to manage such challenges.
- 2) I observed different types of Hacking Health events. During cafés and workshops, I conducted informal and ethnographic interviews with participants in addition to observing and taking notes about the setting. To analyze the hackathons, I joined one team per event in order to fully appreciate the challenges related to bringing together actors coming from different disciplines and organizations, what challenges were resolved by organizing these events and what difficulties were not addressed. I observed how actors interacted with one another and with artifacts, focusing on the bottlenecks occurring during these interactions. I took note of these specific moments and examined how actors were able to move past them or why they got stuck.

I engaged in short real-time informal and conversational interviews (Patton,



2005; Langley and Abdallah, 2011) during the observation phase to understand how actors were interpreting these challenging situations when they occurred. These “ethnographic interviews” (Patton, 2005) were particularly rich and important in this research setting because the observed context involved extensive computer coding and on-screen interactions. I also conducted more regular informal interviews in moments when actors were working individually on their computers for longer stretches, to understand what they were working on and why. These notes were the starting point of the follow-up interviews that took place after the hackathons, but also provided signals of what to look for when observing interactions.

- 3) I continued to shadow four project groups I had observed during hackathons to explore the issues they would face following the development of their prototypes during these hackathons. Each observed project group was created in different hackathons that took place in different years of Hacking Health’s evolution: that is, in 2014, in 2015 and 2016, allowing me to observe the evolution of the challenges related to innovating for digital health in Montreal. It was a way to observe the evolution of the field of digital health that was being constructed before my eyes. Each project group studied in a longitudinal manner was “thought of as a window into the whole (Patton, 2005, pp. 60-61)” story to explain the outcomes of Hacking Health activities for the construction of the emerging field of digital health in Montreal.

I observed these groups’ meetings and followed their activities as they developed their various partnerships, for example with their lawyers, hospitals and research centers. Taken together, I observed 78 meetings lasting one to four hours within these different groups. I also continued to conduct informal “ethnographic interviews” (Patton, 2005) after critical events to understand each actor’s vision. I maintained my virtual observations, mostly on the chatroom software *Slack*, which is specifically designed for communication in project groups, and through email exchanges. These observations were maintained until the project’s

implementation or failure. Out of the four projects, only one ultimately became a digital health project; two became pure research projects and one stopped completely. These stories will be unpacked in the following sections of the thesis.

2. Interviews. Interviews were carried out with different research participants, using different approaches. Most of the interviews were conducted on a “real-time” basis as open-ended interviews (or conversational interviews) with (1) project group members that emerged during hackathons, (2) Hacking Health leaders from Montreal and (3) semi-structured interviews with Hacking Health leaders from different chapters. For the first two groups of interviewees, I selected relevant informants who contributed to the progress (or lack thereof) of project groups and Hacking Health, which allowed the tracking of multiple practices involved in the production of digital health innovation and of the emerging field of digital health.

- 1) I carried out 73 extensive in-depth conversational interviews (Patton, 2005) with project group members and other project contributors. I conducted several interviews over periods of 7 months to 3 years depending on the project's development. These open-ended interviews were structured around the evolution occurring in their activities and innovation processes. Each interview began with questions about changes, new events that occurred, challenges and issues that individuals were facing, which imparted fluidity to the data collection (Rubin and Rubin, 2011). Informants could thus “describe what [was] meaningful and salient without being pigeonholed into standardized categories” (Patton, 2005, p. 56), allowing me to move outside the box of pre-conceptualized theories and of my own preconceptions (Yin, 2017).
- 2) I conducted open-ended interviews with main representatives (12) and partners (9) of HH Montreal and Global. These interviews took place before and after critical moments in the evolution of Hacking Health. For instance, because many activities and connections took place during and after hackathons, I interviewed Hacking Health representatives and their partners in these periods.



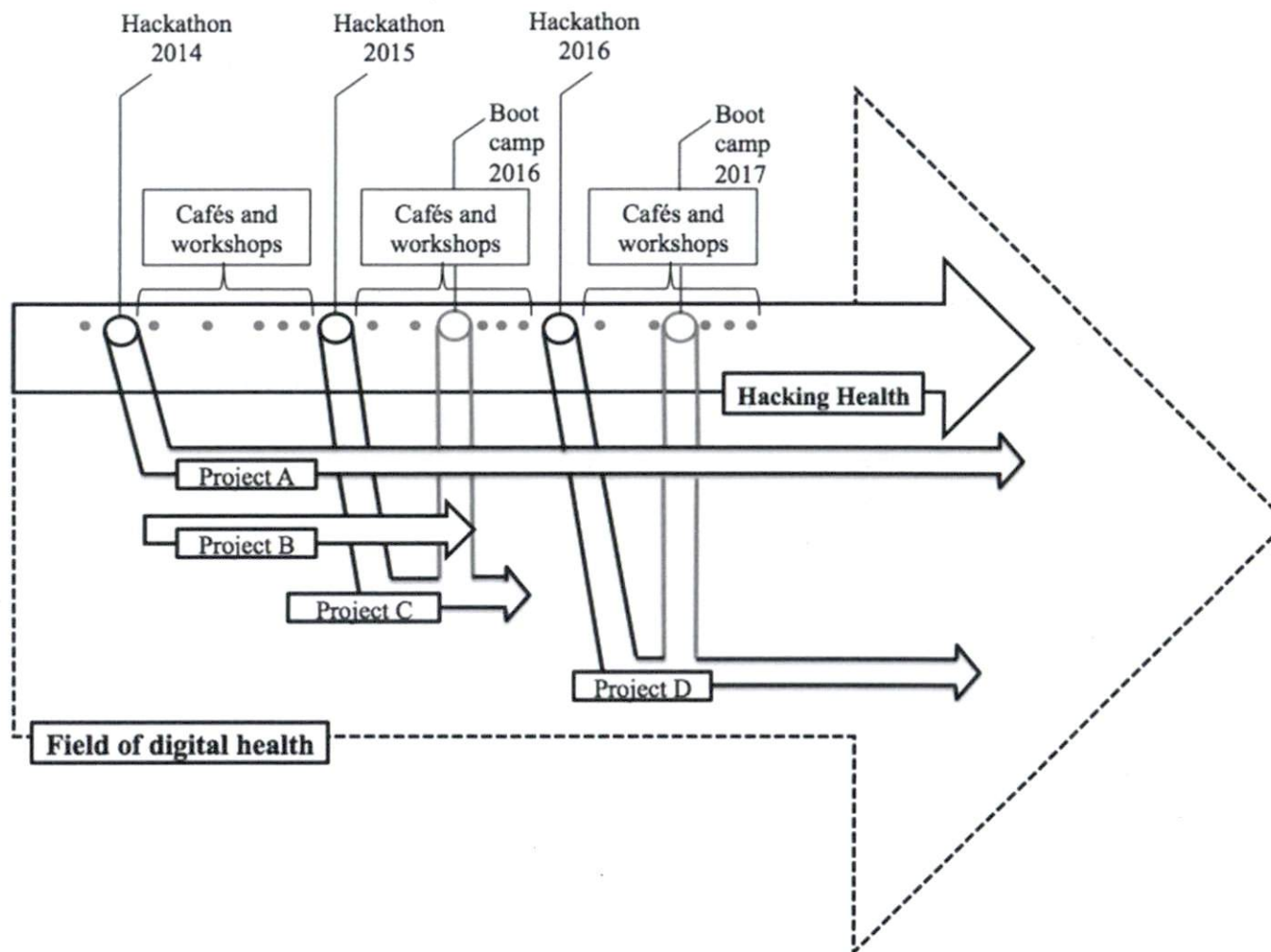
- 3) In addition, I conducted 16 semi-structured interviews with Hacking Health chapter leaders from different cities. The interview guide for this phase of the data collection was built on my observations and understanding of what happened in the Montreal chapter. The interview guide provided a general line of questioning rather than a strictly planned questionnaire. It aimed to validate my understanding of the evolution of a Hacking Health chapter for the construction of a local field of digital health. The interview guide was primarily intended to determine the stage of evolution of the chapter, the challenges that it faced in constructing its local collaborations, how these challenges were managed, the types of members who were participating in their local Hacking Health activities (for example, if there were more coders than clinicians, and why this was the case), the tools and resources mobilized in connecting these actors and the future issues that chapters were looking to tackle. The challenges were related, for example, to attracting specific actors, such as hospital representatives and healthcare clinicians, and facilitating knowledge sharing between actors coming from different disciplines. After observing the evolution of the Montreal chapter (Hacking Health's first and most developed chapter), I then collected more data to validate my understanding of HH activities with multiple other chapters.

3. Documentation. Finally, I had access to copious sets of documentation for the three different nested cases studied for this thesis. Project groups and Hacking Health produced business plans, schedules, meeting minutes, yearly reports, grant applications, funding applications, collaboration agreements, research project proposals and IP contracts. Collecting this documentation was particularly important because boundary objects were considered windows into understanding the various practices embedded in the development of digital health projects (Carlile and Dionne, 2018). These objects are physically enduring, which makes them effective methodological tools in understanding actors' various and sometimes conflicting interpretations of the same situations and observing their evolution across space and time (Hodder, 1994). "The study of material culture is thus of importance for qualitative researchers who wish to explore multiple and conflicting voices, differing and interacting interpretations" (Hodder, 1994). In



addition, analyzing these artifacts is also a means to connect what people say to what people do, which suits a practice-based approach that tracks both actors' activities and their consequences. These objects then became clues in pursuing my investigations (Yin, 2017).

**Figure A: Thesis Overarching Research Design**



## 1.6 Validity Considerations

This thesis, as presented above, aims to revisit our theoretical understanding of opening innovation by analyzing the processes of producing digital health innovation and the deeper consequences of these processes. I built this research on a case study design to create in-depth contextualized data that allow me to develop the practice-based framework underpinning this thesis. Accordingly, this research does not aim to generalize data but rather to expand our collective theoretical understanding of the phenomena related to opening innovation. In addition, although I built on the perspective of different participants to account for their respective points of view and used different sources of data (interviews, observations and documentation) to compensate for their relative strengths and weaknesses and hence increase the validity of my findings (Patton, 2005), the interpretive nature of this research makes it less suitable to positivist validity criteria (Diaz Andrade, 2009). As Pratt (2008) illustrated, the characteristics of an in-depth qualitative case study design that are qualified as limitations from a positivist perspective should rather be considered for their strengths. Indeed, because of my deeper investment and participation in the field, I was able to gain profound knowledge of what was happening on the ground, which allowed me to highlight the detailed and foundational contextual elements of the fieldwork (Langley and Abdallah, 2011). I therefore adopted the grounded theory criteria of *fit*, *relevance*, *workability* and *modifiability* (Glaser and Strauss 1967, Glaser 1978, Glaser 1998) that suits my practice-based approach.

To achieve *fit*, I gradually developed a conceptual understanding while in the field to compare the developed concepts with the work of my research participants to ensure that the theoretical constructions actually represented actors' practices and struggles. The prolonged engagement in the field allowed me to develop a profound contextual feel and sensitivity to the data that informed my overall understanding of what was going on during my observations, what was worth paying attention to, be it actors' challenges or abilities to manage these challenges, by spotting anomalies as they arose in order to improve my theorization (Patton, 2005; Christensen and Carlile, 2009). The



comparative design of this inductive study was also essential in making sure that the conceptualization developed while studying one specific project group also fit with other project groups' contexts.

This research design also allowed me to create a theoretical analysis that is *relevant* to research participants. By focusing on what actors do in their daily activities to deal with their challenges, the practice-based approach underlying this thesis research also ensured the relevance of the findings for practitioners (Feldman and Orlikowski, 2011; Nicolini, 2012). A practice-based approach focuses on actors' real-time activities and therefore provides levers specific to actors' actions. In addition, by analyzing longitudinal dynamics and having constant interactions with project group members and with Hacking Health representatives, I could test my conceptual understanding of their reality to make sure it reflected their real concerns and the ensuing challenges they faced. This improved the "trustworthiness" of my analysis because of the constant feedback I received on the field about my emerging interpretations (Langley and Abdallah, 2011). These conversations were also helpful in targeting specific details in my dataset, looking for additional data and documenting my findings. During the last year of the thesis process, I also contributed to different conferences and seminars developed in collaboration with principal informants of the thesis fieldwork who could validate and provide more details to improve my conceptual understanding.

The comparative approach built on the nested case study design also increased the *workability* and *modifiability* of the developed theory. By building the analysis on comparable empirical cases, I selected the most probable causes that could explain actors' problems, considering the variations and the different dimensions of each case. Such comparisons enable "identification of variations in the patterns to be found in the data. It is not just one form of category or pattern in which we are interested but also how that pattern varies dimensionally, which is discerned through a comparison of properties and dimensions under different conditions" (Patton, 2005). For example, although each project group was composed of clinicians, coders and designers, the last project group observed also involved a physician-researcher. Instead of refuting the developed understanding, this variation in the dimensions of the interdisciplinarity and

project groups' hierarchies actually strengthened the emerging thesis' assumptions and conceptualization. Comparisons across cases were even more powerful because although all of the project groups faced similar challenges, some ended up failing in their attempt to produce innovative outcomes or digital health projects. Indeed, out of the four observed project groups, only one was ultimately implemented in the form of what I label a digital health project (see article 3 for more details) while two of the groups became scientific projects, and one did not survive.

Taken together, these criteria have allowed me to create *ecologically valid* findings, which accurately represent the real-world settings of my fieldwork. These findings improve our collective understanding of open innovation contexts by providing a *novel* integrative framework of opening innovation (see article 1 for more details). Lastly, the continuous conceptualization process across this four-year research gradually allowed me to engage with the deep roots of the observed phenomena to provide the most *parsimonious* definitions and conceptualizations of what was actually occurring during the fieldwork. By participating in multiple academic conferences to present my findings and test my emerging interpretations with colleagues, I have gradually gained a simple and clear yet profound understanding of phenomena related to the production of digital health and the construction of the emerging field of digital health.

These validity considerations, paired with the practice-based approach of this thesis, created the means to produce conceptualizations that are *theoretically generalizable* (Feldman and Orlikowski, 2011). This does not mean that my findings provide predictions in a quantitative way (for instance with statistical generalization), but rather that the approach of this thesis provides a better understanding of the principles that can explain the observed situated actions and guide future actions. They articulate particular struggles, practices and connections that offer insights for understanding other situations from other contexts in other environments and localizations of practice, while being situated, by focusing on the condition of specific activities and outcomes. "As a form of generalization, theory allows us to move between instances within the same study and between studies as well as to expect certain things to happen and explain how and why certain events have happened" (Timmermans and Tavory, 2012). Although different



empirical environments have their own contextual characteristics, the dynamics I have considered for this theorization provide a powerful lens to understand other situations.

## **1.7 Peer Review of the Thesis Chapters**

Note that several chapters of the thesis were presented at academic conferences, and that Chapter Two was submitted to and accepted for publication in an edited book. These sections thus benefited from several rounds of peer review and comments. Here, I clarify the processes that the different sections of the thesis went through.

Article 1 of the thesis, which is the literature review and integrative framework labeled “‘Opening innovation’ across layers of practices: Developing an integrative view of the emergence of digital health” was accepted to be published as a chapter of an edited book in the Research in the Sociology of Organizations (RSO) Series entitled “Managing Inter-organizational Collaborations – Process Views.” The editors of this book are Jörg Sydow and Hans Berends, who have provided some feedback in the writing of this chapter, which was co-authored with Professor Paul Carlile.

The second and third articles benefited from reviews at different academic conferences. Article 2, which is co-authored with Paul Carlile, was presented at EGOS 2017 in “Sub-theme 68: Dynamics of Practices, Knowledge and Work in Healthcare Organizations,” where the paper benefited from a thorough review from one of the sub-theme convenors, Davide Nicolini. This article was also presented in August 2018 at the Open and User Innovation Conference. Article 3 was co-authored with Professors Chantale Mailhot and Patrick Cohendet, and was presented at EGOS 2018 in “Sub-theme 16: Collaborating across Organizational Boundaries: Dealing with Surprises in Distributed Settings,” where it received feedback from one of its convenors, Professor Kristina Lauche, and three other participants in the sub-theme.

## **1.8 Ethics Committee**

All formalities regarding ethics approval for the three studies have been completed, and formal approval was granted in March 2015 with an exception allowing the use of data collected earlier, in 2014.



## CHAPTER TWO

### **“Opening innovation” across layers of practices: Developing an integrative view of the emergence of digital health<sup>1</sup>**

**Karl-Emanuel Dionne and Paul Carlile**

#### **Abstract**

*Innovation challenges are increasingly complex, cutting across distributed actors from different disciplines, organizations and fields. Solving such challenges requires creating the capacities of opening up for innovation to access and develop a greater amount and variety of knowledge and resources. Perspectives on open source, open innovation and interorganizational collaboration have explored such capacities, but from different origins and scopes of analysis. Our practice-based integrative framework of “Opening innovation” helps highlight these differences and connect their relative strengths. Through a critical literature review paired with an analysis of different empirical cases from Hacking Health, a non-profit organization helping drive digital health innovation, we reveal the user-centric, firm-centric and field-centric approaches to opening innovation that progressively connect a greater variety of actors and resources. We show how specific new relational practices they produce address the new relational dynamics these connections bring to accumulate more resources for innovation to keep progressing.*

**Keywords:** Open source, Open innovation, Interorganizational collaboration, practice-based approach, Opening innovation.

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<sup>1</sup> A version of this section has been accepted and will be published as a book chapter in the edited book from the Research in the Sociology of Organizations (RSO) Series titled “Managing Inter-organizational Collaborations – Process Views” in 2019.

## 2.1 Introduction

Academic perspectives of open source, open innovation and interorganizational collaboration clearly recognize that organizations working alone do not have the knowledge, capabilities or resources to meet contemporary challenges of innovation (Powell, 1998; Chesbrough et al., 2014; Chesbrough, 2003; Kenis and Knoke, 2002). Scholars from these traditions argue that tapping into the potential of distributed actors improves product innovation (Lakhani, Lifshitz-Assaf and Tushman, 2013), that firms yield benefits from collaborating with external actors to improve their positions in existing and new markets (Chesbrough, 2006), and that connecting to new institutional contexts helps create shared meaning and new industrial sectors (Grodal, 2018).

Given this potential, it is not surprising that opening up innovation has been unleashed for digital health. For instance, Hacking Health, a Canadian non-profit organization focused on developing digital solutions in health, organizes different types of events such as hackathons and bootcamps to help connect a variety of actors (healthcare clinicians, coders, designers, researchers, entrepreneurs, etc.) and resources (financial resources, knowledge, facilities, etc.) to drive innovation. However, HH had to address significant challenges as they developed a set of events for generating digital health solutions, and building out this new sector. The first HH events were single hackathons built on open source principles - with no focus on IP protection rules, organizational ties, nor commercial interests – that brought together distributed coders with healthcare clinicians to produce digital health prototypes such as better pre-evaluation tools (e.g. virtual questionnaires).

However, hackathons did not gather sufficient variety of actors and resources to support the full development and implementation of these digital solutions in health. For example, solutions had to meet scientific and clinical evaluation standards, which required a greater investment from researchers and hospitals. These types of issues lead to a large number of projects failing to make progress even after initial hackathon success. To address this HH created other events and activities where connections to actors from hospitals, technology firms, and financial institutions could access

additional resources and create more opportunities for projects to develop. Despite progress with those efforts, this did not put projects on sustainable pathways where the digital solutions prototyped during hackathons could actually impact patient health outcomes. Changes made in projects and local institutions such as hospitals were not enough so a broader variety of organizations such as collection of hospitals, regulatory institutions, public funding agencies and venture capitalists needed to be involved. Actors from these institutions needed to be engaged to establish sufficient shared language, meaning and interests around issues from patient safety to data security and project funding to commercial value, to drive these digital health solutions closer to impacting health outcomes.

In this chapter, we will examine in more depth how HH addressed these roadblocks in the process of opening up innovation for digital health. This story affords the opportunity to integrate and build on the insights across the literature of open source, open innovation and interorganizational collaboration to better understand the phenomenon of opening up for innovation as it continues to expand across industries. Each of these perspectives has different empirical and intellectual origins and is oriented by different assumptions and scopes of analysis to frame the processes of opening up innovation. For example, open source innovation is a user-centric approach. By that we mean it focuses on phenomena related to distributed users getting connected and assembled in communities to become producers of innovation by developing solutions to their specific problem (Von Hippel and Von Krogh, 2003; von Hippel, 2005). Chesbrough (2003; 2006) coined the term open innovation in 2003 and his approach is firm centric with a strategy orientation that involves a variety of contributors – firms, suppliers, and organizations from different domains – who already exist. Its scope of analysis therefore centers on the firms that open their boundaries through different firm-related mechanisms such as spinning “off” and “in” or licensing out (Chesbrough, 2003). The interorganizational collaboration literature has some similarities with open innovation (Sydow et al., 2016), but emerged from organizational theorists and sociologists, with some of them focusing on sets of organizations and institutions; and so takes what we label a field-centric view. Some scholars from this tradition examine



how fields, as structuring contexts, influence interactions across organizations through common meaning systems (Scott, 1995), existing power relations (Hardy et al., 2003) and shared rules (Fligstein, 1997) to co-produce value that is captured across a variety of users and firms (Kennis and Knoke, 2002; Powell et al., 2005; Zaheer et al., 2010).

As the phenomenon of opening up for innovation has expanded across different industries such as digital health, the three perspectives of open-source, open innovation and interorganizational collaboration are now overlapping in what and how each tries to explain the practices and outcomes they see. However, these approaches have not systematically acknowledged this and so a collective insight has not been developed. Without clarifying and applying their different origins, orientations, and differences in their language and approach, researchers will not leverage their collective power and the opportunity to create a more coherent understanding of the complex phenomena related to opening up for innovation.

To accomplish this integration we take a practice-based approach to opening innovation that focuses on practice as the common unit of analysis (Nicolini, 2012) across these three different perspectives. This helps us integrate their respective insights in order to afford deeper explanations to the broad and growing phenomena of opening up innovation. For us the phrase ‘opening innovation’ takes a process orientation that frames the user, firm and field-centric activities as driving change and innovation through the practices that developed. Over time these activities generate increasingly overlapping layers of practices that drive the process of opening for innovation. This framework reveals more deeply the empirical dynamics among actors that naturally arise when managing existing sources of value with novel sources of value, the consequences they generate on each other (Carlile, 2004) and the changes required for value to be accumulated when opening up innovation across users, firms and fields.

In what follows, we first clarify our practice-based approach to opening innovation. Second, we draw on this approach as we discuss the three literatures of open source, open innovation and interorganizational collaboration and use cases from the evolution of HH to reveal how HH struggled to open up innovation around the new field of digital

health. These empirical cases stem from a four-year longitudinal research project that began at the end of 2013 (Dionne, forthcoming). Third, by reviewing each literature in relation to each other with our cases, we formalize our framework of opening innovation that integrates the three literatures as examining different layers of practice-based phenomena. Finally, we conclude by showing how our perspective is useful in outlining new questions and potential avenues as researchers try to better understand the expanding phenomena of opening up for innovation.

## **2.2 Opening Innovation: A practice-based approach**

Opening innovation is a practice-based framework that views opening up for innovation as a set of activities that increases the number and variety of actors and resources that can be applied to the problem at hand. This process can reshuffle existing relations among actors and their practices, creating the need to change existing practices and develop new relational practices (Ness, 2009; Manning, 2010) and manage the relational boundaries associated in developing innovative outcomes (Carlile, 2002; 2004; Kaplan et al., 2017). We use the term relational practices in opposition with existing or stable practices to highlight how breakdowns generate problematic relational dynamics that existing practices can't account for, and therefore that require new practices that can deal with new relations and the novelty of the situation. We acknowledge that all practices are relational (e.g. Nicolini, 2012), but we emphasize the relational dimension to highlight that these problematic relational dynamics become even more salient as novelty increases, for instance in context of cross-field interaction. These situations require actors to develop new means to deal with the novelty of the situation and with actors' differences in terms of knowledge and interests. As new relational practices are created, new connections are established for actors to continue to develop and accumulate more resources, which eventually results in more stable practices. Without such efforts of developing new relational practices, opening up for innovation will lack progress and can also generate negative outcomes.

This work of transforming existing and developing new relational practices so value can be created from new connections and resources takes place over long periods of time.



Understanding this requires not just a processual approach, but a practice-based one, which is inherently processual (Nicolini, 2012). By practice-based we mean focusing on actors' practices to explain why opening up for innovation is successful in some situations and not in others. We consider practices as organized constellations of sociomaterial activities performed by multiple actors (Schatzki, 2012; Nicolini, 2017). To maintain this focus we don't invoke "levels of analysis" (Bourdieu and Wacquant, 1992; Nicolini, 2012; Carlile and Dionne, 2018), but instead focus on practice as the "unit of analysis." What this means both empirically and conceptually is that resources and value can only be generated in and through practices and so what impact users, firms and fields only occur through practices. Further, much like a resource-based view of the firm (Barney, 1991) described a firm as a "bundle of resources," our process view of opening innovation sees a firm as "bundles of practices." So instead of the conceptual apparatus of levels of analysis, our is a process view that focuses on a practice and as additional layers of practice become consequential we move from focusing on just a user (actor), to focusing on the increasing complexity (bundling) of a firm and then a field. The cases presented in this chapter focus on a variety of actors and their practices, how they interact with other actors, the breakdowns actors face as they try to innovate and the changes they make to produce digital health innovation. Also, focusing on the accumulation of resources over time reveals a process of developing layers of practices to engage more actors and their resources. So this layering is not only the accumulation of resources, but more importantly the layering (and connecting) of more and more practices.

A layer is a "bundle of practices" that are configured in a way that structures subsequent activities to accumulate specific resources. A hackathon project can be seen as a localized bundle of practices that an interdisciplinary group of actors uses to create an innovative outcome. A bundle of practices is nested in larger bundles of practices typically associated with an organization or firm. Since an organization adds more layers, these "bundles of practices" provide fairly stable relational configurations of practices (Nicolini 2012). A field is composed of firms and so is a bundle of firms, with each made up of bundles of practices and so fields are "bundles of bundles of practices."



Adding layers adds complexity to the relational configurations of practices and so have consequences for other practices (Carlile and Dionne, 2018). This nested or inside-out view of the layering of practices is essential to explain the challenging relational dynamics that must be addressed for opening innovation to take place in our increasingly complex, dynamic and distributed contemporary world (Feldman and Orlikowski, 2011).

### **2.3 Methodology<sup>2</sup>**

Our research is an in-depth single case study with embedded cases studies, (Yin, 2017) based on ethnographic data, which provides the means to observe and track the relational dynamics related to producing digital health innovations. This approach suited the practice-based approach of this research (Langley and Abdallah, 2011) that aimed at observing actors' practices in contributing and driving digital health innovation. Our approach recognizes practice as the basic unit of analysis (Feldman and Orlikowski 2011; Nicolini, 2012), for practice and materiality are central to accumulating and developing the sufficient resources in producing an innovation.

This paper presents a global research project that involved a four-year (from december 2013 to June 2018) observation of the production of digital health innovation in Montreal. With our focus on practice as the unit of analysis, our research moved through different localizations of practices to better understand how digital health innovation was produced. We used Hacking Health (HH), a non-profit organization aiming at stimulating innovation by connecting health clinicians and researchers with designers, developers, innovators and entrepreneurs by organizing a variety of events, as the pillar of our study. HH was created in 2012 by a doctor, an engineer, a coder and a health entrepreneur who observed the tremendous gap that was still standing between the fields of digital technology and health. While hospitals and their professionals were mostly equipped to innovate within their own world, coders and developers wanting to enter healthcare faced difficulties as outsiders to connect and understand how the field of

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<sup>2</sup> This section was specifically added for this dissertation and does not appear in the published version of this article.

healthcare worked, with its norms and regulations standing as barriers to their involvement. Therefore, HH focused on creating opportunities through organizing different types of events held outside organizational boundaries for actors from these different fields to come together to combine their expertise for the production of digital health innovation. But more than a mission of connecting ideas and resources across organizational and field boundaries, HH wanted to engage the healthcare clinicians user base to change their practices in concordance digital technologies.

Healthcare settings are especially challenging to open up as they rely on strong and extensive governmental and institutional regulations as well as deeply institutionalized professional norms that shape the way actors within that field work and innovate, and then create boundaries that are difficult to traverse for actors outside the field. These boundaries are even more solid because of their relations to issues of clinical responsibility and patient safety that explain the degree of clinical conservatism that overshadows actors' practices from the field of healthcare. In addition, the relative difference of the field of healthcare with the startup and technological fields makes it even more challenging to open up to support digital health innovation. These fields each build on their respective regimes of knowing and innovating that shape actors' practices toward different orientations. For instance, validation cycles for new ideas in the field of healthcare are much longer than those from the field of digital technologies. Finally, the value systems at the core of healthcare settings in Canada are profoundly different from those related to commercial interests, which create profound differences between business and social orientations that are difficult to reconcile.

Following activities going on within and across HH was an especially powerful window into observing the variety of things going on for the production of digital health innovation as HH acted as a boundary organization (Guston, 2001; O'Mahony and Bechky, 2008) at the interface of the variety of actors and resources involved in digital health. We therefore examined HH's series of events, for instance their cafés, workshops, hackathons and bootcamps. We specifically investigated the work around one of the founding HH chapter, that of Montreal, which was also house to HH Global's headquarters. As HH events began producing outcomes in the form of new connections



and projects, our research also tracked four projects that were created in HH hackathons in Montreal in their process to further develop their products. These projects had to interact and collaborate with hospitals (Hospital A and Hospital B) to co-create and implement their solutions with clinicians and researchers, therefore making these hospitals another site of practices to be observed for our research.

Since our research is strongly anchored in a practice-based approach, we committed to an “observational orientation” (Nicolini, 2012) to fully appreciate and track actors’ practices for the production of digital health innovation. Our data gathering process was therefore oriented by these practices and what they produced in terms of material (texts, prototypes, contracts, etc.) and relational (connections, disconnections, etc.) outcomes. Our research is built on a 22-month participant observation of HH Montreal, which involved the participation in their bi-weekly organizing committee meetings, on their email exchange, team chatroom (Slack) and their web project management tools. We also conducted informal ethnographic interviews during this participant observation and 30 conversational interviews (Patton, 2005) with HH leaders and collaborators to better understand the challenges HH was facing in facilitating digital health innovation in Montreal. We observed a variety of HH events - cafés (10), workshops (7), hackathons (4) and bootcamps (2) - throughout this four-year research process. As Zilber (2014) suggested, we observed representative yearly HH’s series of events over a four-year period to “further capture the dynamic process of an evolving field” as we focused on examining the “similarities and differences between the various years” (Zilber, 2014) of HH’s activities.

We extrapolated this approach to observing field evolution to the projects that were created in HH hackathons. We selected to longitudinally shadow projects that were created in the 2014, 2015 and 2016 hackathons in their attempts of further developing their prototype into sustainable products. This allowed to explore what changed and what stayed the same outside HH events, in the emerging field of digital health, to better support and produce digital health innovation (for instance, hospital innovation practices, governmental regulations, access to funding opportunities, etc.). We conducted regular meeting observations within these groups and regular individual



interviews with group members to track the challenges they were facing and their progression. We also observed project groups' meetings with peripheral actors such as their lawyers, hospitals' representatives, investors, IP specialists, mentor entrepreneurs and potential partners and conducted informal ethnographic interviews and conversational interviews with these peripheral actors.

### ***2.3.1 Data Analysis***

This paper is built on an abductive analysis (Timmermans and Tavory, 2012) that was first informed by a broad interest in observing how HH gradually connected a greater number and variety of actors and resources to deal with the challenges of producing digital innovation for health. As Timmermans and Tavory (2012) suggested, "this approach rests on the cultivation of anomalous and surprising empirical findings against a background of multiple existing sociological theories." The researcher in charge of data gathering then entered the field informed by theories of open source and open innovation, which were the assumptions underlying the development of HH's approach to stimulating and supporting digital health innovation. The analysis of the collected data was also done in an abductive manner, based on a progressive process of coding with Excel to more organically develop the overarching framework of this paper. The detected patterns were then tested against new observations from the ongoing fieldwork.

We first analyzed a series of interviews and observations taken from years one and two (2014 and 2015) of the fieldwork. We were first surprised by the capacity of the newly created interdisciplinary groups to come together during hackathons and co-create prototypes and of HH to learn from its previous failures to support such connections. Despite their disciplinary differences that oriented their practices, with the right set of actors and the means to pull their knowledge together, the observed groups successfully produced prototypes at the intersection of their respective orientations. However, at this point in time, we also observed the majority of projects' lack of progress in their further development post-hackathon.

We looked back into the data from these first two years and went back to the field to see what were the challenges that kept on occurring within the same projects as well as

across different projects, their different outcomes, and who was participating when they were resolved or when they ended up generating negative consequences. This analysis resulted in the identification of patterns of challenges that group faced post-hackathons that were related to project groups trying to structure their organizational form in order to create associations with hospitals and research centers. Indeed, breakdowns kept happening when groups had to create the means to access to a greater amount and variety of resources for projects to keep progressing.

Finally, while some groups failed to pursue their development at this stage, the others that successfully dealt with this “firm layer” (see section 2) all ended up having to connect with a greater variety of actors - for instance, funding agencies, venture capitalists and other technology firms - which required creating shared meaning system (Scott, 1995) with these actors who were already members of other existing fields. Some scholars from the literature on interorganizational collaboration did tackle issues related to collaboration within fields (Zilber, 2014; Furnari, 2014). However, most of them did not provide sufficient conceptual tools to understanding the challenges related to intersecting fields (Zietsma et al., 2017). In addition, the literature on emerging fields (e.g. Grodal, 2018) - which tried to tackle similar issues than that of constructing a shared meaning system - was mostly built on retrospective analysis, which could not offer sufficient empirical grip to uncover the deeper dynamics of such phenomena. As Zilber (2014) argued, “ethnographic studies may yield indispensable insights about the social dynamics of the field, insights that cannot be discovered and analyzed otherwise.” Our longitudinal ethnographic approach then pinpointed more fine-grained dynamics and practices by examining in more detail the “sequencing of actions, which involves recording who interacts with whom, in what ways, and at what times” (David et al., 2013) offering the means to produce a less bias analysis of actors’ practices than that of a retrospective report (Chiles et al., 2004) to better explain the complexity of opening innovation across existing fields.

This continuous process of moving back and forth (Klag and Langley, 2013) from “surprising events” (Teddlie and Tashakkori, 2009) in the data, theorizing and comparing with existing theories (Dubois and Gadde, 2002) helped us sharpen our



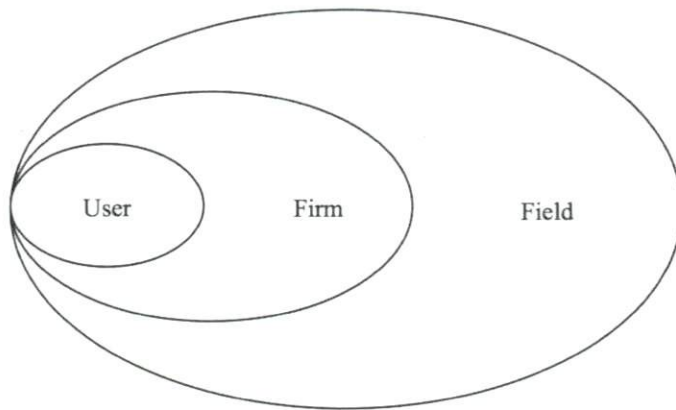
understanding of the relational dynamics occurring in the process of accessing and developing a greater amount and variety of resources to deal with the challenges actors were facing in their attempts of producing and supporting digital health innovation. This process oriented us towards adding the interorganizational collaboration literature to our conceptual toolkit and to see it, with open-source, and open innovation, as interrelated approaches of opening innovation that are consequential to different layers of practices in the production of digital health. Opening innovation with these approaches across the three layers of practices presented in section 2 became the conceptual lens to specifically target episodes to be analyzed in more detail. We then put in relation the outcomes of these events to analyze the way their that had become a stable practice for HH's activities progressively accumulated resources for the production of digital health.

#### **2.4 Literature review and cases: Three approaches of opening innovation**

We now discuss the user, firm and field centric approaches that have examined contexts of opening innovation, their different assumptions and origins to then integrate them into a holistic framework of opening innovation. To do this, we use stories from HH to show how, over time, this organization has helped develop three successive layering phases of opening innovation to access and develop the resources to drive digital solutions in health. HH started with a user-centric orientation focused on product innovation, then expanded to a firm centric approach concerned about ownership and governance, and finally, to a field-centric approach focused on developing meanings and practices to engage actors coming from across the sectors of digital, health and business that form the nexus of the nascent field of digital health (see Figure B).



**Figure B: Integrating the Literatures for Opening Innovation**



#### ***2.4.1 Open Source Innovation: The User-centric Approach***

The user-centric approach on opening innovation comes from the observation of user innovation and open source software movement that leverages a collaborative product development process built on users contributing their time, for free, to develop everything from sports equipment (e.g. von Hippel, 2005) to software (e.g. Shah, 2006). We qualify these as user-centric approach since both traditions of user innovation and open source focus on actors who contribute because of their user interest in solving a problem and enhancing products to improve their own lives. In an open source software setting, users who are generally distributed across different localizations and organizations create virtual and self-organizing communities that contribute to projects by freely sharing knowledge and needs and iteratively developing and evaluating code that builds on others work (Baldwin and von Hippel, 2011; Franke and Shah, 2003; Faraj and Johnson, 2011, O'Mahony and Lakhani, 2011; Boudreau and Lakhani, 2015). The vast majority of users are intrinsically motivated to join these projects based on their problem-focused needs or to learn from others by participating (von Hippel and von Krogh, 2003; Shah, 2006). This view on product development has attracted increasing attention from scholars and practitioners since it moves the locus of innovation from firms to users (Benkler, 2006; von Hippel, 2005; Baldwin and von Hippel, 2011). This presents a contrasting alternative model to traditional hierarchical and linear innovation models (von Hippel and von Krogh, 2003; Lakhani and von Hippel, 2004; Murray and O'Mahony, 2007) that challenges our existing theories of

innovation, knowledge sharing and firm boundaries (Lakhani et al., 2013). There has been a strong belief amongst open source scholars that such models of innovation are spreading to other economic and social areas (von Hippel and von Krogh, 2006; O'Mahony, 2007), such as genomics (e.g. Hill et al., 2017) and biomedical research (van Dam et al., 2017).

The growth of open source approach is explained in part because of the modularity of the projects, which allows fragmenting the project into multiple parts and tasks so that knowledge can be dispersed (Lakhani et al., 2013) between participants who can easily choose to work on what is most valuable to them. This modular architecture makes it easy to match user incentives to what actors care about most, but also supports the voluntary revealing of actors' contributions to others that was not easy to do before these open product development marketplaces were developed (von Hippel, 1986; von Hippel, 2002).

This flexibility allows communities to develop their own emergent social structure (e.g. O'Mahony and Ferraro, 2007; Fleming and Waguespack, 2007) that supports distributed decision-making processes among peers (Dahlander and Frederiksen, 2012). These communities assemble around a shared project initiated by an individual or small group that has a solution to develop and then posts it on a public platform (von Hippel and von Krogh, 2003). The project initiators generally become the project leaders (von Krogh and von Hippel, 2003) and anybody who is capable and willing to contribute can join the community deciding the tasks to tackle and working with whom they want to (Dahlander and O'Mahony 2011).

An open source community is constituted by a community of users - newcomers and tenured members – that is shaped as they continuously interact around common problems and shared practices supported by various technical tools (Dahlander and Frederiksen, 2012). Newcomers participate in the community and learn while developing coherent practices from more experienced contributors, receive direct feedback on their ideas and viewpoints, and then can develop their own resources and status for their respective projects (von Krogh et al. 2003; O'Mahony, 2007). This social

structure is supported by inexpensive and easy to access computers, shared coding languages and tools as well as an accepted “copyleft” licensing that governs distribution arrangements (von Hippel and von Krogh, 2006). This social and technical infrastructure opens up avenues of interaction between individuals across the community to drive collective learning and rapid improvement to the solutions they develop.

We have clear evidence of how users innovate in such context (Lakhani et al., 2013), but lack an understanding of the interactions or relational practices that need to occur across different actors and communities with distinctive social structures (Dalhander and Frederiksen, 2012). For example, the complexity of bridging an open source community with a firm that builds on proprietary software and whose business model is designed on restricted licensing (von Krogh and von Hippel, 2003) has shown to be much more difficult to manage since these collaborations brought issues related to actors’ diverging interests (O’Mahony and Bechky, 2008). Lakhani et. al (2012) argued that “open and firm based innovation are based on contrasting assumptions of agency, control, motivation, and locus of innovation, [and that] our emerging theory of organizing for innovation must reflect these paradoxical and internally inconsistent innovation modes.”

#### *Using the Hacking Health case to Understand the User Centric Layer*

The following story comes from the early days of HH and their initial efforts to use a software hackathon format to instigate the creation of digital products in a health context. This hackathon took place in 2014 with Hospital A. The story presents the use of hackathons as the initial layering of opening innovation, but also reveals that after some initial success, the “products” progress fell short because of the limited variety of actors who contributed to the projects and that further commitment was needed to move the product forward after the hackathon. It was this eventual “failure” to progress that made HH realize that additional events and activities would have to be developed for significant progress to be made.

HH initially used hackathons as a space to recruit different contributors and share their



ideas and problems. Clinicians from Hospital A would typically present their problems through a one-minute pitch in front of a crowd of outsiders - such as coders and designers - who then voluntarily selected which project they want to participate. For example, Dyna, a speech therapist clinician and an employee of Hospital A, wanted to develop a tool that would allow her to remotely collect children's speech samples so she could evaluate their speech conditions more efficiently. Robert (a coder) joined Dyna's project because his "son had been diagnosed with a speech condition." Thomas (also a coder) felt like he "had the skills needed to contribute to the project" and Robin (a graphic designer) "wanted to participate with a fun group" and use her design expertise after recently graduating from design school. These three joined Dyna's project to improve the situation for her patients.

Focusing on clinicians and patients as the users, participants had a practical focus that made it fairly easy to develop shared language, meaning and interests within the constrained format of a 48-hours hackathon. They were able to develop a shared method and make the necessary collaborative adjustments around Dyna's problem that led to them winning first place in the hackathon. Despite significant differences in disciplinary and professional training, most were put aside for the sake of creating a viable prototype to win the hackathon. However, as work continued after the hackathon, many of these differences could no longer be ignored. Dyna wanted to get a solution in the hands of patients as soon as possible. Thomas wanted a functionally robust software even if that meant producing a simpler solution. Robin wanted the prototype to have the look and feel of a video game and finally Robert had concerns about the commercial sustainability of the product. As work continued after the hackathon the initial user centric approach was no longer sufficient to bridge actors who had different interests about the possible trajectory of the project.

Eventually Thomas and Robin left Dyna's project because their interests diverged and commitment waned given other opportunities. Robert remained but disagreements about how to commercialize the product became a sore spot. Robert wanted to sell memberships while Dyna preferred to diffuse it freely so that more patients could

benefit from it. Also, since Dyna was a hospital employee and he was not, Robert wanted to establish an arrangement with the hospital that would recognize and protect each contributor's investments in the product. These differences led to a pivotal negotiation about intellectual property and commercialization rights that nearly ended the project. A successful negotiation allowed Hospital A to change its IP protection practices and then the product could be accepted across key stakeholders and eventually into the hands of the patients for a pilot run. A governance structure and a business model to fund the project was put in place so the project could continue to progress. The ongoing success of Dyna's project was a critical impetus for Hospital A to transform its existing IP practices to support more opening up.

This HH case is typical of early efforts to develop digital health solutions. HH built its approach based on open-source methods, but these lacked additional shared methods to address the diverging interests that eventually arose. Challenging issues and tensions related to individual and firm IP and commercialization strategies naturally exist in a complex ecosystem like healthcare, so opening innovation requires practices beyond what user-centric approaches have historically provided.

#### ***2.4.2 Open Innovation: The Firm-centric Approach***

The second approach of opening innovation is built on Chesbrough's concept of 'open innovation' (2003). Chesbrough takes a firm centric orientation as he recognizes that a firm's innovation strategy can be augmented by more than just joint ventures and partnerships, but by opening themselves up to distributed actors and communities of users. According to Chesbrough (2003), 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, 2003c, p. 24). Indeed, just like in open source literature, open innovation considers that talent is distributed, and that innovative processes are highly collaborative (Chesbrough, 2003; Dahlander and Frederiksen, 2012). However, with its deep roots in business economics and strategy, especially the literature on spillovers, the theory of the firm (Tucci et al., 2016) and the resource-based view (Grant, 1996; Teece et al., 1997), open innovation's scope of analysis is on the firm and the



mechanisms firms use to benefit from internal and external resources to create new market opportunities. This focus on the firm's benefits and on the pathways of innovative outcomes (Bogers and West, 2012; Chesbrough, 2006b) clearly positions open innovation as a firm centric approach.

Three organizational processes are explored for firms to benefit from flows of knowledge and resources: inside-out (or outbound), outside-in (or inbound) and a coupled approach which combines outbound and inbound (Gassman and Enkel, 2004; Chesbrough and Crowther, 2006; Enkel et al., 2009). The inside-out approach presents the way the firm introduces ideas to the market, giving up property rights and multiplying the transfer of technologies to the outside environment. The outside-in process is based on transactional and non-transactional mechanisms to improve an organization's knowledge by integrating knowledge coming from outside organizational boundaries. These internal and external flows of knowledge have led researchers to focus on the new forms of business models and intellectual property (IP) practices existing organizations adopt when opening innovation. Instead of organizations controlling their IP so that others do not benefit from it, opening innovation is built on idea sharing across organizational boundaries (Paasi et al., 2010; Chesbrough, 2003), which demand important changes in the way firms traditionally managed their IP (West and Gallagher, 2006; Enkel et al., 2009) to capture value out of their innovations (Chesbrough, 2006; Teece, 1998). This creates a variety of IP-related issues and tensions (Hart et al., 2011; Candelin-Palmqvist et al., 2012; Manzini et al., 2016; Ayerbe et al., 2014; Felin and Zenger, 2014) in regard to how decisions are made about the ownership of knowledge and inventions, the rights of its usage, and organizations' liabilities (Rhoten and Powell, 2007; de Beer and al., 2017).

Practices related to IP management exist in different ways depending on organizational settings (Cohendet and Pénin, 2006; Hertzfeld et al., 2006; Slowinsky et al., 2009; Mehlman et al., 2010; Somaya et al., 2011). According to Henkel et al. (2014), most industries are still characterized by tight protection of IP, which may hinder organizations' capacity to open their boundaries. For example, patents are still considered an effective way of protecting knowledge in the pharmaceutical industry



(Cohendet and Pénin, 2006; Manzini et al., 2016) as is generally the case in the private sector (Mergel, 2017). Possessing, controlling and having exclusivity over IP has also become a condition for startups aiming at attracting venture capital (Hanel, 2006). In the public sector, Mergel (2017) highlights that employees are not entailed to make profits out of their inventions. According to Arundel et al. (2015), government organizations traditionally operate with a request for proposals process with clear governance mechanisms over IP. Universities and research centers also have conflicting IP practices with private firms. Indeed, academic practices of knowledge development that are embedded in scientific publications conflict with the potential of protecting knowledge through trade secrets and patents (Hertzfeld et al., 2006). Finally, developers participating in open-source communities also have motivations, norms and methods that conflict with the ways that private firms protect their IP (Lakhani and von Hippel, 2003; Cohendet et al., 2003).

These different practices take a variety of forms depending on the business models on which firms and communities build their capabilities (Paasi et al., 2010). According to Chesbrough (2006), there is a strong relation between changes in IP protection practices and the “landscape for crafting business models.” Multiple researchers (e.g. Hienerth et al., 2011; Vanhaverbeke, 2006) argue that firms that are opening innovation need to adapt their business models accordingly (Saebi and Foss, 2015) and in a coherent manner with the partners they innovate with so that it benefits all contributors (Chesbrough, 2006).

A firm centric approach naturally assumes a stable organization with established interests and so focuses on evolving both its business model and how it governs its IP. A firm already has built in resources, methods and governance mechanisms intended to bridge actors’ differences (Puranam et al., 2014) whereas ideas emerging from user-centric approaches don’t. Traversing this barrier between both approaches therefore can create major challenges.

### *Using the Hacking Health to Understand the Firm Centric Layer*

This story builds on the outcomes of the story in the previous section (see 3.1.1) and shows how HH began to add post-hackathon programs such as the Mission camp to develop the missing set of practices that could connect user centric to firm centric approaches (in this case Hospital A) to more successfully open up innovation for digital health products. These practices would also help hackathon groups become committed to a longer-term trajectory necessary to continue the development of their solution. This story presents how this Mission camp allowed participants to represent and then align their divergent interests so they could integrate their knowledge and pull resources across individual and firm boundaries. These negotiations were not just within the group but also with other organizations such as Hospital A that group members were either employed by or had become associated with. This was essential since the project needed to perform pilot runs inside the hospital to not only validate its impact on health services, but also to show its potential commercial value in order to attract more financial resources to hire additional contributors to this project.

Marshall is a research clinician from Hospital A and participated in a 2016 HH hackathon. Just like Dyna, Marshall wanted to pull in the knowledge and resources from external actors to develop a digital solution to improve his clinical services. Marshall's group won second prize and after the hackathon also faced difficulties in creating commonality across the diverging interests of the members of his newly created group. Coders wanted to develop a startup while he would have preferred the product to be free to patients in the hospital clinic.

To manage this divergence HH helped organize along with a newly created innovation unit in Hospital A and a financial institution a "mission model" camp (or Mission camp). This new innovation unit was developed to address the challenging relational dynamics (i.e., Robert and Dyna different interests) through the development of artifacts such as IP contract for Dyna's project. This helped open up the project to a greater variety of actors, connecting their practices and developing new relational practices, connecting their practices and developing new relational practices. Dyna eventually



became the formal coordinator of this innovation unit. The camp is an eight-week program with bi-weekly meetings aimed at supporting successful hackathon projects. Based on a variety of tools and methods, such as the mission model canvas and customer interviews, organizers help projects such as Marshall's develop their business model, be it via building a startup, a non-profit organization or an internal hospital project. At the end of the program, projects were invited to select partner organizations that could help them further develop their solution in ways that are consistent with the business model they chose. Mission camp organizers select a panel of mentors from across various organizations and professional disciplines. For example, Marshall's panel was mostly selected by Hospital A's innovation unit who assembled a group coming from different departments (research, IT, HR, etc.) since his project was largely internally focused. For other startups the assembled panels could involve insurance and pharmaceutical companies, venture capitalists and other key stakeholders organizations. This project-specific panel helped project members understand the how, what and the why of their evaluation criteria, but also engaged panel members to help guide the project's path of development in their respective organizations. The program provided a way in for projects and panel organizations to build collaboration methods for working across organizational boundaries and pulling in additional people and resources to move the project along.

MHcardio was the first prize winner in the same 2016 Hackathon that Marshall participated in, but the clinicians came from Hospital B. Like Marshall, MHcardio benefited from the Hackathon in forming the group and its prototype and now the Mission camp to develop its business model more fully. However, when the MHcardio prototype was taken back to Hospital B, Hospital B lacked the practices for collaboration that had been developed at Hospital A. So while MHcardio had worked on their IP issues during the Mission Camp event, Hospital B wasn't able to engage in conversation about IP governance in a way that would benefit MHcardio contributors. Marshall's second place project was able to make much more progress after the hackathon events because of Dyna's project efforts starting in 2014 Hospital A had an innovation unit specifically designed for open innovation initiatives. This allowed



Marshall's team to work through the IP issues and engage productively in the Mission camp. For this reason Marshall's project continued to progress whereas MHcardio remained undecided about its path of development and ultimately failed to accumulate resources at the firm layer.

Getting the appropriate access to another set of participants, their knowledge and resources, and the right organizational arrangement to do so is essential in opening innovation in digital health. This is why an existing firm's organizational practices had to be transformed so it could be open to the large set of knowledge and resources required to continue to make progress. This is why projects in Hospital A could benefit more from the Mission camp because existing practices had been transformed and new relational practices developed.

We can see that in some situations, practices at both the user and firm layers were developed, however, at this stage, practices at the field layer had yet to be developed. In the following section we will see that practices at the field layer had yet to be developed to connect and engage additional actors and resources. Examples would be developing the means to access public and private capital services, diffusing Hospital A's new relational practices across multiple hospitals to create more opportunities for projects to progress and engaging regulatory and professional associations that would all be necessary to support the creation of a new digital health field.

#### ***2.4.3 Interorganizational Collaboration: The Field-centric Approach***

Interorganizational collaboration literature has some similarities with a firm centric approach. Both perspectives agree on the potential benefits of innovating across organizational boundaries, competitive advantage and opportunities for learning (Powell et al., 1996; Goes and Park, 1997). Yet, instead of focusing on how firms achieve competitive success, most scholars from interorganizational collaboration literature "have characterized collective patterns of survival, growth, and sustainability" among a set of organizations (Osborn and Hagedoorn, 1997). A field is a social space encompassing "those organizations [and occupations] that, in the aggregate, constitute a recognized area of institutional life" (DiMaggio & Powell, 1983: 148) and interact more

frequently with one another than with actors outside of the field (Scott, 1994, 2001). These organizations can include firms, regulatory agencies, governments, universities and NGOs. We focus on scholars who have taken a field-centric approach to understand collaboration among the fields' organizational members (Hardy et al., 2005) and the challenges to co-producing value when working within and across fields.

We label this a *field*-centric approach instead of industry or network because the breadth of the concept of a field can include actors and organizations coming from different industries and networks (Powell et al., 2005). However, creating shared meaning and interest between actors coming from different industries and domains who have different interests raises important challenges and difficult negotiations (Phillips et al., 2000; Lawrence et al., 1999). Since these field collaborations are not governed by specific market nor hierarchical mechanisms - which is characteristic of the firm-centric approach - more work is required to create and negotiate coalitions, produce and share information and define collective interests (Phillips et al., 2000).

Interactions between field members are stabilized by a particular distribution of resources and methods that operates as a shared meaning system (Scott, 1995) and becomes institutionalized by constantly being produced and reproduced (Barley and Tolbert, 1997; Scott, 2001; Phillips et al., 2000). This shared meaning system among actors is the glue between field members and allows such a variety of field actors to develop a shared interest in collaborating and sharing resources to address complex problems (Wood and Gray, 1991; Wooten and Hoffman, 2008; Zietsma and Lawrence, 2010). Eventually these forces push organizations to converge towards organizational forms, templates and trajectories that better create opportunities to drive innovation and produce value (DiMaggio & Powell, 1983; Powell and Sandholtz, 2012).

Emphasizing the accumulation of layers of practice and resources to understand interactions between field members sheds some light on the more complex across field relational dynamics and what needs to be done to create a shared context for collaboration. Organization scholars have just recently started to look at interactions occurring across field boundaries (Furnari, 2016; Zietsma et al., 2017). Scholars from



the field centric have mostly focused on collaborations between field members who already have some shared methods, practices and rules to rely on in their interactions. But what happens when these contextual elements are not shared?

This requires the development of relational practices given the lack of existing practices to support across field efforts as well as the changes required to existing within field practices. Profound changes occurred in a variety of practices and new one's developed to bridge actors from different fields and the use of their resources to drive digital health innovation. The result of this process is a more or less structured field with a variety of actors who share institutionalized rules and resources, but who still maintain some of their differences in orientations.

#### *Using the Hacking Health to Understand the Field-centric Approach*

This last case is a continuation of the previous narratives (see 3.1.1 and 3.2.1) and reveals the cross-field practices that need to be developed so additional varieties of actors, resources and firms can be brought to sustain the development of digital health solutions. This story shows that from a user centric to a firm centric approach, the prototypes of products evolved into startups in collaboration with existing firms and yet the outcomes of such approaches were limited to an existing organizational field (i.e., hospitals). Questions about scientific research, the long-term path for product development and financing remained because new relational practices to connect to actors and resources from these different fields were not developed.

Concerning the field of scientific research, the two clinicians (two nurses) primarily driving MHcardio had continued to make progress for six months after the hackathon when they learned that Hospital B's intellectual property policy did not recognize their IP contribution to the project as was the case with their physician-researcher colleague (i.e., physician-researcher received a 50/50 split). Hospital B's IP policy reflected the existing policies of most academic hospitals designed around the notion that researchers were the most important contributors to driving knowledge creation in health. Hospital A was also an academic hospital, but specifically dedicated to improving the health of



children and mothers and had already transformed its IP practices so clinicians (i.e., Dyna) could benefit. A similar set of new relational practices needed to be developed at Hospital B and other hospitals in Montreal to create more opportunities for digital health products and firms to emerge.

The conflict between research and clinical oriented practices is related to measuring and valuing different things, but also to power relations and how one group's measures dominate another. We see this challenge across different practices as MHcardio determined they needed to build rigorous scientific validation around its product to prove its worth. The technologists in the group were using a lean, iterative approach focused on producing a minimally viable product to be easily commercially tested, but this did not support the scientific standards of scientific researchers. For example, the mobile application's features were not developed enough to validate scientific measures such as patient rehospitalizations and reconsultation for heart failure through a control group's approach. The scientific research orientation at MHcardio was strengthened by Hospital B's newly created innovation unit that was primarily built around the expertise of scientific methodologists in public health and epidemiology. This limited variety of actors and their associated practices steered MHcardio toward a narrow reach path of development. Further, the technological lean startup approach originally taken by taken by the MHcardio group did not meet the product development requirements of public agencies that could provide more financial resources and legitimacy. Public health agencies were driven to support well-established scientific validation methods rather than agile approaches. For these reasons MHcardio was paired with an existing tech firm that had fully operational research methods.

This existing technology firm was not willing to create a collaborative agreement that would split the potential benefits with an emerging digital health startup such as MHcardio. Venture capitalists had only specialized in digital products outside of health and were focused on supporting and using familiar business models built on exponentially scalable opportunities. MHcardio's product, however, was not ready to pitch to these investors and not interested in losing major ownership to these venture

capitalists at such an early stage. Funding opportunities available for MHcardio's project were not designed to provide early support for scientific, commercial and digital development at the same time. In the end, the digital technologists ceased to be involved in MHcardio as it was put on a traditional scientific health pathway that ended its development as a digital health project.

This case reveals that a variety of new relational practices at the field layer were needed for the development of a digital health product. Significant transformation across existing practices from different fields (i.e., scientific, clinical, financial, technological, regulatory) must occur for a collective approach across the variety of actors and resources required. By contrast, Marshall's project (see section 3.2.1) at Hospital A took a more applied clinical approach, which more easily connected them to a funding campaign driven by parents (rather than pursuing scientific grants). This funding source provided flexibility in regard to their expected outcomes and helped them continue to create bridges to resources across a variety of fields.

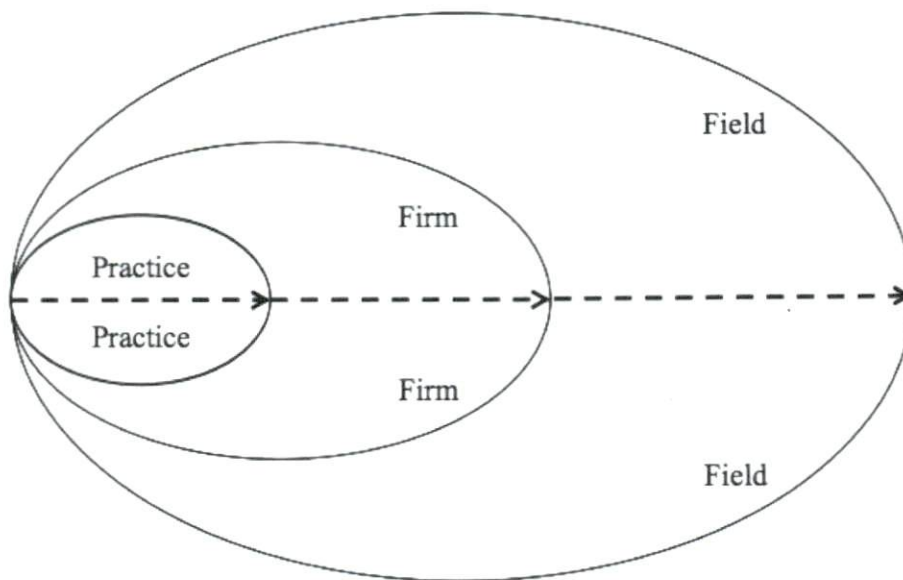
Innovation usually requires disrupting existing relational practices and developing new ones especially when trying to work across fields where what is measured, what is valued can be so different. When HH engaged different fields such as public agencies, venture capitals and existing tech firms, actors within those organizations needed to commit to creating value in a new and highly uncertain field. Without successfully getting this variety of actors to participate, the field of digital health would not be able to accumulate the requisite resources to populate it with projects and firms to fuel its emergence. Creating these new relational practices through these events and activities was essential for resources to be accumulated at the field layer.

## **2.5 Discussion: Developing an Integrative Framework of Opening Innovation**

Rather than focusing on either open source, open innovation or interorganizational collaboration, we have chosen to focus on the broader process of *opening innovation*. This process perspective not only allowed us to see the relationships across each of these literatures, but also revealed their respective focuses on user, firm and field as three

layers of the process of opening innovation, while also recognizing that each approach has a relative strength in what it can explain. Drawing on the literature review and the empirical cases from Hacking Health, Figure C provides an integrative framework that makes explicit the relational dynamics of *opening innovation* between practices (i.e., Dyna and Robert), firms (i.e., hospital A and the start up) and fields (i.e., digital technology, health science and public agencies) that must be addressed. To represent this in Figure C we alter Figure B by replacing “user” with “practice” to emphasize that users are actors who must engage in a practice to get work done and acquire resources. Further there is a series of dotted arrows running from left to right and down the middle that indicate the relational dynamics that have to be managed across practices, firms and fields for the process of opening innovation to make progress.

**Figure C: Conceptualizing the Layers of Opening Innovation for Digital Health**



### ***2.5.1 Conceptualizing the Layering of Practices when Opening Innovation in digital health***

Taking a practice perspective of *opening innovation* reveals the deeper relational dynamics that impact an actor’s ability to collaborate across different practices (Osterlund and Carlile, 2005). Opening innovation gradually brings in a greater variety of actors and novel resources to develop new solutions, so by definition it disrupts



existing relational dynamics among actors and the existing relational practices that support them. For example, Levina and Orlikowski (2009) argue that sources of difference bring in novelty that generates ambiguity between actors and creates “openings for the reconfiguration of power relations and status hierarchies” to take place. When sources of difference are known, existing relational practices among actors are adequate. But when sources of difference are novel this leads to breakdowns in relational dynamics requiring more relational “work” to address them (Deken et al. 2016).

Our longitudinal examination tracked a variety of actors, the practices they engaged with and developed, and the progress or the lack thereof as they tried to create digital health innovations. A lack of progress can indicate that new relational practices have not yet been developed and so the *layering* of practices to accumulate key resources does not take place to further develop digital health projects. The series of dotted arrows running through the middle of Figure C indicates that new relational practices have to be developed to move from a hackathon prototype to accessing knowledge and resources in different firms and across different fields. To represent this layering of practice more fully Figure D below is a side view of Figure C.

**Figure D: Conceptualizing the *layering* of practices when Opening Innovation**

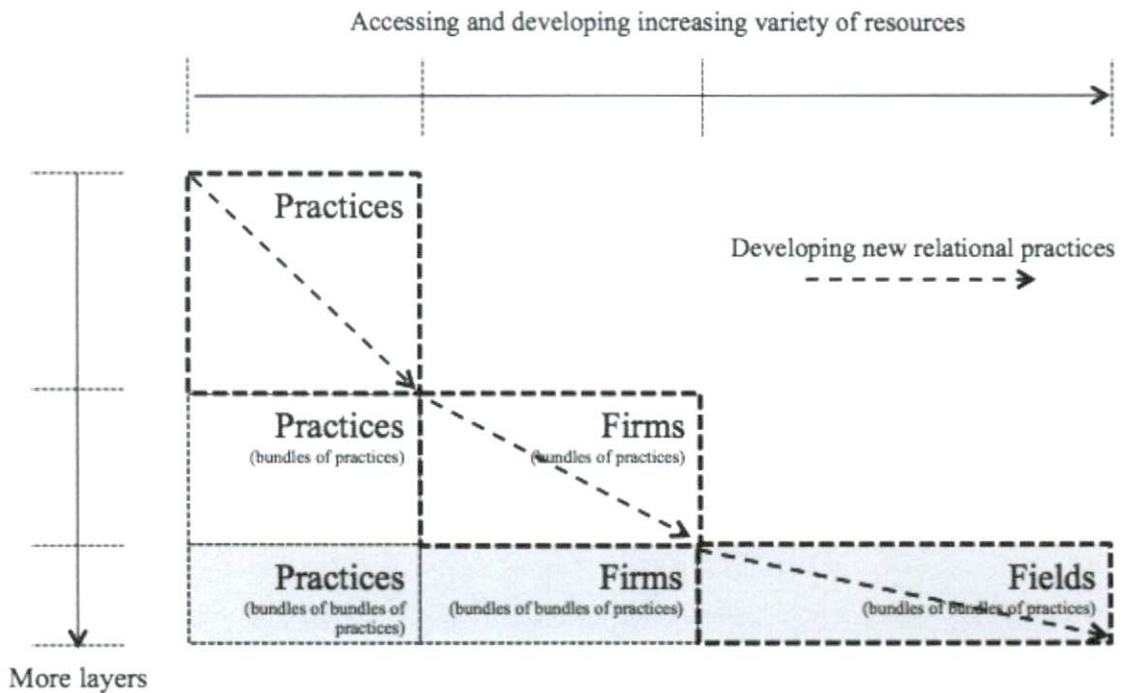


Figure D represents that practices are the core of where action takes place and how resources are accumulated through all layers. This is consistent with how we defined a layer as a “bundle of practices” that is configured in a way that structures subsequent activities to accumulate specific resources. Figure D also represents that each row of conceptual categories (i.e., practices, firms, and fields) is equivalent in terms of the number of layers of practices. Further, adding more layers is required to access and develop a greater variety of resources, but the more added, the more it constrains potential innovative action given the potential dependencies generated across those practices. We have represented this increasing constraint as a compression and an increase in density of the second and third rows as more layers are involved. This acknowledges a socio-archeological view of sociomateriality (Carlile, 2015) that describes the progressive and sedimentary *layering* of practices and how that constrains action and impacts how resources are accumulated.

The increasing length of the series of dotted lines representing the development of new relational practices moving down more layers is recognition of the increasing work to

address the relational dynamics with more layers. This layering of practices highlights the new relational practices that are required for opening innovation as it moves from a less constrained and localized bundle of practices in a hackathon, to the additional layering of bundles of practices that make up firms and fields. For example, a digital health prototype is much easier to develop from new combinations of practices in a hackathon setting than in a hospital that is constrained by more existing layers and dependencies across those practices. It also explains why firms look to access and develop novel approaches by encouraging their employees to participate in a less constrained bundle of practices such as hackathon events and online communities (Faraj et al., 2016).

#### *2.5.1.1 Layer of Practices*

For example, at the first layer, a hackathon event bridges practices locally to help groups produce a collective outcome in the form of a digital health prototype. Creating a prototype indicates a capability to create meaningful connections between actors from different disciplines in this less-constrained layer of practices. We argue that the power of a user-centric approach comes from this less constrained nature of this layer, so this is what lies at the heart of the insight of user and open source approaches to innovation (Von Hippel 2001; Von Krogh et al. 2003). This puts the success of hackathons in their proper context where a working prototype is a sufficient outcome of success while also explaining why they are not sufficient to sustain the innovation process beyond this less constrained layer of practices. For that we turn to additional layers of practices.

#### *2.5.1.2 Layer of Firms (Bundles of Practices)*

Firms add more layers and so are “bundles of practices” that provide fairly stable relational configurations across these practices (Nicolini 2012) and so connotes existing and more constrained relational dynamics where innovation would need to play out. Projects emerging from the less constrained hackathons had to deal with these additional relational dynamics by creating new relational practices with a hospital’s practices. Piller and West (2014) have acknowledged such processes of moving up and down layers by seeing this as a coupled process of innovation. They expand on this notion of



coupled process, which, according to them, gives rise to co-creation of new joint projects, alliances, and cooperation with individual users and firms. This view explicitly combines von Hippel's User innovation approach with Chesbrough's (2003) Open innovation. As actors from firms move down to participate in a less constrained hackathon event, they can more easily experiment with new actors and approaches. Yet Piller and West don't acknowledge the need to create the relational practices to deal with actors' differences in knowledge and interests as they move from a firm, to an open innovation event and then back to a firm to accumulate the resources to drive innovation.

The new relational practice and IP agreement (artifact) developed at Hospital A helped Dyna address their different interests when working between the hospital and their emerging start up. This effort took nearly two years of negotiating and transforming existing practices to deal with the differences between group members' orientations as well as transforming existing relational practices (e.g. IP) in Hospital A to begin a pilot project. This effort led to a pilot project that combined the resources from the startup and the hospital to move project's development and implementation forward. From Dyna's successful project an innovation unit was created that provided a relational capability that Marshall and others used to help their projects evolve and interact with a broader variety of actors and resources to produce digital health innovations.

By contrast, MHcardio implementation at Hospital B reproduced current relational practices in the form of existing IP practices (see case 3.3.1). Existing IP policies only valued the contribution of researchers and not clinicians. If new IP policies at Hospital B were developed, these new relational practices would have reshuffled institutionalized patterns of participation by creating opportunities for clinicians and traditional researchers to develop new services, therefore changing their respective roles. This fits Lifshitz-Assaf's (2017) observation that some NASA researchers didn't change their existing practices and continued to focus on being a solution provider whereas other researchers established new relational practices and so changed their identities and so adapted to the requirement of opening innovation.

### *2.5.1.3 Layer of Fields (Bundles of Bundles of Practices)*

At the layer of fields, there is a bundle of firms, so we have bundles of bundles of practices. For HH projects to continue to progress, they have to open themselves up to an even larger set of actors, resources and firms that exist in a variety of fields. The failure of MHcardio to make progress at the field layer was a result of not creating new relational practices to engage clinical, technological and commercial interests distributed across different firms and fields. Ultimately this led MHcardio to focus narrowly only on scientific research and not developing a digital health trajectory. Marshall, on the other hand, by creating a “scaling plan” that involved different stakeholders, identified their interests and developed new relational practices to be able to access and develop the knowledge and resources associated with commercialization.

In settings where different fields are brought together, such as digital health, institutional contexts may not provide new relational practices and meaning systems to manage the new sources of novelty (Levina and Orlikowski, 2009). Each field is built on its own “rules of the game” (Bourdieu and Wacquant, 1992) that orient and sustain specific practices for the production and accumulation of resources. So for actors coming from different fields, this likely results in diverging meaning and interests of the same project and making the pragmatic negotiations across their interests significantly more challenging (Carlile, 2004). Yet, creating new relational practices across these differences is essential to develop and accumulate an increasing amount and diversity of resources. For instance, Lawrence et al. (2002) showed that through local collaborations, an under-resourced organization NGO overcame the power asynchronies in its field by gathering more resources across different actors by creating new practices, rules and technologies that transcended the local context of their initial collaboration to support new field interactions.

Murray (2010) observed the reconstruction of patents as the means to create hybrid zones of exchange at the intersection of commercial and scientific fields in the context of a collaboration between universities and private companies. Boundary practices for the reconstruction of patents’ meaning were instrumental in helping researchers access



more resources to produce better outcomes in their own field rather than choosing to either stay in their traditional lane or moving to the commercial field. Powell and Sandholtz (2012) focused on the transformation of existing organizational forms for the creation of “dedicated-biotech firms” that created a bridge between practices from the pharmaceutical field and the field of biological science. These transformations helped gather more resources from venture capitalists and scientific agencies, and created new meaning systems for the field of biotechnology to emerge. Bridging different practices, firms and fields occurred as actors developed new relational practices to accumulate the necessary variety of resources to move digital health innovation outcomes along.

## **2.6 Conclusion: Why Study *Opening Innovation*?**

This chapter has been more than a review of the open source, open innovation and interorganizational collaboration literatures. We adopted a practice perspective of opening innovation, which revealed three progressive layers of user-centric, firm-centric and field-centric approaches. We empirically demonstrated the value of this layering framework using case examples from Hacking Health. We described how actors had to change their existing practices, and develop new relational practices and artifacts to address the novel sources of difference that arise when opening innovation to accumulate a greater variety of resources.

By taking a longitudinal view of opening innovation, we were able to track the evolution of digital health from its initial layer of hackathon events. Now after five years of developing and adding different events and activities, Hacking Health has brought together a variety of actors from universities, hospitals, pharmaceutical companies, non-profit organizations, communities of patients and developers, venture capitalists, startup companies and governmental agencies. This has led to the development of new relational practices that helped produce digital health innovations across the variety of actors gathered. For example, there are now specific funding agencies and grants organized for digital health product and startup development. Venture capitalists have also developed new funding practices and some startups have scaled to being companies with more than 100 employees. Today, there are a variety of sequenced events and



numerous relational practices that support interactions between a much larger variety of actors and their resources in developing digital health projects and startups. This longitudinal understanding of Hacking Health makes clear what it means to develop a capability for opening innovation.

Today innovation challenges, such as digital health, are increasingly complex, cutting across layers (i.e., practices, firms and fields), so it is crucial to better understand how this works. For example, “grand challenges” (George et al., 2016) like climate change and the aging population (Kulik, Ryan, Harper and George, 2014; Howard-Grenville et al., 2014) can only be tackled through developing “big” ideas commanding the mobilization and coordination of a variety of resources coming from numerous actors, firms and fields (Colquitt and George, 2011; Olsen et al., 2016). Clarifying the flow of this layering process is at the heart of our integrative contribution for both the literature and the phenomena of opening innovation.

Our integrative approach also identifies important opportunities for more research in the context of opening up for innovation across layers. First, with the increasing number of nascent industries (Davis and Marquis, 2005; Benner and Tripsas, 2012), such studies could better understand the overall process of nascent field evolution and configuration by providing empirical evidences of the relational dynamics involved in opening innovation. Second, this overall process requires the mobilization of key relational practices, such as the organization of a variety and order of events for the assemblage and configuration of shared practices at the intersection of existing fields. Third, this overall process of transforming and creating new relational practices required for the accumulation of critical resources can provide significant insight for projects getting developed in nascent fields. Exposing the three layers of opening innovation helps us see what is involved in the development of a nascent field, which then helps us see what is required to open up innovation more effectively. Finally, our “density” and “sedimentary” argument gives a new understanding of a socio-archeological view of sociomateriality (Carlile, 2015) to better methodologically orient researchers into digging deeper in the relational dynamics associated with the “strong program” of

practice-based approach (Nicolini, 2012). Altogether, this goes much further than our previous conceptual and practical understanding of openness as a way to expand innovation.

## References

- Arundel, A., Casali, L., & Hollanders, H. (2015). How European public sector agencies innovate: The use of bottom-up, policy-dependent and knowledge-scanning innovation methods. *Research Policy*, 44(7), 1271-1282.
- Ayerbe, C., Lazaric, N., Callois, M., & Mitkova, L. (2014). The new challenges of organizing intellectual property in complex industries: a discussion based on the case of Thales. *Technovation*, 34(4), 232-241.
- Baldwin, C., & Von Hippel, E. (2011). Modeling a paradigm shift: From producer innovation to user and open collaborative innovation. *Organization Science*, 22(6), 1399-1417.
- Barley, S. R., & Tolbert, P. S. (1997). Institutionalization and structuration: Studying the links between action and institution. *Organization studies*, 18(1), 93-117.
- Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of management*, 17(1), 99-120.
- Bechky, B. A. (2003). Sharing meaning across occupational communities: The transformation of understanding on a production floor. *Organization science*, 14(3), 312-330.
- Benkler, Y. (2006). *The wealth of networks: How social production transforms markets and freedom*. Yale University Press.
- Benner, M. J., & Tripsas, M. (2012). The influence of prior industry affiliation on framing in nascent industries: The evolution of digital cameras. *Strategic Management Journal*, 33(3), 277-302.
- Bogers, M., & West, J. (2012). Managing distributed innovation: Strategic utilization of open and user innovation. *Creativity and innovation management*, 21(1), 61-75.

- Boudreau, K. J., & Lakhani, K. R. (2015). "Open" disclosure of innovations, incentives and follow-on reuse: Theory on processes of cumulative innovation and a field experiment in computational biology. *Research Policy*, 44(1), 4-19.
- Bourdieu, P., & Wacquant, L. J. (1992). *An invitation to reflexive sociology*. Chicago, University of Chicago press.
- Brown, J. S., & Duguid, P. (2001). Knowledge and organization: A social-practice perspective. *Organization science*, 12(2), 198-213.
- Candelin-Palmqvist, H., Sandberg, B., & Mylly, U. M. (2012). Intellectual property rights in innovation management research: a review. *Technovation*, 32(9-10), 502-512.
- Carlile, P.R. (2002). A pragmatic view of knowledge and boundaries: Boundary objects in new product development. *Organization science*, 13(4), 442-455.
- Carlile, P.R. (2004). Transferring, translating, and transforming: An integrative framework for managing knowledge across boundaries. *Organization science*, 15(5), 555-568.
- Carlile, P.R. (2015). The Irony of Making Materiality of Consequence. *British Journal of Management*, 26, 22-25.
- Carlile, P. R., & Dionne, K. E. (2018). "Unconventional yet consequential" in Bryman, A., & Buchanan, D. A. (Eds.) *Unconventional Methodology in Organization and Management Research*. Oxford, Oxford University Press, p. 233-254.
- Unconventional Methodology in Organization and Management Research*, 233-254.
- Carlile, P.R., & Lakhani, K. (2011). Innovation and the challenge of novelty: The novelty-confirmation-transformation cycle in software and science. HBS Working Paper.
- Chesbrough, H., & Crowther, A. K. (2006). Beyond high tech: early adopters of open innovation in other industries. *R&d Management*, 36(3), 229-236.
- Chesbrough, H., Vanhaverbeke, W., & West, J. (Eds.). (2014). *New frontiers in open innovation*. Oup Oxford.



- Chesbrough, H. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston, MA: Harvard Business School Press.
- Chesbrough, H. (2003). The logic of open innovation: managing intellectual property. *California Management Review*, 33-58.
- Chesbrough, H. W. (2003). A better way to innovate. *Harvard business review*, 81(7), 12-3.
- Chesbrough, H. W. (2006). The era of open innovation. *Managing innovation and change*, 127(3), 34-41.
- Chesbrough, H. 2006b. Open innovation: A new paradigm for understanding industrial innovation. In H. Chesbrough, W. Vanhaverbeke, and J. West (Eds.), *Open Innovation: Researching a New Paradigm*: 1-12. Oxford:Oxford University Press.
- Cohendet, P., Farcot, M., & Pénin, J. (2006). Entre incitation et coordination: repenser le rôle économique du brevet d'invention dans une économie fondée sur la connaissance. *Management International*, 10, 65-84.
- Cohendet, P., Créplet, F., & Dupouët, O. (2003). Innovation organisationnelle, communautés de pratique et communautés épistémiques: le cas de Linux. *Revue française de gestion*, (5), 99-121.
- Colquitt, J. A., & George, G. (2011). Publishing in AMJ—part 1: topic choice. *Academy of Management Journal*, 54(3), 432-435.
- Dahlander, L., & Frederiksen, L. (2012). The core and cosmopolitans: A relational view of innovation in user communities. *Organization science*, 23(4), 988-1007.
- Dahlander, L., & Gann, D. M. (2010). How open is innovation? *Research policy*, 39(6), 699-709.
- Dahlander, L., & O'Mahony, S. (2011). Progressing to the center: Coordinating project work. *Organization Science*, 22(4), 961-979.
- Dahlander, L., & Frederiksen, L. (2012). The core and cosmopolitans: A relational view of innovation in user communities. *Organization Science*, 23(4), 988-1007.

- David, R. J., Sine, W. D., & Haveman, H. A. (2013). Seizing opportunity in emerging fields: How institutional entrepreneurs legitimated the professional form of management consulting. *Organization Science*, 24(2), 356-377.
- Davis, G. F., & Marquis, C. (2005). Prospects for organization theory in the early twenty-first century: Institutional fields and mechanisms. *Organization Science*, 16(4), 332-343.
- de Beer, J., McCarthy, I. P., Soliman, A., & Treen, E. (2017). Click here to agree: Managing intellectual property when crowdsourcing solutions. *Business Horizons*, 60(2), 207-217.
- Deken, F., Carlile, P. R., Berends, H., & Lauche, K. (2016). Generating novelty through interdependent routines: A process model of routine work. *Organization Science*, 27(3), 659-677.
- DiMaggio, P., & Powell, W. W. (1983). The iron cage revisited: Collective rationality and institutional isomorphism in organizational fields. *American Sociological Review*, 48(2), 147-160.
- Enkel, E., Gassmann, O., & Chesbrough, H. (2009). Open R&D and open innovation: exploring the phenomenon. *R&D Management*, 39(4), 311-316.
- Faraj, S., & Johnson, S. L. (2011). Network exchange patterns in online communities. *Organization Science*, 22(6), 1464-1480.
- Faraj, S., von Krogh, G., Monteiro, E., & Lakhani, K. R. (2016). Special Section Introduction—Online Community as Space for Knowledge Flows. *Information systems research*, 27(4), 668-684.
- Felin, T., & Zenger, T. R. (2014). Closed or open innovation? Problem solving and the governance choice. *Research Policy*, 43(5), 914-925.
- Fleming, L., & Waguespack, D. M. (2007). Brokerage, boundary spanning, and leadership in open innovation communities. *Organization Science*, 18(2), 165-180.
- Fligstein, N. (1997). Social skill and institutional theory. *American Behavioral Scientist*, 40(4), 397-405.

- Franke, N., & Shah, S. (2003). How communities support innovative activities: an exploration of assistance and sharing among end-users. *Research Policy*, 32(1), 157-178.
- Furnari, S. (2016). Institutional fields as linked arenas: Inter-field resource dependence, institutional work and institutional change. *Human Relations*, 69(3), 551-580.
- Garud, R. (2008). Conferences as venues for the configuration of emerging organizational fields: The case of cochlear implants. *Journal of Management Studies*, 45(6), 1061-1088.
- Gassmann, O. and Enkel, E. (2004) Towards a theory of open innovation: three core process archetypes. Proceedings of The R&D Management Conference, Lisbon, Portugal, July 6–9.
- Goes, J. B., & Park, S. H. (1997). Interorganizational links and innovation: The case of hospital services. *Academy of Management Journal*, 40(3), 673-696.
- Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic management journal*, 17(S2), 109-122.
- Grodal, S. (2018). Field expansion and contraction: How communities shape social and symbolic boundaries. *Administrative Science Quarterly*, 63(4), 783-818.
- Hanel, P. (2006). Intellectual property rights business management practices: A survey of the literature. *Technovation*, 26(8), 895-931.
- Hardy, C., Lawrence, T. B., & Grant, D. (2005). Discourse and collaboration: The role of conversations and collective identity. *Academy of management review*, 30(1), 58-77.
- Hart, S. L., & Dowell, G. (2011). Invited editorial: a natural-resource-based view of the firm: fifteen years after. *Journal of management*, 37(5), 1464-1479.
- Henkel, J., Schöberl, S., & Alexy, O. (2014). The emergence of openness: How and why firms adopt selective revealing in open innovation. *Research Policy*, 43(5), 879-890.
- Hertzfeld, H. R., Link, A. N., & Vonortas, N. S. (2006). Intellectual property protection mechanisms in research partnerships. *Research Policy*, 35(6), 825-838.



- Hienert, C., Keinz, P., & Lettl, C. (2011). Exploring the nature and implementation process of user-centric business models. *Long Range Planning*, 44(5-6), 344-374.
- Hoffman, A. J. (1999). Institutional evolution and change: Environmentalism and the US chemical industry. *Academy of management journal*, 42(4), 351-371.
- Howard-Grenville, J., Buckle, S. J., Hoskins, B. J., & George, G. (2014). Climate change and management.
- Kenis, P., & Knoke, D. (2002). How organizational field networks shape interorganizational tie-formation rates. *Academy of Management Review*, 27(2), 275-293.
- Kimble, C., Grenier, C., & Goglio-Primard, K. (2010). Innovation and knowledge sharing across professional boundaries: Political interplay between boundary objects and brokers. *International Journal of Information Management*, 30(5), 437-444.
- Kulik, C., Ryan, S., Harper, S., & George, G. (2014). aging populations and management. *Academy of Management Journal*, 57(4), 929-935.
- Lakhani, K. R., Lifshitz-Assaf, H., & Tushman, M. (2013). Open innovation and organizational boundaries: task decomposition, knowledge distribution and the locus of innovation. *Handbook of economic organization: Integrating economic and organizational theory*, 355-382.
- Lakhani, K. R., & Von Hippel, E. (2004). How open source software works: “free” user-to-user assistance. In *Produktentwicklung mit virtuellen Communities* (pp. 303-339). Gabler Verlag.
- Lampel, J., & Meyer, A. D. (2008). Guest Editors’ Introduction: Field-Configuring Events as Structuring Mechanisms: How Conferences, Ceremonies, and Trade Shows Constitute New Technologies, Industries, and Markets. *Journal of Management Studies*, 45(6), 1025-1035.
- Lawrence, T. B., Phillips, N., & Hardy, C. (1999). Watching whale watching: Exploring the discursive foundations of collaborative relationships. *The Journal of Applied Behavioral Science*, 35(4), 479-502.

- Lawrence, T. B., Hardy, C., & Phillips, N. (2002). Institutional effects of interorganizational collaboration: The emergence of proto-institutions. *Academy of management journal*, 45(1), 281-290.
- Levina, N., & Orlikowski, W. J. (2009). Understanding shifting power relations within and across organizations: A critical genre analysis. *Academy of Management Journal*, 52(4), 672-703.
- Manzini, R., & Lazzarotti, V. (2016). Intellectual property protection mechanisms in collaborative new product development. *R&D Management*, 46(S2), 579-595.
- Marchington, M., & Vincent, S. (2004). Analysing the influence of institutional, organizational and interpersonal forces in shaping inter-organizational relations. *Journal of Management Studies*, 41(6), 1029-1056.
- Mehlman, S. K., Uribe-Saucedo, S., Taylor, R. P., Slowinski, G., Carreras, E., & Arena, C. (2010). Better practices for managing intellectual assets in collaborations. *Research-Technology Management*, 53(1), 55-66.
- Mergel, I. (2017). Building holistic evidence for social media impact. *Public Administration Review*, 77(4), 489-495.
- Meyer, A. D., Gaba, V., & Colwell, K. A. (2005). Organizing far from equilibrium: Nonlinear change in organizational fields. *Organization Science*, 16(5), 456-473.
- Murray, F. (2010). The oncomouse that roared: Hybrid exchange strategies as a source of distinction at the boundary of overlapping institutions. *American Journal of sociology*, 116(2), 341-388.
- Murray, F., & O'Mahony, S. (2007). Exploring the foundations of cumulative innovation: Implications for organization science. *Organization Science*, 18(6), 1006-1021.
- Nicolini, D. (2012). *Practice theory, work, and organization: An introduction*. Oxford. Oxford University Press.
- Nicolini, D. (2017). Practice theory as a package of theory, method and vocabulary: Affordances and limitations. In *Methodological reflections on practice oriented theories*

(pp. 19-34). Springer, Cham.

O'Mahony, S. (2007). The governance of open source initiatives: what does it mean to be community managed? *Journal of Management & Governance*, 11(2), 139-150.

O'Mahony, S., & Bechky, B. A. (2008). Boundary organizations: Enabling collaboration among unexpected allies. *Administrative science quarterly*, 53(3), 422-459.

O'Mahony, S., & Ferraro, F. (2007). The emergence of governance in an open source community. *Academy of Management Journal*, 50(5), 1079-1106.

O'Mahony, S., & Lakhani, K. R. (2011). Organizations in the shadow of communities. In *Communities and organizations* (pp. 3-36). Emerald Group Publishing Limited.

Oliver, C. (1990). Determinants of interorganizational relationships: Integration and future directions. *Academy of management review*, 15(2), 241-265.

Olsen, A. Ø., Sofka, W., & Grimpe, C. (2016). Coordinated exploration for grand challenges: The role of advocacy groups in search consortia. *Academy of Management Journal*, 59(6), 2232-2255.

Osborn, R. N., & Hagedoorn, J. (1997). The institutionalization and evolutionary dynamics of interorganizational alliances and networks. *Academy of Management Journal*, 40(2), 261-278.

Østerlund, C., & Carlile, P. (2005). Relations in practice: Sorting through practice theories on knowledge sharing in complex organizations. *The Information Society*, 21(2), 91-107.

Paasi, J., Luoma, T., Valkokari, K., & Lee, N. (2010). Knowledge and intellectual property management in customer-supplier relationships. *International Journal of Innovation Management*, 14(04), 629-654.

Phillips, N., Lawrence, T. B., & Hardy, C. (2000). Inter-organizational collaboration and the dynamics of institutional fields. *Journal of management studies*, 37(1), 23-43.

Piller, F., & West, J. (2014). Firms, users, and innovation. *New frontiers in open innovation*, 29(1).



- Powell, W. W., & Sandholtz, K. W. (2012). Amphibious entrepreneurs and the emergence of organizational forms. *Strategic Entrepreneurship Journal*, 6(2), 94-115.
- Powell, W. W., Koput, K. W., & Smith-Doerr, L. (1996). Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. *Administrative science quarterly*, 116-145.
- Powell, W. W., White, D. R., Koput, K. W., & Owen-Smith, J. (2005). Network dynamics and field evolution: The growth of interorganizational collaboration in the life sciences. *American journal of sociology*, 110(4), 1132-1205.
- Powell, W. W. (1998). Learning from collaboration: Knowledge and networks in the biotechnology and pharmaceutical industries. *California management review*, 40(3), 228-240.
- Puranam, P., Alexy, O., & Reitzig, M. (2014). What's "new" about new forms of organizing?. *Academy of Management Review*, 39(2), 162-180.
- Rhoten, D., & Powell, W. W. (2007). The frontiers of intellectual property: Expanded protection versus new models of open science. *Annual Review of Law and Social Science*, 3, 345-373.
- Rosenkopf, L., & Nerkar, A. (2001). Beyond local search: boundary-spanning, exploration, and impact in the optical disk industry. *Strategic Management Journal*, 22(4), 287-306.
- Saebi, T., & Foss, N. J. (2015). Business models for open innovation: Matching heterogeneous open innovation strategies with business model dimensions. *European Management Journal*, 33(3), 201-213.
- Scott, W. R. 2001. *Institutions and organizations* (2nd ed.). Thousand Oaks, CA: Sage.
- Scott, W. R. 1995. *Institutions and organizations*. Thousand Oaks, CA: Sage.
- Schatzki, T. R. (2012). A primer on practices. In *Practice-based education* (pp. 13-26). SensePublishers, Rotterdam.
- Shah, S. K. (2006). Motivation, governance, and the viability of hybrid forms in open

source software development. *Management science*, 52(7), 1000-1014.

Sharfman, M. P., Gray, B., & Yan, A. (1991). The context of interorganizational collaboration in the garment industry: An institutional perspective. *The Journal of applied behavioral science*, 27(2), 181-208.

Slowinski, G., Hummel, E., Gupta, A., & Gilmont, E. R. (2009). Effective practices for sourcing innovation. *Research-Technology Management*, 52(1), 27-34.

Somaya, D., Kim, Y., & Vonortas, N. S. (2011). Exclusivity in licensing alliances: using hostages to support technology commercialization. *Strategic Management Journal*, 32(2), 159-186.

Star, S. L., & Griesemer, J. R. (1989). Institutional ecology, translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social studies of science*, 19(3), 387-420.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic management journal*, 18(7), 509-533.

Teece, D. J. (1998). Capturing value from knowledge assets: The new economy, markets for know-how, and intangible assets. *California management review*, 40(3), 55-79.

Tucci, C. L., Chesbrough, H., Piller, F., & West, J. (2016). When do firms undertake open, collaborative activities? Introduction to the special section on open innovation and open business models. *Industrial and Corporate Change*, 25(2), 283-288.

Vanhaverbeke, W. (2006). The interorganizational context of open innovation. *Open innovation: Researching a new paradigm*, 205-219.

Hippel, E. V., & Krogh, G. V. (2003). Open source software and the "private-collective" innovation model: Issues for organization science. *Organization science*, 14(2), 209-223.

Von Krogh, G., & Von Hippel, E. (2006). The promise of research on open source software. *Management science*, 52(7), 975-983.

- Von Hippel, E., & Von Krogh, G. (2006). Free revealing and the private-collective model for innovation incentives. *R&D Management*, 36(3), 295-306.
- Von Hippel, E. (1986). Lead users: a source of novel product concepts. *Management science*, 32(7), 791-805.
- Von Hippel, E. (2002). Open source projects as horizontal innovation networks-by and for users.
- Von Hippel, E. (2005). *Democratizing innovation*. MIT press.
- Von Krogh, G., & Von Hippel, E. (2003). Special issue on open source software development.
- Von Krogh, G., Spaeth, S., & Lakhani, K. R. (2003). Community, joining, and specialization in open source software innovation: a case study. *Research policy*, 32(7), 1217-1241.
- West, J., & Bogers, M. (2014). Leveraging external sources of innovation: a review of research on open innovation. *Journal of Product Innovation Management*, 31(4), 814-831.
- West, J., & Gallagher, S. (2006). Challenges of open innovation: the paradox of firm investment in open-source software. *R&d Management*, 36(3), 319-331.
- Wood, D. J., & Gray, B. (1991). Toward a comprehensive theory of collaboration. *The Journal of Applied Behavioral Science*, 27(2), 139-162.
- Wooten, M., & Hoffman, A. J. (2008). Organizational fields: Past, present and future. *The Sage handbook of organizational institutionalism*, 1, 131-147.
- Zaheer, A., Gözübüyük, R., & Milanov, H. (2010). It's the connections: The network perspective in interorganizational research. *Academy of Management Perspectives*, 24(1), 62-77.
- Zietsma, C., & Lawrence, T. B. (2010). Institutional work in the transformation of an organizational field: The interplay of boundary work and practice work. *Administrative science quarterly*, 55(2), 189-221.



Zietsma, C., Groenewegen, P., Logue, D. M., & Hinings, C. R. (2017). Field or fields? Building the scaffolding for cumulation of research on institutional fields. *Academy of Management Annals*, 11(1), 391-450.

## CHAPTER THREE

### **The sequencing of Field-configuring events in the emergence of the field of digital health: Collecting different resources trajectories**

**Karl-Emanuel Dionne**

**Paul R. Carlile**

#### **Abstract**

*Field configuring events (FCE) play a powerful role in the construction and configuration of fields. To be clearer about their role, in this research we describe how events transform existing resources and practices from different fields and develop new ones that lead to the emergence of a new field. Our research focuses on Hacking Health (HH), a non-profit organization that created a series of events informed by open innovation approaches to generate the flow of resources and knowledge to help create digital health projects in Montreal. Using a 42-month qualitative study, we examined a variety of events, such as hackathons, cafés, workshops and bootcamps, to observe how HH eventually developed these different types of events to address a lack of progress in generating and sustaining digital health projects. We found that the sequencing of these different types of events addressed the distributed, distanced and dedicated nature of the trajectories of resources that need to be accumulated from actors across existing fields. This longitudinal view of how a sequence of events addressed these three relational dimensions of resource accumulation allows us to better conceptualize what is involved in field emergence.*

**Keywords:** Field emergence, Field-configuring event, Open innovation, Hackathon, Longitudinal research, Accumulation of knowledge, Resource trajectories.

### 3.1 Introduction

Knowledge and resources are the lifeblood of innovation whether than be in an organization or in the development of a new organization or industry. The processes of creating, gathering and accumulating resources within organizations and communities as been well documented, but much less is known about the longitudinal processes of developing a new field for an industry to emerge (De Santos and Eisenhardt, 2009; David et al., 2013; Zietsma et al., 2017). Key events have been shown to play a powerful role in the process of configuration of existing fields (Anand and Watson, 2004). Meyer et al. (2005) framed these events as field-configuring events (FCE) and defined them as “temporary social organizations such as tradeshow, professional gatherings, technology contests, and business ceremonies that encapsulate and shape the development of professions, technologies, markets, and industries.” Lampel and Meyer (2008) view FCE as a concept that helps link both analytically and empirically the discontinuous and localized processes of field configuration.

The concept of FCE has been developed primarily through institutional theory’s definition of fields as “organizations that, in the aggregate, constitute a recognized area of institutional life” (DiMaggio and Powell, 1983) and “that partakes of a common meaning system and whose participants interact more frequently and fatefully with one another than with actors outside of the field” (Scott, 1994). However, Garud (2008) has argued that these definitions of fields are based on observations of already interconnected organizations with shared and stable practices and meaning, leading scholars to empirically examine the dynamics within existing fields (Hardy and Maguire, 2010) and leaving relatively unexplored the deeper processes associated with the emergence of a new field. The empirical challenges of studying nascent and emergent phenomena are well known (Lewin and Volberda, 1999), so it is not surprising that FCE scholars have generally focused on single existing fields and on the impact of one type of event such as conferences (e.g. Zilber, 2011) and other highly structured events (e.g. Hardy and Maguire, 2010; Schussler et al., 2014).



To address this empirical challenge of the role of FCEs in new field emergence, we conducted a 42-month study – from December 2013 to July 2017 – of the emerging field of digital health in Montreal. This nascent field was developed at the intersection of the existing fields of digital technologies and health. Over this period we focused on Hacking Health (HH) a non-profit organization that used open innovation events to stimulate digital health projects and startups. Over time HH improved its approach, from organizing a single hackathon event once a year to building a coherent sequence of different types of events to better generate and sustain digital health projects. Participant observation techniques were used to examine events, such as *hackathons* (3 cases), *cafés* (10 cases), *workshops* (7 cases) and *bootcamps* (2 cases). We tracked the actors involved and the resources they deployed through these different types of events and how as FCEs they were contributing in different ways to the accumulation of resources necessary to drive the emergence of a field of digital health. By resources we broadly include the personal (knowledge and time), social (relations and connections) and financial capital that actors bring to bear to produce an outcome.

Open and distributed innovation approaches seek to develop new connections to increase the amount of knowledge and resources that can be exchanged to produce innovation across disciplinary and organizational boundaries (Chesbrough, 2003; von Hippel, 2005; Dionne and Carlile, forthcoming). Events such as innovation contests (Boudreau et al., 2011), design competitions (Lampel et al., 2012) and hackathons (Lifshitz-Assaf, 2018), are creating new opportunities for actors from different organizations, domains and fields to create new combinations that generate novel solutions in existing and emerging fields. Our research examines the consequential role HH's events played in transforming existing practices and developing new ones that bring a greater variety of actors and resources from across fields to create novel approaches. In this paper we explore *how different types of field-configuring events and their sequence contribute to the process of field emergence taking place across existing fields?*

From this study we propose a framework built on Bourdieu's concept of trajectories (Bourdieu and Wacquant, 1992) to more adequately explain the relational dynamics that

must be addressed through this series of events to accumulate adequate resources from multiple existing fields to drive the emergence of a new field. Our framework suggests three dimensions that make up these relational dynamics that impact the accumulation of resources. First, the needed resources that must be gathered are *distributed* in distinct trajectories across different departments, organizations, communities and fields. Second, those distinct trajectories can be more or less similar in terms of their specialization and interests, and so are relatively *distanced* and must be bridged. Third, given the time and effort actors invest to develop and acquire those resources (Bourdieu, 1985; Carlile, 2002), their trajectory is *dedicated* to a particular direction that must become collectively oriented in a new direction. These three dimensions define the relational dynamics that must be addressed to accumulate the necessary resources to develop sustainable projects in digital health.

This longitudinal study significantly improves our understanding of the role that FCEs play in the configuration of an emerging field. First, using the concept of trajectory helped us better understand the relational dynamics of resource accumulation and the process of field emergence. Second, by building on this, we were able to account for different types of FCE and their outcomes to propose a more conceptualized and prescriptive account of FCE. Finally, our longitudinal analysis has allowed us to track the accumulation of resources across a sequence of different types of events, and then, to understand their cumulative impact on field emergence. Changing the processes and practices used to manage the relational dynamics (Deken et al., 2016) among actors is essential to developing new connections among the requisite variety of resources to generate and sustain field emergence.

### **3.2 Theoretical Background : Field-Configuring Events for Innovation**

In this literature review we outline three conceptual moves that expand the use of the FCEs approach to understand how resources are accumulated from different existing fields for a new field to emerge. First, we need to move from within field interactions to across fields interactions. This shifts the conceptual and empirical focus on the role of FCEs in gathering resources from different existing fields (e.g. Powell and Sandholtz,



2012; Grodal et al., 2015). Second, increasing variety of actors and creating connections across them requires more work to generate shared approaches for a new field to emerge from different existing fields. We argue for a longitudinal approach that takes into consideration the interactions among actors occurring in each FCE, but also accounts for the sequencing of different types of FCEs and their cumulative impact on field emergence. While some scholars have begun focusing on series of events, we suggest a turn towards considering the sequencing of different types of FCEs arranged in a specific order. Third, we propose to open up the conversation of FCEs to include a greater variety of types of events. Rather than focusing on event formats such as conferences and trade shows that characterize existing fields, we look into research that studied open innovation events for their problem-solving potential but that has yet to focus on their field configuring capacity. We consider open innovation events as fertile ground for new connections among actors and resources, and the creation of innovative outcomes that propel the emergence of a new field.

### ***3.2.1 Field-Configuring Events: From Within Single Existing Fields to Across***

The concept of Field-configuring events (FCEs) has attracted attention in organization studies, especially in fields looking to increase their innovation capabilities. Most research on FCEs comes from institutional theories, and more specifically is based on the concept of organizational field. The generally accepted definition of field is “those organizations that, in the aggregate, constitute a recognized area of institutional life: key suppliers, resource and product consumers, regulatory agencies, and other organizations that produce similar services or products” (DiMaggio and Powell, 1983, p. 148). Fields are formed around “a community of organizations that partakes of a common meaning system and whose participants interact more frequently and fatefully with one another than with actors outside of the field” (Scott, 1994: 207–208).

These definitions of field have oriented FCEs scholars to focus on “well-formed” organizational fields as empirical entities encompassing a set of existing organizations. Empirically, this explains why they have observed a limited variety of types of events in a single and already “existing” field. Most empirical settings upon which the FCE



literature was developed involve conferences, trade fairs, award shows and other highly institutionalized “mega-event” formats, such as the Grammy Awards (e.g. Anand and Watson, 2004; Schussler et al., 2014). Powell and Jansson (2008) focused on the outcomes of trade fairs in the furniture industry showing how they generated business relations and new exchanges between actors who would not have interacted otherwise in their usual daily activities. This reveals the potential of events in gathering and connecting a greater variety of actors and resources for members of a field.

Hardy and Maguire (2010) studied the United Nations conference leading to the Stockholm Convention on Persistent Organic Pollutants. They suggested that FCEs can “have a significant impact on the regulation of organizational activities by creating or altering rules and laws that proscribe or prescribe particular practices, establish membership eligibility, or specify reporting requirements.” They argue that by providing discursive spaces to create, diffuse and stabilize new narratives in the field, FCEs can contribute to generating coherence by rejecting activities that can be harmful to a field’s evolution and by promoting other activities so that they become shared among a diversity of field actors. In that regard, Zilber (2011) studied tech conferences among the Israeli startups field and revealed how field configuration practices could support or hinder the maintenance of different institutional logics to benefit from their generative intersection for the creation of new products and ventures. She highlighted, for example, that plenary activities within tech conferences “reflected the interests of the VCs and service providers [while], parallel activities, which focus on managerial problems and suggested solutions, configured the field in a more balanced way, allowing the VCs, entrepreneurs, and service providers to engage in a direct dialogue about their mutual interests.” This suggests that the way events are structured has an impact on how a field gets reconfigured in terms of the types of actors’ orientation took into consideration and how they interact to build on their respective interests.

Thiel and Grabher (2015) focused on the cross-field impact of the single, yet major event of the London Olympic Games that for a limited time made connection across a set of fields. In particular, they showed that every Olympic Games participant’s practices, from sports competitors to event organizers, are appraised from good to bad

based on criteria related to their respective fields. This appraisal has the potential to reconfigure each field's practices by changing and stabilizing the methods, tools and approaches that proved effective for the event. However, like most of the literature on FCEs, their empirical approach focused on the impact of a single short-term and large-scale event that can't create the required coherence to generate lasting intersections across these different fields.

### ***3.2.2 Sequencing Different Types of Events for Field Emergence***

Recent research has begun looking at the capacity of series of FCEs to transform loose networks, and sometimes unconnected actors, into a coherent field with shared vision (McInerney, 2008; Zilber, 2007) by providing a context and methods that facilitates converging multiple perspectives (Nissila et al., 2014). Garud (2008) described, through the analysis of three successive conferences on the development and commercialization of cochlear implants, the process of creating associations between a variety of actors (human and non-human) to build technological paths and developing shared standards that helped structure this emerging field. He has used a sociology of associations perspective that focused on activities related to field pre-formation processes to show that conferences are episodes that can entangle and guide actors from multiple worlds and with distinctive perspectives towards a shared process of field emergence by amplifying specific resources, standards and practices while diminishing others.

Schussler et al. (2014) highlighted variations in event structures, processes, and outcomes when studying the conference of parties (COP) series of events. Their study showed the impact of "regular" and "high-stakes" events. The former type of events provided more opportunities for participants to connect and share knowledge and resources ("interactional openness") while the latter stimulated a sense of urgency ("temporal boundedness"), pushing participants to converge around shared methods, standards and rules. According to these authors, "in the early phases of field development, the interaction of regular and high-stakes events facilitated institutional change by allowing for both trust building and momentum creation (Schussler et al., 2014)." They have, however, shown that the progressive introduction of new



participants with greater relative distance between their interests and that of the earliest participants shifted the role of FCEs from “catalysts of change” to “mechanisms of field maintenance” (Schussler et al., 2014). Participants with similar orientations would more naturally come together, therefore hindering events’ capacity to generate organic interactions across differences. So in addition to event format, who participates and the distance between their interests also explains why, in the end, these events have not led to transformations of practices and effective solutions to combat human-induced global warming.

However, it is recognized that more work is needed to understand the accumulative effects between different types of FCEs (Liao, 2016), which is essential to create coherence between distanced actors to drive the longitudinal processes of field emergence. Nissila et al. (2014) focused on the expectation work occurring in FCEs during the construction of the solar technology field across multiple years and events (conferences and workshops). They point to the importance of multiplying event topics in order to diversify the types of contributors and their resources and increase networking opportunities between these various actors by gradually including their different narratives during field formation. They argue that this process can engage a variety of actors’ interests in the field. However, they did not examine how different types of events align actors’ sometimes-diverging interests.

Liao (2016) studied the processes of associations and continuous negotiations occurring between different communities’ visions during conferences and standard meetings in the emerging field of Augmented Reality (AR). He focused on the process of defining the organizing vision - or the focal idea for the application of technologies - of AR and on the impact of such definitions on the boundaries and the configuration of the field. These boundaries shape who participates, how they participate (Liao, 2016) and the resources accumulated during field emergence. Liao highlighted actors’ underlying interests in defining the organizing vision of AR to reconstitute the field in a specific form in order to shift actors’ positions to their advantage. According to Liao (2016), the way these relationships and definitions get “jelled” has a profound impact on the further development of emerging technologies within the field.



This focus on a series of events highlights the challenges of gradually gathering new resources and aligning actors' differences for a field to emerge. However, we still lack a clear understanding of how these series of events are combined to create an effective sequence helping accumulate resources and sustain field emergence. Most research on FCEs has been built on retrospective reports within single fields and events, while the minority of scholars who have used ethnographic data to study FCEs have done so at a specific point in time, which only allows to observe snapshots of field emergence during these specific events (e.g. Zilber, 2011). These empirical considerations explain why these researches can't account for the particular order in which events follow each other and understand the impact of such sequencing on field emergence. Multiple scholars have therefore called for more studies built on longitudinal and ethnographical data in newly emerging fields (Chiles et al., 2004; Zilber, 2011; David et al., 2013; Liao, 2016). Such methodological approach is essential to fully appreciate the progressive evolution of series of events into an effective sequence that deal with the difficult challenge of gathering resources from different existing fields, create coherence between different perspectives, negotiate differences in orientations and sustain field emergence.

In addition, despite the recent focus on series of events, scholars are still studying events characterizing already emerged fields - such as conferences - rather than looking into other episodes and events that are more characteristic of emergence. As Cohendet et al. (2013) pointed out, these conferences usually center on a specific domain of professional or scientific activity with specialized experts that have similar social positions. Furnari's (2014) research outlines spaces of interactions "occurring between different fields rather than within an organization." These "interstitial spaces", such as "small clubs and informal gatherings (such as the Homebrew Computer Club)," allow for experimenting with new activities and ideas, generating the seeds for new fields to emerge. We therefore need to open up our empirical stories to observe the breaches that are created to gather new actors (with their resources) from different existing fields, and to transform their existing resources and practices.

### ***3.2.3 Open Innovation Events: Creating New Openings for Field Emergence***

Open innovation events are interesting contexts to look at attempts to gather a variety of actors and resources and deal with across field dynamics to generate new technologies and spark field emergence. Events such as innovation contests (Boudreau, Lacetera and Lakhani, 2011), design competitions (Lampel et al., 2012) and hackathons (Briscoe, 2014) are designed to attract a greater variety of actors to a specific existing field (i.e., space exploration, music, and health). These actors bring their respective resources, expertise and methods to this field to develop innovative solutions (e.g. Terwiesch and Ulrich, 2009; Boudreau et al., 2011; Bullinger et al., 2010; Almirall et al., 2014; Briscoe, 2014). Despite their potential for gathering resources and experimenting with new combinations of ideas and knowledge, the OI literature has yet to account for the field-configuring capacity of these events.

Jeppesen and Lakhani's (2010) research on innovation contests in different scientific fields showed that these events have the capacity to remove barriers of entry into a field (Jeppesen and Lakhani, 2010; Lifshitz-Assaf, 2018) to reach actors who are distant from the focal field and access their novel knowledge and approaches. They showed that "the provision of a winning solution [in an innovation contest] was positively related to increasing distance between the solver's field of technical expertise and the focal field of the problem" (Jeppesen and Lakhani, 2010).

However, Angelidis et al. (2016) observations of hackathons in health showed that the challenge of gathering sufficient resources is not only in accessing distant actors and their alternative resources, but also lies in bridging the right set of actors. For example, their analysis of a Colombian hackathon highlighted that the lack of healthcare providers was detrimental to reaching innovative outcomes. This suggests that additional work is needed to carefully curate the amount and types of resources to be fed in these innovation contests. To benefit from this increasing variety, events should also provide the means to deal with actors' differences in terms of language, methods and interests. For example, guidelines, design tools and programming toolkits have been shown to be helpful in generating innovative outcomes in innovation contests and hackathons (King



and Lakhani, 2013; Briscoe, 2014; Angelidis et al., 2016). These methods allow actors to adapt their activities to other actors' practices to better collaborate with them despite their differences. In that regard, Angelidis et al. (2016) presented a program of successive events where coders and engineers were introduced to the technical and clinical perspectives related to health in order to better work with clinicians in designing digital health solutions in the following hackathon. This helped technologists in understanding the challenges of innovating in digital health and the practices needed to overcome such challenges.

However, Almirall et al. (2014) observed how difficult it was to deal with actors' differences in regard to their interests and existing commitments. They presented the mismatch between some government departments' commitment to specific shared practices that have been leading to "guaranteed results" for decades and the competing interests of other employees who were getting rewarded for taking risks and changing existing activities. Other situations, such as scientific problem-solving, also showed how incentives in existing fields were driving actors toward mobilizing specific practices that can limit the capacity of events to access resources for projects outside actors' orientation (Lakhani et al., 2010).

Most open innovation events are contest-based and designed to foster contributions from a variety of actors in spite of actors' commitments to other paths of activities. With their prize systems, these events can funnel actors' interests towards the focal area's specific needs and challenges (Bullinger et al., 2010; Lakhani et al., 2010; Murray et al., 2012; Johnson et al., 2014). Furthermore, Lampel et al. (2012) studied a design competition and showed that, with the resources they provide, their sets of rules, their evaluation criteria and their embedded standards, design competitions could structure the development of practices in line with a specific orientation. For example, the Ansari X Prize aligned innovators towards a specific business orientation for their projects to gather the required resources.

Where most research on open innovation has shown that key events and their structures can align a variety of resources, expertise and methods to develop innovative solutions,



a perspective acknowledging the ordering of a set of different events and their cumulative field-configuring capacity might also reveal that they can shape actors, their knowledge and resources. Lifshitz-Assaf (2018) started considering this when she looked at how a new open innovation strategy at NASA using crowdsourcing and hackathon events to develop new solutions actually reconfigured NASA researchers' professional boundaries. Yet, the open innovation literature, by focusing mostly on specific key events like hackathons, innovation contests and design competitions, has not unpacked the upfront efforts of identifying and gathering resources and the additional work of sustaining the outcomes produced by these events that could result in the construction of an emerging field.

### **3.3 A Framework of Relational Dynamics of Field Emergence : The Three D's**

Since this paper aims at deepening our understanding of how FCEs support the accumulation of resources in the development of a new field we turn to Bourdieu to get a deeper understanding of what produces field dynamics. While most research on FCEs has been built on institutional theory's definition of fields that emphasizes stable and mature relations between organizations (Zilber, 2014), Bourdieu's conceptualization of field focuses on the competition that stems from the limited resources individual actors build upon to position themselves in relation to others. For Bourdieu a field is "a configuration, of objective relations between positions" (Bourdieu and Wacquant, 1992: 97) with its own "feel for the game" that orient actors towards specific activities to improve their accumulation of resources and positioning (Bourdieu 1977). Fields are conceived as hierarchical spaces with asynchrony of resources where field participants are in a constant struggle to secure and improve upon their social position through the accumulation of the resources that give them the capacity to act. Bourdieu's perspective helps focus on individual actors' constant struggles, movements and accumulation of resources. It also offers a conceptual apparatus to see how fields are constructed around specific "rules of the games" that orient actors' practices while allowing to understand how actors' accumulation of resources can continuously generate new rules. This is certainly the context of digital health as actors try to create projects and drive innovation

that potentially takes them outside of their existing field and organizational context. Bourdieu's perspective therefore offers the conceptual framework to dynamically track the concrete role FCEs play in generating and supporting actors' repositioning through the accumulation of resources, which has an impact on the evolution and the reconfiguration of the field.

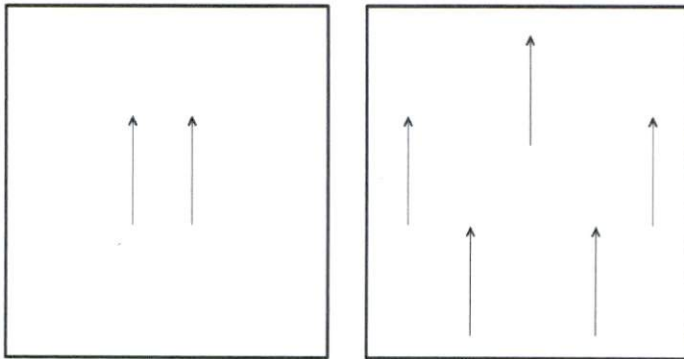
Framing actors positions and repositioning as central to the configuration of existing fields and the construction of a new field helps us better define and then operationalize the process of how actors accumulate resources and the overall process of how a number of actors collectively accumulate an adequate variety of resources to sustain the development of a new field. To give full expression of how actors accumulate resources as they position and reposition themselves we refer to Bourdieu's idea of trajectory that helps us engage with the process of how resources are structured in social spaces. A trajectory is a spatio temporal concept that traces and represents an actor's series of positions and repositioning as they seek to accumulate resources in relation to other actors as they move within and across existing fields (Bourdieu 1979; Wacquant and Bourdieu, 1989).

The idea of a trajectory is both actor centric in terms of the positions and repositioning of actors, yet it is also structural in that such positions and repositioning to accumulate resources can only happen in relation to other actors through shared practices. To clarify the structural consequences of trajectories we describe them in three dimensions and by doing so we explain what must be addressed for a number of actors to identify, gather, transform and sustain a variety of resources from across such different contexts and fields in order to drive field emergence. The three dimensions are as follows: first, resource trajectories are *distributed*; second, some resource trajectories are more *distanced* relative to each other than others; third, resource trajectories are *dedicated* to a particular direction or orientation. These three dimensions help outline the relational dynamics that must be addressed to develop a collective trajectory at the intersection of different individual trajectories as they move both within and across fields.

### 3.3.1 Distributed

First, actors' trajectories are spatially *distributed* within and across different fields. The challenge when dealing with field issues – compared for example to organizational issues - is that the amount of distribution to take into account is greater since it involves a greater variety and location of actors' trajectories. These trajectories can be distributed across different organizations, disciplines, communities and industries based on where those resources are developed (Bourdieu, 1990) making it hard to assemble the needed variety of actors and their resources for a field to emerge. For example, nurses and doctors are distributed in different departments in the same organization whereas coders and venture capitalists are distributed in different organizations. The difficulty of managing this distributed challenge is in identifying the needed resources and in what trajectories they are active in order to gather and bridge them with trajectories from other fields.

**Figure E: Trajectories as Distributed**



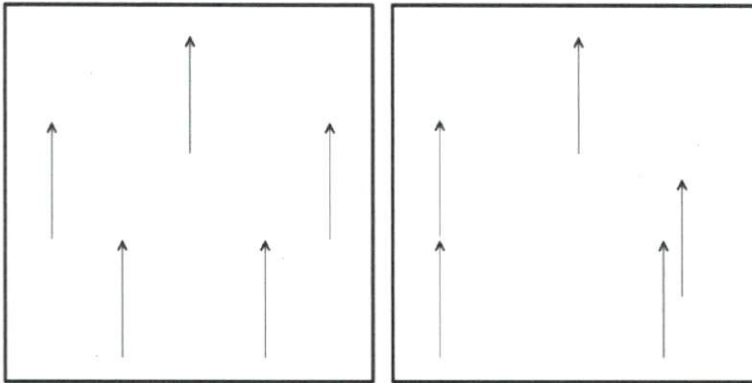
### 3.3.2 Distanced

Second these distributed trajectories have a relative distance with each other in terms of their language, methods and interests (Levina and Arriaga, 2014). So, actors' resource trajectories are *distanced* one from another in different or relative ways. For example, Edmonson and Harvey (2017) argued that the relative distance between engineers and programmers' practices is smaller and so easier to address than the distance between engineers and social workers. Actors develop preferences to specific objects, methods and practices suitable to their trajectories and that of actors on less distanced trajectories,



but also an aversion and lack of understanding towards the preferred objects and practices of actors engaged on more distanced trajectories (Bourdieu, 1979; 1987). Relative distance therefore is highly consequential in processes of association and collaboration (Bourdieu, 1985) and, by extension, to the amount of effort required to bridge different actors' trajectories.

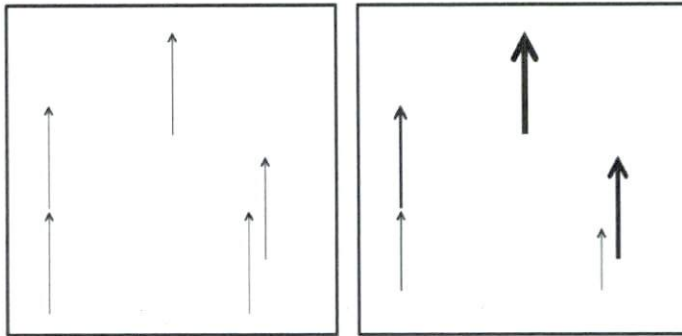
**Figure F: Trajectories as Distanced**



### 3.3.3 *Dedicated*

The third dimension recognizes that cumulative experiences, in time and effort, means that actors are committed to how they acquire resources and so are *dedicated* to the future orientation of their trajectory. Actors are dedicated to a set of practices, the validity of its rules, what is at stake and the desirability of their outcomes (Bourdieu and Wacquant, 1992). This is experienced in actors' daily interaction as an unconscious recognition that the accumulation of resources, and what is of value is attainable through a specific trajectory that they know. For example, a long-term physician-researcher will find it difficult to change her focus from publishing academic research to using language that frames the commercial value of her work in a way that venture capitalists can both understand and value. This creates systemic obstacles for actors to change their trajectories and commit their actions and resources to other fields and the orientation of trajectories of resources being developed there. In that sense, the two previous dynamics of distributed and distanced generate consequences for collaboration: trajectories can be hard to change since they are “paid for in work, in efforts and above all in time (moving up means raising oneself, climbing, and acquiring the marks) (Bourdieu, 1985).”

**Figure G: Trajectories as Dedicated**



Taken together the three dimensions – the three Ds – provide a deeper understanding of the relational dynamics that must be addressed when accumulating knowledge and resources from existing fields to a nascent field. The more *distributed* different resource trajectories are that need to be identified and gather, the more *distanced* they are and need to be bridged, and the more *dedicated* they are to different orientations the harder it is to develop collective trajectories from these individual trajectories to sustain the emergence of a nascent field. We presented this framework upfront to reveal the relational dynamics that FCEs are trying to address in the findings section. In short, FCEs provide a social space where the trajectories of actors can be brought together with other trajectories in new and different ways and where a collective trajectory can be developed and potentially sustained.

### **3.4 Methodology**

Our research is built on an in-depth single case study (Yin, 2017) based on ethnographic data, with a focus on practice as the main unit of analysis (Nicolini, 2012). This provides the means to observe and track the relational dynamics related to the emergence of the nascent field digital health in Montreal.

#### **3.4.1 Case Study**

We chose to study the emerging field of digital health for three reasons. First, this emerging field is at the convergence of digital technologies with health and healthcare delivery. Therefore, there was a need to bridge actors from distinct organizations and fields that did not traditionally intersect to produce digital health innovation. Second, the

level of complexity of healthcare innovation is unequaled by most industries, as it builds on multiple practices (Ali and Gittelman, 2016), making it an interesting extreme case to explore the challenges of bridging different existing fields. This complexity explains why most attempts in opening health to entrepreneurship and digital innovation have failed (Miller and French, 2016). Third, the field of digital health qualifies as a nascent industry (Davis and Marquis, 2005; Chiles et al., 2004) since it did not have clear financial results nor impacted healthcare when we started our study in 2013. For example, Rock Health, which was the first venture fund in the US purely focusing on digital health, only started tracking initial investments in 2011, and stated in a 2017 report: *“It’s clear that the early game has concluded and digital health is entering the “middle innings” as an investment sector.”* (Rock Health, 2017). Digital health in Montreal, where this research was conducted, is considered to be a few years behind the United States in its development so its nascent status is without question.

### **3.4.2 Hacking Health in Montreal**

The research focuses on the context of HH, a non-profit organization in Montreal, Canada, with embedded case studies (Yin, 2017) of events they organized to “Foster innovative digital health ecosystems. Engage and inspire its stakeholders.”<sup>3</sup> We investigated the work of the first HH chapter that was founded in Montreal, in the province of Quebec. Quebec’s healthcare system is mainly under provincial jurisdiction, which means that Quebec determines its own healthcare policies. Quebec’s healthcare system is essentially a single public-payer system with the majority of investments being made from the provincial budget. Our investigation started in 2013. To tackle its mission of fostering a digital health ecosystem, HH organizes series of events, which is the core of its activities:

*So what we need is to find the people who have ideas and to integrate them into the community so that they can speak to the people who have the capacity to develop these ideas into innovations. For me this is what HH is all about. And it’s*

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<sup>3</sup> Citation from [www.hackinghealth.ca/aboutus](http://www.hackinghealth.ca/aboutus)



*something that is tremendously apparent during the events” (Adele, HH Director of Development).*

As we discussed in the literature review, most FCEs research was focused on conferences, or other already institutionalized events. By contrast, HH initial hackathon events were free, with no specific affiliation (organizations or disciplines) needed. Over the course of nearly four years HH developed other events to increase its capacity to reach across different disciplines and sector to address the lack of progress of the digital health innovations they were observing. The four categories of events are described in the following paragraph.

*Cafés* were first organized in 2014. They are two-hour events built on specific topics related to digital health during which keynote speakers are selected to present their projects and perspectives of the future of healthcare. *Workshops* were also first organized in 2014. They are aiming at developing and enhancing different process methods related to creative and collaborative capabilities – for example related to developer skills, design skills, pitching skills or funding skills. They are 1 to 3 hours events in which participants are supported by different specialists and mentors. *Hackathons* were the first events organized by HH in 2013. These events are competition-based events where, over one weekend, groups are developed to create a prototype of a digital solution. Hackathons supported the creation of 10 to 40 prototypes depending on the number of participants in each event. *Bootcamps*, developed in 2016, are post-hackathon programs that take place over a one to two-month period during which project groups participate in weekly or bi-weekly meetings to develop their prototypes into valorizable projects. These bootcamps mostly tackle issues related to developing a business model to inform the progression of groups’ prototypes into implementable products.

### ***3.4.3 Data Sources About Hacking Health Events***

The main source of our data comes from observing different types of HH events, in different years of the evolution of HH in Montreal between 2014 and 2018. We used participant observation techniques - observations and interviews - in a longitudinal

manner across a variety of events during a 42 months process. To understand the impact of hackathons and bootcamps, one of the co-authors joined one project group per event (2014-2015-2016) to fully appreciate challenges related to bringing together actors coming from different fields, what was resolved by these events' structures, what was still challenging and what were the accumulated outcomes from one event to the other. We selected the project groups to be observed based on a few criteria. First, they were led by a healthcare clinician. Second, solutions were not designed prior to the event. Projects, in a methodological sense, were used as artifacts representing what actors and resources are needed to produce an innovation in the field of digital health. Third, groups were built on at least healthcare clinicians, developers and designers. Fourth, groups had to involve members of different organizations. These criteria helped focus on the relational dynamics occurring in these groups since the emergent field structure was not mature enough to provide clear practices to rely on for actors coming from existing fields and different organizations to collaborate.

During these events, we observed the selected groups for the whole duration of hackathons (30 to 35 hours of observation per event) and bootcamps (10 to 20 two to four hours meetings per event). We engaged in short real time informal interviews (Patton, 2005; Langley and Abdallah, 2011) during the observation phase to understand how actors were interpreting situations as they occurred. These ethnographic interviews (Patton, 2005) were particularly important in our setting since some events – for example hackathons - involved a whole lot of computer programming and on-screen interactions while being the site of important yet quick negotiations in regard to projects' directionality. We also conducted observation during cafés and workshops as well as ethnographic interviews to better understand the role of these events in dealing with the three Ds.

The notes taken during our observations were the starting points of the follow-up interviews that took place after the observation periods. After HH events (hackathons, workshops, bootcamps), we conducted open-ended interviews with participants who shared the challenges they faced during these events and how they resolved them. This approach suited the practice-based perspective since these actors – who came from



different knowledge domains - were representatives of their own fields of practice (Nicolini, 2011; Bourdieu, 1993). Adding interviews to our observations has allowed to account for actors' motivations, intentions and understandings of events (Zilber, 2011; David et al., 2013) and to reach areas of their social reality that we could not approach directly through observation (Zilber, 2014). We also interviewed HH's main representatives to understand retrospectively what happened in HH's first year when organizing the first hackathon in 2013 and why they decided to add to this type of event by developing cafés and workshops in 2014.

**Table A: Data Sources**

Data collection levels	Source of data	Collected data
Hacking Health	Participant Observation	22 months
	Meeting Observations	24
	Interviews with chapter leaders, Hacking Health Global representatives (director, global coordinator, partnership coordinator) and Hacking Health partner organizations (Hospitals, financial institutions, investors)	30
	Virtual communications (emails, team chatroom, etc.)	Yes
	Material data (contracts, business models, grant applications, etc.)	Yes
Hacking Health events	Cafés	10
	Workshops	7
	Hackathons	4
	Bootcamp	2
	Follow-up interviews (after events)	32

#### **3.4.4 Data Analysis**

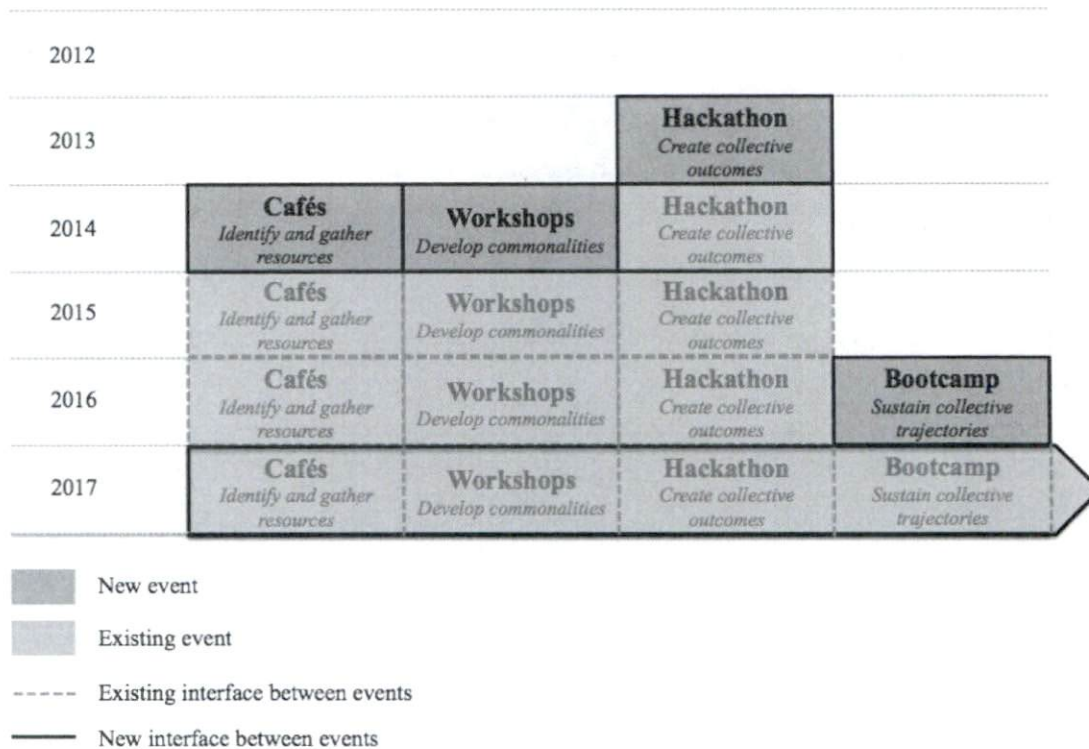
We built on an abductive research design that was first informed by an interest in the role that HH events played in developing the field of digital health by involving actors coming from various existing fields and organizations. We first analyzed each type of event on their own in a chronological order of their appearance in HH activities to see what were the challenges related to each of the events, their different outcomes, and who was participating. This first stage of the analysis led to the development of the conceptual apparatus of the three Ds, which was complemented by building on Bourdieu (1987; 1993) and Carlile (2002)'s language. The three Ds became the conceptual lens to specifically target episodes to be analyzed in more detail to better explore the role of FCEs in dealing with the development of an emerging field. This then helped us go back



to our data and to the field to sharpen our understanding of the relational dynamics occurring during field emergence. We iteratively moved back and forth (Klag and Langley, 2013) between surprising episodes (Teddlie and Tashakkori, 2009) from the fieldwork and the theoretical matching (Dubois and Gadde, 2002) of our evolving conceptualization. We then put in relation the outcomes of these episodes to analyze the way the sequencing of events that had become a stable practice for HH's activities progressively accumulated resources. However, this paper does not emphasize the learning process of HH that progressively developed this sequence of events but rather focuses on the resulting sequence of events as a driver for field emergence.

Figure H presents the chronological development, from 2013 to 2017, of this one-year sequence of events HH that is central to the way the findings are presented in the following section to highlight the way this sequence deals with the relational dimensions of actors' trajectories (3 Ds). From its first hackathon in 2013, Hacking Health developed additional events to complement its goal of intersecting different fields for the emergence of the field of digital health. In their first appearance in HH's series of events, these events were experiments that were not fully integrated that therefore did not clearly interface to accumulate each event's outcomes into a full sequence. Interferencing these events helped understand the role of each event as well as the way they complemented each other into a full sequence that collectively help to accumulate more resources for the field of digital health to emerge. For instance, cafés helped identify and gather the required resources, workshops supported the development of shared methods and language for actors to collaborate, hackathons provided the means for small groups to experiment new combinations of resources coming from different fields into creating a collective outcome (shared prototype), and bootcamps helped sustain the created prototypes by focusing on developing a collective orientation for actors' resources to be committed to the new field of digital health.

**Figure H: The chronological development of HH's sequence of events**



We built the analysis of the emergence of the field of digital health on case vignettes (Carlile, 2002) focusing on episodes that kept occurring during HH's sequence of events. Vignette analysis has allowed to pinpoint specific details of our fieldwork to provide a vivid portrayal of the relational dynamics occurring during FCEs and how HH events helped address them (Jarzabkowski, 2014). This approach suits our research purpose by rethinking the distinctions between micro and macro phenomena to focus on how global and "objective structures" of existing fields are manifested in actors' daily activities, and how they are changed through actors' negotiations during the construction of the emerging field of digital health. Our participant observation data has then allowed us to capture the relational dynamics occurring in practice to explain processes of field emergence (Jarzabkowski, 2014).

### **3.5 Findings: Vignettes on Managing the Three “D” for The Construction of the Emerging Field of Digital Health in Montreal**

In this section we present vignettes that represent each of the HH sequence’s four types of events. The vignettes of these events are not presented in the chronological order they were developed by HH, but in the sequence that HH eventually learned to use them in to most effectively identify, gather, bridge and then collectively organize the variety of actors and resources necessary in the development of the emerging field of digital health in Montreal (see Figure H). The order of these events also shows how they sequentially addressed the three relational dimensions associated with individual actors’ trajectories in order to organize new collective trajectories. These vignettes do not represent specific actors’ stories but rather focuses on the variety of actors’ practices helping generate, transform and sustain the new practices and resources that are foundational for the emergence of a new field.

#### ***3.5.1 Cafés: Going Where Actors and Resources Are to Identify and Gather Variety***

This vignette shows how cafés help gather an increasing variety of actors engaged in distributed trajectories to create better opportunities for productive intersections in the hackathon. Because of actors’ distributed, distanced and dedicated trajectories, HH had to develop and organize series of cafés in different venues to reach actors who would not otherwise go “off-track” of their respective trajectories. Each café targeted a specific set of actors from different localized practices and specializations to gradually gather an adequate variety of actors and resources. In this vignette, we present a café that was organized in collaboration with two technology driven organizations and that took place in an institute specialized in neurological research. The organization BCIM (Brain-Computer Interfaces Montreal) along with HH, hosted a café on Brain-Computer Interfaces (BCI) featuring experts from university, clinic and startup contexts who presented their research, mobile applications and visions of the future.

*This café attracted 49 participants with 29 technologists and coders, 10 entrepreneurs and 10 clinicians. After the break where attendees had a chance to try out some technological tools, demos and other devices from BCIM and other*



*collaborators, the presentations resumed. The director of a research lab, which aimed at bridging the gap between digital technologies and biomedical engineering, presented the state of the art of BCI. He suggests that "cognitive biometrics, context-sensitive software that can deduce mood and mental states and intervene accordingly, and interactions between EEGs and virtual reality" are still unexplored domains with high potential in BCI. He also stated in his concluding remarks that "many of the consumer wearable products need refinement to improve their accuracy in measurement." The last participant presented his startup that creates APIs (Application programming interface) that translate data from supported wearable health tech devices that report on users' emotions. Following these presentations, one of the organizers from BCI asks the audience "Who would implant a BCI chip in their head if it could improve their quality of life?" The first answer from the crowd is "it depends on who owns the data..." while the second answer is "how easily could I could get it out?"*

This café was attended by a majority of coders and technologists who were looking to assess the potential of BCI to develop products. During the café, they were even allowed to test some of the most up-to-date products, which gave them a feel of what was to come in this field. The presentations were also aligned with coders and technologists' trajectories since it focused on the technology improvements that could be addressed next. In addition, the closing remark of one of the café's organizer was answered by technologists who clearly provided answers informed by their engineering perspective rather than actually focusing on the potential health benefits of these technologies. Therefore, this café was able to gather another type of actors, the technologists, and dealing with the distributed nature of trajectories.

However, cafés dealt with more than identifying and gathering different actors' distributed trajectories. Since there is a lot of distance between digital health's potential contributors' trajectories and because they are dedicated to these trajectories, HH had to engage these contributors on their respective turf to lure them in. For example, researchers in geriatric health were so dedicated to their trajectories that they would not even participate to a HH café taking place in another hospital about a topic focused on

child care. Furthermore, the dedicated nature of their trajectories is even more consequential as the relative distance increases between actors' disciplines. HH therefore organizes monthly cafés in different environments – for instance different organizations and communities – to identify actors' different trajectories to gather the requisite variety of resources to feed in the following hackathon for the field to emerge. Therefore, from these cafés, HH was able to identify and gather clinical, entrepreneurial and technological trajectories to lure them into the space of digital health. However, even if these actors learned about other fields working on related topics of inquiries, no participants actually formed lasting relations with actors from different trajectories nor began working on shared projects to reorient their trajectories. This was caused by the lack of common language and understanding between these relatively distanced trajectories, which makes it hard for actors to actually see why they need to deal with these differences. This explains the need to organize workshops to help actors develop shared language and methods to further collaborate and experiment new combination of resources.

### ***3.5.2 Workshop: Developing Commonalities to Reduce the Distance between Trajectories***

With the increasing variety of actors cafés identified and gathered from different organizations and disciplines, HH created workshops to deal with actors' different methods to facilitate collaboration. HH organized different formats of workshops for actors to learn process methods such as design thinking, rapid prototyping and pitching in front of a crowd before entering the yearly hackathon. Some of these workshops (for instance, design thinking) were held a couple of weeks prior to a hackathon and others (such as the pitch clinic) only took place a few hours before it began. In either case, the goal was to propose shared methods so that participants could more easily develop common language that could be used during hackathons to reduce the distance between other trajectories to produce better outcomes given their newly formed interdisciplinary group. This vignette presents one specific HH workshop, the pitch clinic, which prepares actors (mostly clinicians and health researchers) to present the value of their ideas in the hackathon to actors outside their discipline. In this workshop, actors can



develop and test their pitches before presenting it in front of the whole crowd that would take place during a hackathon.

*Dinah, a speech therapist, is preparing to present her pitch at the hackathon that begins in two hours. During the one-hour “pitch clinic” Dinah interacts with other clinicians and health researchers, but also with mentors specialized in evaluating pitches. These mentors are physician-entrepreneur, venture capitalists, and experienced programmers who are used to valuing ideas from a variety of positions. After a brief presentation given by these mentors to expose the pitch structure, Dinah and other participants are paired in groups of three including a mentor to try their pitches.*

*“[...] research in speech therapy has shown that 80% of children’s language difficulties related to speech pathologies can be resolved when children are diagnosed before they are ...” (Dinah)*

*“And time!” (Mentor)*

*“Already! I didn’t have time to say half of it.” (Dinah)*

*Dinah can’t make it fit in the one-minute pitch length. She asks the mentor “how can I explain thoroughly how research supports my argument?” He answers, “well you don’t! It’s not what coders and designers look for in a project.” The mentor continues and tells her that she should focus less on the specialized terms such as “data bank” that could scare programmers who understand the complexity of such word. It would be better to present the challenges she faces in her clinical responsibilities and how it limits her ability to treat the children in her clinical activities. Framing the problem more broadly would help her attract other people than clinicians that would be needed to develop a potential digital solution. Before leaving the room, a clinician-researcher tells me: “we are not used to presenting our projects so briefly. We usually have thirty minutes or even more to do so!”*

This vignette shows that clinicians’ presentation methods had to be changed to attract and engage actors from different disciplines to contribute to their project. Clinicians,



like Dinah, had difficulties to pitch their idea in one minute because of their disciplinary approach that involved building on thorough scientific analysis to present their ideas in much longer time frames. The mentor was asking for Dinah to detail how she usually provided her services and the specific breakdowns that should be tackled to improve her daily work with her patients. This changed the type of elements she focused on in her pitch. By adapting to the one-minute pitch structure and focusing on more concrete language through presenting problems they and their patients faced in their clinical activities, clinicians bridged the relative distance with actors from other trajectories who have different disciplinary language (such as designers and coders) who could either relate to clinicians' stories or understand how their resources could be useful to the project. Therefore, after cafés gathering different trajectories and increasing the distance across actors' trajectories, workshops helped develop shared language and methods for actors to start bending their perspective to better connect with actors outside their respective trajectories. For instance, this pitch workshop became a cornerstone event prior to hackathons because of their cumulative effect for introducing clinicians to the hackathon and to new methods, increasing their potential to attract and work with contributors coming from different trajectories.

### ***3.5.3 Hackathon: Creating a Collective Outcome to Bridge Different Trajectories***

Hackathons follow the groundwork laid in the cafes and workshops. This vignette shows how the weekend-long hackathons allowed to represent actors' different approaches, pushing teams to rely on new developmental processes to produce shared outcomes such as prototypes of a new digital health device. To do so, this vignette presents different moments in a hackathon, following the group MHspeech in its effort to develop a prototype of a digital solution to record children in their natural environment to improve the patient-clinician interactions and the clinicians' capacity to evaluate their speech conditions. In this story, an interdisciplinary group was formed around Dinah's (speech therapist from the previous pitch workshop) project - with two developers (Thomas and Robert) and three designers (Chris, Stephany and Robin) - at the beginning of the 2014 hackathon to tackle such challenge. The first part of this hackathon vignette is about the group's misalignment caused by their different languages, methods and visions that

drove them toward different preferences and approaches to developing the solution. In that sense, their respective resources were consequential in limiting their ability to move in a shared orientation.

*Dinah had already answered several questions in the first two hours of hackathon's day one of development to clarify her problem and ideas for the solution with her newly created hackathon group. It was important to her to create a solution allowing to record children speaking in their natural environment at home to receive reliable language samples in order to increase her efficiency in evaluating children's speech capacity. After six hours of development in the hackathon, MHspeech's group members are undergoing their separate tasks. Thomas and Robert are working on their assignments (backend and frontend coding) at their respective corner of the table. Dinah, sitting in the middle of the table, is waiting to answer questions when and if necessary, and the three designers at the other end of the table are still trying to make sense of the challenges Dinah is facing in her clinical practices.*

*Stephany and Robin – two young industrial designers with a training focusing on understanding user-centered design – think that it is fundamental to design a fun experience for the patients. Robin (designer) says she “wants to humanize the application so that kids would enjoy talking to the app by playing with it.” Dinah, who did not understand why the humanization of the application would be relevant, says “well I am not sure we need to do this now, it's already an innovation to be able to record kids at home. But let's keep an open mind about it.” Thomas, seeing that the team is discussing, frees one of his earbuds to listen. Overhearing that Dinah and Robin are discussing a gamification idea, he starts back his music and continues working on his code. At the other end of the table, Robin, after defending a little more her ideas with Dinah, leaves the group to go on her own to another more quiet room to focus on drawing persona designs for the game. Thomas confesses to me later: “I voluntarily somewhat excluded myself from the group to work on a deliverable product that could be functional at the end [of the hackathon].” He insisted that he did not want to build a proof of concept or a*



*prototype simulating potential gaming features, but a functional and working tool so that Dinah could use it in her practice the following week.*

This first part of the vignette shows that the relative distance standing between trajectories do not only come from their distribution in different events, but also from their differences in terms of accumulated resources, and the specialized methods on which their respective orientations are built. Dinah didn't know what to do with Robin's ideas of gamifying the mobile application since she was focused on her idea of collecting patient data, which was supported by research in her field and her clinician-user perspective. And while Robin and Stephany never stood up to see the work done by Thomas, he did not even listen to their gamification ideas. Robin and Stephany's trajectories - built on their human design training - oriented their practices towards focusing on user experience and engagement. Likewise, Thomas's coding experience oriented his focus during the hackathon on producing a working prototype by the end of the 48-hour event instead than generating more abstract ideas such as Robin's gamification features that would require additional resources to develop after the hackathon. Dinah, Thomas, and Stephany and Robin each focused on different orientations that were fueled by their respective resources and built on specific methods and approaches to interacting and producing a prototype. Therefore, they were not able to value others' ideas, and hence their suggestions in orienting the project.

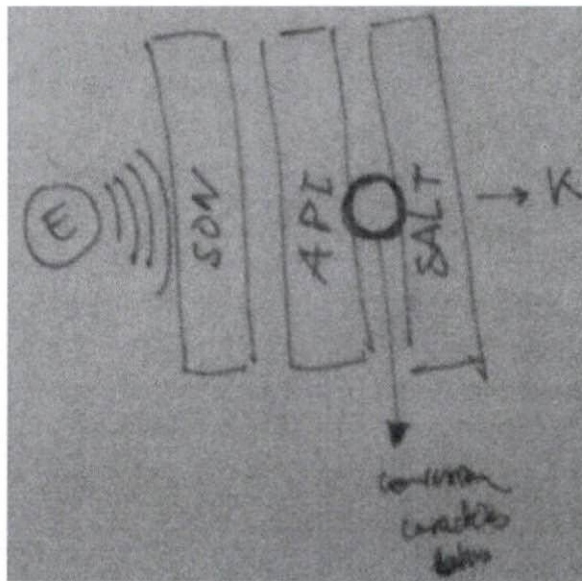
However, a valuable prototype in a HH hackathon involves a variety of orientations that are representative of the complexity of digital health products rather than focusing solely on pure coding. This was reinforced by the jury's composition that was representative of the different perspectives to be considered for a digital health project to be successful. Hence, hackathon groups needed to learn from each orientation without profoundly engaging in one or the other to develop a worthy prototype. The next part of the vignette, which presents a story that occurred in the same day as the previous story, is about how the relative distance created between different disciplinary language created one specific breakdown that propelled group members to change their shared approaches to developing their prototype. They then recognized that the siloed approach they relied on, with each member working on their respective features, to accelerate the



production of different features was in fact counterproductive because it generated misunderstandings that could end up being difficult to resolve post-hoc.

*A few hours later, Chris (designer), after having listened to Dinah's problem and goals, and discussed with Robert and Thomas's (programmers) development needs, draws a wire frame (Figure I) of the project and presents it to the team. Thomas raises his eyes above his laptop's screen and seems surprised: "Why is API standing there in the middle?" Dinah is alarmed: "We have been talking about API for the whole day!" She had asked several times to the coders if it would be possible to build a feature allowing her to read the API transcript of the recorded samples of children with none of them giving clear answers. Dinah then clarifies that "API means 'Alphabet Phonétique International' (a French technical term meaning International Phonetic Alphabet)."*

**Figure I: Wire frame From MHspeech Hackathon Experience**



*Thomas strongly reacts: "that's what you meant when you talked about API! When you told me about API, I did not see symbols, I imagined other things." He later told me that it "pushed him towards an understanding of what she was saying that was not making any sense." API, in the coding field, means Application Programming Interface, which is a set of routine definitions, protocols, and tools for building*

*software and applications. According to Thomas, “from there, I think everyone realized that we had to pay more attention to how we share information if we did not want to head straight into the wall.” Chris – who is an experienced designer from the cinema industry – suggests, to prevent this from happening: “we should increase the number of sprints by shortening their duration before every iteration.” The group then changed its development process by doing iteration meetings every 1 or 2 hours to make sure everyone had a shared understanding.*

The second part of the vignette shows how the HH hackathon allowed to change actors' usual approaches to intersect their respective practices. By working on a shared prototype, project groups had to figure out ways of collaborating and therefore of intersecting their perspectives. The moment of breakdown surrounding the term “API” emphasized how the siloed processes of development was detrimental to dealing with actors' relative distance. It showed that the difference in languages and interpretations could create misconceptions of each member's role and of their dependencies in the process. Based on the story of the first part of the vignette, we see that this difference generates more than a language issue, but rather is related to actors' deeper orientations.

Indeed, the group also saw that not only their differences in language were consequential but also that the different approaches of prototyping on which they were each relying were actually greater than they had thought of. For example, they understood that the hackathon was not so much a matter of dividing tasks to execute more features faster. It was a matter of understanding each actor's perspective to generate a shared orientation building on their different resources. Chris's (designer) role was consequential in changing the development process since he translated the design of the solution in a simple drawing (see Figure I) so that group members could picture their role in the overall project and the project's features. This mockup clarified a misunderstanding between the clinician and one coder that was central to creating a prototype in line with the clinicians' vision. It helped specify dependencies at the interfaces of actors' resources to better understand the way they needed to interact to better include the technological, user-oriented and clinical perspectives. The group then changed its collective approach to include more frequent iterations increasing the



opportunities of negotiations and discussions to better orient and reorient actors and deal with their relative distance during the hackathon.

In addition, the short duration of the hackathon forced project groups to deal with these differences as fast as possible to create a winning prototype. If group members would have stayed in their silos, like in the first part of the vignette, they may not have created an outcome at the intersection of their respective orientations. However, the hackathon duration is a double-edged sword. Participants did start to see the value in collaborating with other trajectories and to do so, in adapting their own. For instance, coders saw the limitations their approach to developing functional software brought for constructing shared understanding between different members of the group. Clinicians also learned the value of collaborating with designers to better share their ideas by using drawings to create shared language across different trajectories. This led to the development of a more iterative development process where actors would focus on creating a shared understanding to deal with the distance between actors' trajectories towards building on their respective orientations for the production of a shared prototype. Changing this development process was essential since the different trajectories within the group (clinical, design and technological) oriented the prototype towards different directions that were not coherent. Yet, some members minimally adapted their approaches to work out an outcome for the hackathon and then, when going back to their respective field, felt back into the directionality of their respective trajectories. This resulted in some group members leaving projects after the hackathon if the solution was evolving in a direction that was not relevant to their interests since these prototypes alone did not generate a shared orientation for actors from different trajectories to sustain their commitment and reorient their trajectories despite their differences. This is why HH organized Bootcamps to create opportunities and pathways for groups to create new collective orientations for different trajectories to sustain the changes to their practices.

#### ***3.5.4 Mission Model Camp: Sustaining the Collective Outcome***

This vignette presents the Mission Model bootcamp (MM bootcamp) that was held in 2017 through the lens of the project MHcardio. The MM bootcamp is an 8-week



program of bi-weekly three-hour evening meetings with homework to do in-between. The program was created to build on the collective outcomes produced in the hackathons after HH had observed the difficulties groups faced in sustaining their projects in the long run. MHcardio was created in the 2016 HH hackathon that was held 5 months earlier. The differences in terms of specialized methods and practices that surfaced during the hackathon became more consequential after the hackathon because group members had to deal with the difficult question of defining how to turn their prototypes into sustainable projects.

These conflicts were related to selecting and aligning three different approaches to sustaining projects: (1) maintaining a localized orientation of helping clinicians with their patients within a specific clinic, (2) creating a startup or any entity supporting the diffusion to more users in multiple clinics and hospitals (yet mostly in Quebec), and (3) developing a scalable model to commercialize across a more global Canadian and US market. In either orientation, groups had to figure out issues of sustainability that presented themselves as an either/or conflict, making it difficult to bridge different development approaches. Furthermore, in the case of HH supported projects, deciding on an approach was even more consequential because group members generally had full-time occupations in their respective fields. Creating a sustainable project was not just about generating financial resources but also meant for group members to have an interest in committing temporal resources to work on it despite their full-time job.

These tensions are representatives of the challenges MHcardio faced in developing further its prototype to sustain it. MHcardio is composed of Jessica and Francine (nurse-clinicians specialized in heart failure), Pierre, their physician-researcher colleague, Antoine (coder), Phil (senior architect and entrepreneur) and Fred (UX designer). They created a heart failure patient follow-up platform prototype that would allow clinicians to collect regular data on the evolution of their patients' health condition to better adapt their services and react to critical situations in a timely manner to avoid rehospitalizations. Some of actors' orientations were less problematic than others. For example Fred (UX designer) was focused on developing a product to answer the needs of patient and clinician users and Antoine (coder) focused on creating a testable software. However,

other perspectives were more difficult to reconcile. For clinicians, this tool would be a better way to collect data from their patients than the existing pink form patients gave them in person at their weekly appointment. For Phil, the project could expand outside Quebec to reap financial benefits. After the hackathon, the group agreed upon building a commercial entity to support their development, but they did not agree on the scaling orientation it would take. The vignette will point to the nature of the struggle in terms of creating a sustainable entity.

The MM bootcamp was tailored to provide the resources to question these specific sustainability issues. It was structured around the Mission Model Canvas and a variety of additional tools complementing it, and assigned mentors specialized in business development. Its purpose was to create a sustainable model for groups, like MHcardio, to develop their project. This vignette is divided into three key moments that occurred throughout the MM bootcamp to show the evolution of the reconstruction of the different individual orientations of MHcardio into a sustainable collective trajectory. The first part of the vignette takes place in a virtual meeting with MHcardio group and their assigned mentor who was asked by HH to help the group think of its next steps of development.

*After their first meeting with Patrick, MHcardio reconvenes in a virtual meeting to riddle Patrick with questions about his experience and perspective of their project. Patrick is a director in a major firm specialized in conducting clinical research, managing data and selling such data. He thinks that the MHcardio platform is very compelling, saying “We have many similar applications that help with communication between patients and their medical teams to really help them better manage their life and their treatment outside of the hospital and the clinic. (...) But all these applications collect a lot of data, (...) and all of this data has a lot of value for pharma.” Jessica, who seems pessimistic on the potential of developing such mobile apps in Quebec, asks: When you say that you have already created several similar applications, (...) do you have any examples, do you have a particular market, is it more in the United States than in Quebec? Because in my everyday*



*activities with my patients, I don't really see any mobile application being used in the health system."*

*Patrick presents an example of an application that was developed in Quebec to provide better services in a specific clinic, but says that most of his company's market is in the USA. Francine, for whom clinical validation is essential to implementing new services is wondering where research lies in all of these examples. Patrick explains that research is a very important aspect of their projects to "prove their selling points." Here, research is seen in two different perspectives, with Patrick considering it for its potential to create business value while Francine see it for its capacity to validate clinical hypothesis. Pierre sees the importance of relying on the business perspective, but as a means to expanding their services to more patients: "We are wondering how to value our tool so that we can develop it to expand to more patients. So we understand that this needs to go through a certain financial viability. (...) Can reselling this data really be a viable model in the long run?"*

*Answering Pierre, Patrick says "It's a very good question, it's not quite easy. (...) But what's the size of your [target] market?" Pierre has been thinking about this since the creation of the prototype and thinks that the group should target the Quebec market by building on the existing network of heart failure patients that he and the two other clinicians in the group are already involved with. But Phil does not share this perspective and asks Patrick: "What do you think of the American market?" For Patrick, there are more important monetization opportunities in the US, but he clarifies that there are two orientations to developing a startup: "you can [either] create a job for yourselves [referring to approach 2 of diffusing across Quebec] or develop something [referring to approach 3, which is a scalable data-oriented startup] that focuses on an exit strategy to become millionaires (...). The idea is to align with the problem to be solved and who will pay [the commercial approach] (Patrick)."*



This meeting highlights differences within the group in regard to the development approach to rely on, whether to build on data collection for pharmaceutical companies to create a platform for Quebec's patients or to drive an expansion towards the US market. This conflict in regard to the path of development kept recurring, especially between Phil, Jessica and Francine. The next part of the vignette takes place in the fourth MM bootcamp meeting and shows that the group members' different trajectories direct them towards different orientations for the project.

*Standing in the lobby of the hospital hosting the MM bootcamp to continue the conversation after the bi-weekly meeting is over, Phil says to Jessica, Francine and Fred "today, we still do not have a business model even though we have moved a little further on the initial goal. The idea, we have it." Jessica adds "but what we don't have is how to sustain the project." For Phil, it's unthinkable to break through in health if you don't go on the US market. He says that any investor would ask if they evaluated the US market as a target and that none of them would fund their development without such exploration. Jessica asks a question that dropped a cold shower on the group: "Can we be satisfied with the project staying in Quebec, or we absolutely need investors to get bigger?" No one responds for a few awkward seconds. "This is an excellent question," says Phil before nervously laughing. Everyone else stays still and silent for a while longer.*

*Phil finally breaks the silence again: "that's a personal choice for each of us. (Pause). And yet I think the challenge is related to the amount or the effort in terms of money and time. If we are all full-time working [on the project], it's different than if we are at one hour per week." Cutting Phil, Francine says "and now we have zero money in the bank." "And no time [to work on the project] (Phil)."*

This second part of the vignette represents a vivid negotiation between different scaling orientations within the group. This conversation shows that group members recognize the necessity of a sustainable approach to dedicate adequate resources (in time and money) to developing the project. Yet, while the business orientation of Phil is focused on creating a pathway tailored for exponential expansion in the US market, the clinical

group members (Jessica, Pierre and Francine) would rather focus on a local expansion. The next part of the vignette represents a meeting that occurred two weeks later, at the fifth and last MM bootcamp meeting. This meeting presents a conversation where the group began thinking the different scaling approaches as a sequence rather than an either or situation.

*During their virtual weekly meeting, Phil questions the group's business model, which is now tailored for selling data to pharmaceutical companies. "Maybe pharmas' revenue would be a medium-term plan to fund the platform, but we should think of another way for the longer term (Phil)." He argues that investing in a model of saving hospitalization costs appears to be less interesting for a public setting than the US private hospital system. For him, proving the benefits of their services with a research "will interest hospital suppliers in a private context. This explains [my take on] the American market. It looks like it eventually is going to be towards this direction that we will have to go if we want to be profitable. What do you think?" Pierre, who thinks that the group should first create, develop and evaluate their platform through monetizing with pharmaceutical companies in Quebec, answers "Honestly, I got to admit that I do not have much to say about it because I have no idea how it works in other Canadian provinces and in the US. That's something that I don't really know about." He then acknowledges that monetizing within the Quebec healthcare system is no easy task, but that it still should be the first step before leaning towards the US market. "I would not do the business plan from the angle of the US market because it would be too abstract for now. It would be for a second step, for another round of investment (Pierre)." Phil ends up agreeing that Quebec could be seen as an experimentation opportunity before reaching for the American market.*

MHcardio's MM bootcamp experience finishes two weeks after the fifth MM bootcamp. The group presents for two high-level executives of a large pharmaceutical company to receive a sponsorship for developing the first version of the platform to test it on patients within the province of Quebec. Although Phil wanted to expand to the US market and reach out for some venture capitalist funding



to do so, he eventually agreed that getting funded by pharmaceutical companies to develop a first version and testing in a more reachable and controlled setting would provide a stronger footing before entering a larger market. In that sense, the stage approach MHcardio created aligned clinicians (Jessica and Francine), researcher (Pierre) and Phil's trajectories. What was framed as an either or problem shifted to thinking of the clinical research as an experiment for the more global market expansion approach. But creating this alignment was challenging since some clinicians' trajectories were more distanced with business orientations than others among clinicians, technologists and business. For example, Jessica said during the fifth MM bootcamp meeting *"my plan has never been to create a startup when I embarked in this adventure. Clearly between Phil and I there is a clash. In the sense that you (speaking of Phil) can relate when you see these [startup ideas], and you can even go back to your experiences to say 'yes, it makes sense'. But I didn't even know it existed!"* This is an example of the differences in terms of group members' trajectories in relation to their ability to see the potential coherence with the business-oriented trajectory being developed. The vignette shows that the MM bootcamp helped bridge different orientations and collectively see the value of a two-stage approach. Patrick's mentoring role, his trajectory, his business knowledge and personal contacts also helped the distanced and dedicated trajectories of MHcardio members to reorient themselves in developing a collective trajectory that was essential to spur a two-stage growth approach. So, building on the collective outcomes they generated during the hackathon, groups could develop a sustainable collective trajectory that reoriented actors' trajectories towards a shared orientation for their different resources to be further committed to developing digital health innovations.

### **3.6 Discussion: Field-Configuring Events for Field Emergence**

The purpose of this paper has been to understand the role different types of field-configuring events and their sequencing play in the emergence of a field from existing fields. To address the pragmatic challenges of accumulating sufficient resources for the new field of digital health to emerge, we have moved from a focus on existing well-



formed fields to tracking the development of resource trajectories through different field-configuring events. This has allowed a better understanding of the challenges of fueling field emergence from the previous literature. We then developed a framework that dimensionalized these trajectories as *distributed*, *distanced* and *dedicated* to better understand the effort required to identify and intersect different actor's trajectories from multiple fields. We have shown that the sequencing of different types of events is essential in connecting and reorienting these trajectories into new collective trajectories that became the seeds of the new field of digital health. This also contributes to the open innovation literature by focusing on these events' capacity to drive field emergence.

### ***3.6.1 Field-Configuring Events: From Within Single Existing Fields to Across trajectories to understand emergence***

Current literature on FCEs and on field emergence mainly conceptualizes fields according to institutional theory, which defines it as a stable set of organizations (Scott, 1994; Hardy and Maguire, 2010). Although useful in understanding sources of stability, this has generated struggles in this literature to account for field emergence at its earliest stages (Garud, 2008; Zilber, 2014). This is why we used Bourdieu's conceptualization of field since it emphasizes the dynamics of positioning and repositioning that are an active part of efforts to both stable and also transformation existing fields. Building on Bourdieu helps in seeing fields as dynamic social spaces where actors continuously maneuver to access and accumulate resources through both existing practices and modifying other practices. This more dynamic understanding of fields helps see how FCEs support the accumulation of resources in the development of the new field of digital health, as actors tried to create innovative projects that took them outside of their existing organizational context and fields.

Furthermore, most research on FCEs uses retrospective reports or qualitative in-vivo at a specific point in time, within single events, which only allows to observe snapshots of field emergence during these specific events (e.g. Zilber, 2011). So, in addition to the use mainstream definitions of fields (Garud, 2008), these empirical considerations explain why these studies can only account for field structures after they are formed, such as shared meaning (Hardy and Maguire, 2010), but can't see the more detailed

dynamics related to field emergence that only a longitudinal and observational research design can afford (Chiles et al., 2004; Zilber, 2011; David et al., 2013). Framing actors' positions and repositioning as central to the construction of a new field by using the concept of trajectories helps us better define the process of how actors accumulate resources across different existing fields and the overall process of how a number of actors collectively accumulate an adequate variety of resources to sustain the development of a new field.

It helps expand Bourdieu's conceptualization of field that, just like institutional theories, emphasizes a within field analysis, which can't focus on the intersection of different fields for the production of a new one. His perspective could not explain our observations that showed that digital health innovation required actors to change the way they usually worked and innovated in their respective fields to develop new ways of accumulating the necessary resources at the intersection of different fields. In that sense, FCEs provided opportunities for actors to develop new relations and knowledge outside their fields to improve their positions and change existing fields. FCEs also promoted the elaboration of new rules that reoriented actors' practices towards new means of accumulating resources. This explains why we use the concept of trajectory to track how actors move from one field to the other to accumulate resources and improve upon their social positions, and by the same token, change existing rules and create the foundations of a new field.

Our longitudinal research shows the value in observing the unfolding role of FCEs on field emergence from a trajectory point of view. Seeing resources as trajectories, dimensionalized with their *distributed*, *distanced* and *dedicated* nature, we acknowledge the orientation that past accumulation of resources give to individual actors that explain more deeply the pragmatic challenges of reorienting their resources trajectories as they move across disciplines, organizations and fields for the development of a new field. As we analytically add each dimension to the framework, the concept of trajectory becomes richer and helps understand how hard it can be and so the work involved in moving and reorienting one's trajectory. This concept of trajectory calls for further attention to better explain its conceptual potential to organization theories as we examine more deeply



contexts of emergence and the pragmatic transformations they require. The concept of trajectory provides opportunities to trace actors' evolution for longer periods to account for their pragmatic issues in regard to (Carlile and Dionne, 2018) the existing orientation of their knowledge and resources and the process of their reorientation as they engage in new activities and practices. For instance, after changing their orientations during events to develop new collective trajectories, will clinicians and researchers, like Dinah and Pierre, maintain this new trajectory, and if so, why?

Our longitudinal account of these innovation processes has helped augment Bourdieu's concept of social trajectory by developing the concept of "collective trajectory" to better understand the outcomes of dealing with the three Ds. Bourdieu used the concept of social trajectory (Bourdieu, 1979) to explain the stabilization of social classes (Jaquet, 2014), but our case contained both stability (i.e., positioning and orientation) and change (i.e., repositioning and reorientation) since innovation requires pragmatic transformations of actors knowledge (Carlile 2004) and their trajectories. Before entering FCEs, actors' individual trajectories were already consistent with their respective collective trajectories nested in their current organizations, disciplines and fields, so individual trajectories had to be reoriented within a new collective trajectory. We have shown that as actors collaborate across their respective trajectories to construct new types of product, project, service or company, they commit resources and reorient their practices toward the orientation of a new collective trajectory. We argued that tracking the development of such new collective trajectories, at the intersection of existing trajectories, allows to observe the beginning stages of the emergence of a new field, before the field has actually "jelled" (Garud, 2008) and even prior to actors knowing that they are participating in a new emerging field.

In our case, we can't say that the field of digital health has fully emerged into a "well-formed" field, yet we were able to show that HH, by addressing the three Ds with specific events, helped support the creation of new collective trajectories for the production of digital health oriented products and services. Over time these early collective trajectories and their new practices will get further develop and distributed to generate more resources, attract more actors and establish standards that becomes a



field. Our four-year study, punctuated by the temporal cuts of different events over time, was essential to track from its earliest stages how a field emerges and to improve our understanding of actors' trajectories as processes of reorientations and repositioning from one collective trajectory to the other.

### ***3.6.2 Sequencing Different Types of Events to deal with the three Ds for field emergence***

FCEs scholars have recently turned from studying single events to studying series of events to better account for the evolution of fields (Schussler et al., 2014; Liao, 2016). Yet, these studies did not provide sufficient longitudinal detail of the temporal connections across a series of events and how this facilitates the development of knowledge and resources that actors in field evolution. One important insight from our study is that such accumulation can be facilitated from sequencing these different types of events. By sequencing, we mean that there is a particular ordering and combination of events that better leads to the necessary accumulation of knowledge and resources for digital health projects to be created and sustained. In that sense, the above Figure H gives us a conceptual glimpse at why HH progressively added events. HH first developed a single hackathon in 2014 and then added new events that became a series events that temporally followed each other, but not necessarily in a carefully crafted order. By gradually learning to interface these events, HH ended up constructing in 2017 a full sequence of events that better deals with the three Ds to generate innovative outcomes.

Despite Schussler et al.'s (2014) attempt at understanding the relations between two different types of events, most of the literature that accounted for series of events mostly emphasized similar types of events, such as yearly conferences occurring over multiple years (Garud, 2008; Zilber, 2011). Therefore, this did not explore how different events can be better interfaced to build upon each other in accumulating sufficient resources to help improve innovative outcomes for field emergence. Our research shows the interactions occurring within different types of events and also between these different events. This lays the ground to understanding the specific impact each event plays in dealing with breakdowns related to the three Ds, but also their role in the full sequence

of events that funnels resources into the emerging field of digital health. In table B, we present a summary of the means and the outcomes of each type of event that supports field emergence. Our findings show that *cafés* (and their multiplication) first help in identifying and gathering a variety of actors and their resources. *Workshops* provide the process methods to create a shared language that helps further funneling specific resources into the groups that, during the hackathons, make it easier to create a collective outcome from a new assemblage of knowledge and resources. Then, *bootcamps* help turn these collective outcomes into more sustainable collective trajectories. The strength of this paper comes from its longitudinal approach to the events that HH developed over time that revealed the positive impact of their sequential ordering. Given the particular nature of the digital health field we observed, these four phases of the sequence we tracked are likely to be different in other contexts of emergence. Another avenue for research would then be to examine this in other settings to see how actors' trajectories evolve across different events or episodes and how actors negotiate the tensions generated from these reorientations.

**Table B: Summary of Events' Capacities to Support Field Emergence**

<i>C A F É</i>	<i>Means</i>	<i>Outcomes</i>
	<ul style="list-style-type: none"> <li>• Each café targets a specific theme that cuts across different practices</li> <li>• Speakers from different disciplines and areas</li> <li>• An event that is easy to take into different locales</li> <li>• Cumulative effect of multiple cafés</li> </ul>	Identify and gather a variety of actors and resources from different trajectories into the emerging field
<i>W O R K S H O P</i>	<i>Means</i>	<i>Outcomes</i>
	<ul style="list-style-type: none"> <li>• Provide and develop process methods</li> <li>• Mentoring to show the value of these methods</li> </ul>	Develop methods to create a shared language to gather resources into potential projects
<i>H</i>	<i>Means</i>	<i>Outcomes</i>



A C K A T H O N	<ul style="list-style-type: none"> <li>• Focus on generating a prototype</li> <li>• Build on end users' experience (clinicians)</li> <li>• Role of designers</li> <li>• Short time frame</li> <li>• Prize system, evaluation criteria and jury composition</li> </ul>	Create a collective outcome to test the new reorientation of actors' resources
	<i>Means</i>	<i>Outcomes</i>
	<ul style="list-style-type: none"> <li>• Mentors coherent with group's shared outcome</li> <li>• The business model tools to represent actors' distance in regard to their orientation</li> <li>• Social resources to question and test possible orientations</li> <li>• A flexible outcome that is adaptive for each group</li> </ul>	Assemble more resources to reorient and sustain the project and construct a collective trajectory of resources
B O O T C A M P		

Finally, while some scholars from the literature on fields and FCEs are calling for more studies on events and settings that better represent field emergence at the intersection of different existing fields (Furnari, 2014; Schussler et al., 2014; Zietsma et al., 2017), current research on FCEs is predominantly focusing on events that are characteristic of already well-formed fields (Hardy and Maguire, 2010; Zilber, 2011; Glynn, 2008). This explains why FCE scholars can better account for within field dynamics than actually representing the early stage work required to develop a new field that emerges from the intersection of different existing fields. Our research expanded the use of the FCE concept to types of events in an open innovation context that had not been studied for their field-configuring capacity. Observing events from this open innovation context has allowed to track the early experimentation of new practices, ideas and combination of resources from different fields that generated the seeds for the field of digital health to emerge. This therefore contributes to the conversation on FCEs and more broadly to the literature on across-field dynamics and field emergence. This generates an interesting venue for future research exploring events as windows into emerging phenomena, from nascent organizations, to occupations, disciplines, fields and ecosystems. Events are settings where experiments and innovation can more easily occur outside organizational and disciplinary constraints, therefore offering spaces for driving interactions at the



intersections of different domains. Events therefore become opportunities to track these interactions before they become stabilized into new practices, organizations and fields.

### ***3.6.3 Open Innovation Events: Creating New Openings for Field Emergence***

Current research focusing on open innovation events has examined their capacity to engage a variety of actors and their resources to collectively solve problems (Hippel and Krogh, 2003). Lifshitz-Assaf (2018) recently expanded this area of research by focusing on the relational dynamics associated with specific professional boundaries within NASA that impact the success of a new problem-solving approach developed in open innovation events. Yet, most research on OI events have had a hard time understanding the impact of relational dynamics because they focus on successful outcomes in terms of producing novel ideas and solutions from a distributed crowd rather than the process (Boudreau et al., 2011; Jeppesen and Lakhani, 2010). The three D framework helps reveal the spectrum of relational dynamics associated with the distributed nature of resources that must be addressed when generating innovative outcomes from these open innovation events. Looking at the application of OI events in a more complex context than those usually explored in the OI literature was instrumental in revealing the full spectrum of the relational dimensions. First, we observed more relational breakdowns in the construction of digital health because of the greater differences between actors' trajectories that were required to generate these across field innovations. Second, our focus on the emergence of the field of digital health helped bring to light the underlying issues that had to be dealt with to gather sufficient resources and create commonalities in such a diverse crowd to generate innovative outcomes.

In addition, open innovation scholars who look at events emphasize the generative potential of specific and single key events such as hackathons, design competitions and innovation contests (Lampel et al., 2012; Bullinger et al., 2010; Lakhani et al., 2010; Johnson et al., 2014). However, as discussed above, because of the current focus of OI scholars on contexts that are less complex than digital health, this literature has not considered the deliberate efforts required to identify, connect and bridge diverse yet specific resources, and sustaining actors' involvement in the new field. But when we

consider the three Ds, the nature of these challenges is revealed. Our perspective therefore adds to research on OI events. Our case study represents an atypical open innovation context since it does more than create specific outcomes or momentary collective orientations, but rather focused on the sequencing of different types of events before and after the central hackathon in order to accumulate sufficient resources to create and sustain innovative projects. Our research then creates interesting avenues of research for OI scholars. Our longitudinal approach shows how different events and their sequencing impact open innovation outcomes beyond specific interactions within events. For example, as OI approaches are taken to more complex context such as healthcare, education and climate change, these types of grand challenges (George et al., 2016; Olsen et al., 2016) need to be carefully studied in terms of how a significant variety of actors can be assembled into new collective trajectories by a sequence of different types of events over time.

### **3.7 Conclusion**

Knowledge and resources are what fuel innovation and change for organizations as well as for the development of a new sector or industry. We took this into consideration as we examined the emerging processes of the new field of digital health that is very complex given the variety and scale at which knowledge and resources have to be identified, gathered, bridged and fully developed. The empirical window used to address this challenging conceptual and empirical task was to focus on events organized by HH and how this eventually led to the accumulation of knowledge and resources necessary for the emergence of the field of digital health. We took a longitudinal, yet detailed qualitative approach that tracked how a variety of actors engaged in these events and the outcomes they produced. What was found is that the events developed over time by HH provided a process whereby actors and their knowledge and resources could be gathered and then reoriented into sustainable digital health projects.

The critical insight is that the types and sequences of events could establish a process of accumulation that addressed the distributed, distanced and dedicated nature of actors' resource trajectories at such an emerging stage that created traction for a new field to

emerge. By doing all of this we were able to add value to the literature on FCEs focusing on field emergence and in particular how different types of events and their sequencing lead to sustained collective trajectories that gave shape to emergence of the field of digital health in Montreal. This research also brought conceptual insight around how actors move as an individual trajectory of resources in an existing field and reposition themselves through these events and potentially engage in a new collective trajectory with other actors that gives force and momentum to this emerging field.

## References

- Ali, A., & Gittelman, M. (2016). Research paradigms and useful inventions in medicine: Patents and licensing by teams of clinical and basic scientists in Academic Medical Centers. *Research Policy*, 45(8), 1499-1511.
- Almirall, E., Lee, M., & Majchrzak, A. (2014). Open innovation requires integrated competition-community ecosystems: Lessons learned from civic open innovation. *Business Horizons*, 57(3), 391-400.
- Anand, N., & Watson, M. R. (2004). Tournament rituals in the evolution of fields: The case of the Grammy Awards. *Academy of Management journal*, 47(1), 59-80.
- Angelidis, P., Berman, L., Casas-Perez, M. D. L. L., Celi, L. A., Dafoulas, G. E., Dagan, A., ... & Otine, C. (2016). The hackathon model to spur innovation around global mHealth. *Journal of medical engineering & technology*, 40(7-8), 392-399.
- Boudreau, K. J., Lacetera, N., & Lakhani, K. R. (2011). Incentives and problem uncertainty in innovation contests: An empirical analysis. *Management science*, 57(5), 843-863.
- Bourdieu, P., & Nice, R. (1977). *Outline of a Theory of Practice* (Vol. 16). Cambridge: Cambridge university press.
- Bourdieu, P. (1987). What makes a social class? On the theoretical and practical existence of groups. *Berkeley journal of sociology*, 32, 1-17.



- Bourdieu, P. (1979). *La distinction*, les Éditions de Minuit. *Paris*.
- Bourdieu, P. (2011). The forms of capital. (1986). *Cultural theory: An anthology*, 1, 81-93.
- Bourdieu, P. (1990). *The logic of practice*. Oakland, Stanford university press.
- Bourdieu, P., & Wacquant, L. (1992). *An Invitation to Reflexive Sociology*. Chicago and London: The University of Chicago Press.
- Bourdieu, P. (1985). The social space and the genesis of groups. *Information (International Social Science Council)*, 24(2), 195-220.
- Bourdieu, P. (1993). *The field of cultural production: Essays on art and literature*. New York, Columbia University Press.
- Bourdieu, P., & Wacquant, L. (1992). *An Invitation to Reflexive Sociology*. Chicago und London: The University of Chicago Press.
- Briscoe, G. (2014). Digital innovation: The hackathon phenomenon.
- Bullinger, A. C., Neyer, A. K., Rass, M., & Moeslein, K. M. (2010). Community-based innovation contests: Where competition meets cooperation. *Creativity and innovation management*, 19(3), 290-303.
- Carlile, P. R. (2002). A pragmatic view of knowledge and boundaries: Boundary objects in new product development. *Organization science*, 13(4), 442-455.
- Carlile, P. R. (2004). Transferring, translating, and transforming: An integrative framework for managing knowledge across boundaries. *Organization science*, 15(5), 555-568.
- Carlile, P. R., & Dionne, K. E. (2018). "Unconventional yet consequential" in Bryman, A., & Buchanan, D. A. (Eds.) *Unconventional Methodology in Organization and Management Research*. Oxford, Oxford University Press, p. 233-254.

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

Chiles, T. H., Meyer, A. D., & Hench, T. J. (2004). Organizational emergence: The origin and transformation of Branson, Missouri's musical theaters. *Organization science*, 15(5), 499-519.

Cohendet, P., Héraud, J.-A. and Llerena, P. (2013), 'A microeconomic approach of the dynamics of creation', in P. Meusburger, J. Glückler, and M. el Meskioui (eds.), *Knowledge and Economy. Klaus Tschira Symposia: Knowledge and Space*, Vol. 5 (Berlin: Springer), 43- 59.

Cohendet, P., & Simon, L. (2007). Playing across the playground: paradoxes of knowledge creation in the videogame firm. *Journal of Organizational Behavior: The International Journal of Industrial, Occupational and Organizational Psychology and Behavior*, 28(5), 587-605.

David, R. J., Sine, W. D., & Haveman, H. A. (2013). Seizing opportunity in emerging fields: How institutional entrepreneurs legitimated the professional form of management consulting. *Organization Science*, 24(2), 356-377.

Davis, G. F., & Marquis, C. (2005). Prospects for organization theory in the early twenty-first century: Institutional fields and mechanisms. *Organization Science*, 16(4), 332-343.

Deken, F., Carlile, P. R., Berends, H., & Lauche, K. (2016). Generating novelty through interdependent routines: A process model of routine work. *Organization Science*, 27(3), 659-677.

DiMaggio, P., & Powell, W. W. (1983). The iron cage revisited: Collective rationality and institutional isomorphism in organizational fields. *American sociological review*, 48(2), 147-160.

Dionne, K. E., and P. R., Carlile (forthcoming). "Opening innovation" across boundaries: Assembling the emerging field of digital health in Berends, H., Y., Sydow

(Eds)., Managing Inter-organizational Collaborations – Process Views, Research in the Sociology of Organizations (RSO) Series, ed. by Michael Lounsbury.

Dubois, A., & Gadde, L. E. (2002). Systematic combining: an abductive approach to case research. *Journal of business research*, 55(7), 553-560.

Edmondson, A. C., & Harvey, J. F. (2018). Cross-boundary teaming for innovation: Integrating research on teams and knowledge in organizations. *Human Resource Management Review*, 28(4), 347-360.

Furnari, S. (2014). Interstitial spaces: Microinteraction settings and the genesis of new practices between institutional fields. *Academy of management review*, 39(4), 439-462.

Garud, R. (2008). Conferences as venues for the configuration of emerging organizational fields: The case of cochlear implants. *Journal of Management Studies*, 45(6), 1061-1088.

George, G., Howard-Grenville, J., Joshi, A., & Tihanyi, L. (2016). Understanding and tackling societal grand challenges through management research. *Academy of Management Journal*, 59(6), 1880-1895.

Glynn, M. A. (2008). Configuring the field of play: How hosting the Olympic Games impacts civic community. *Journal of Management Studies*, 45(6), 1117-1146.

Grodal, S., Gotsopoulos, A., & Suarez, F. F. (2015). The coevolution of technologies and categories during industry emergence. *Academy of Management Review*, 40(3), 423-445.

Hardy, C., & Maguire, S. (2010). Discourse, field-configuring events, and change in organizations and institutional fields: Narratives of DDT and the Stockholm Convention. *Academy of Management Journal*, 53(6), 1365-1392.

Hippel, E.V. and Krogh, G.V., 2003. Open source software and the “private-collective” innovation model: Issues for organization science. *Organization science*, 14(2), pp.209-223.



Jaquet, C. (2014). *Les transclasses, ou la non-reproduction*. Paris, Presses universitaires de France.

Jarzabkowski, P., Bednarek, R., & Lê, J. K. (2014). Producing persuasive findings: Demystifying ethnographic textwork in strategy and organization research. *Strategic Organization*, 12(4), 274-287.

Jeppesen, L. B., & Lakhani, K. R. (2010). Marginality and problem-solving effectiveness in broadcast search. *Organization science*, 21(5), 1016-1033.

Johnson, P., & Robinson, P. (2014). Civic hackathons: Innovation, procurement, or civic engagement?. *Review of Policy Research*, 31(4), 349-357.

King, A., & Lakhani, K. R. (2013). Using open innovation to identify the best ideas. *MIT Sloan management review*, 55(1), 41.

Klag, M., & Langley, A. (2013). Approaching the conceptual leap in qualitative research. *International Journal of Management Reviews*, 15(2), 149-166.

Lakhani, K. R., Boudreau, K. J., Loh, P. R., Backstrom, L., Baldwin, C., Lonstein, E., ... & Guinan, E. C. (2013). Prize-based contests can provide solutions to computational biology problems. *Nature biotechnology*, 31(2), 108.

Lampel, J., & Meyer, A. D. (2008). Field-Configuring Events as Structuring Mechanisms: How Conferences, Ceremonies, and Trade Shows Constitute New Technologies, Industries, and Marketsguest Editors Introduction. *Journal of Management Studies*, 45(6), 1025-1035.

Lampel, J., Jha, P. P., & Bhalla, A. (2012). Test-driving the future: How design competitions are changing innovation. *Academy of Management Perspectives*, 26(2), 71-85.

Langley, A., & Abdallah, C. (2011). Templates and turns in qualitative studies of strategy and management. In *Building methodological bridges* (pp. 201-235). Emerald Group Publishing Limited.

Levina, N., & Arriaga, M. (2014). Distinction and status production on user-generated content platforms: Using Bourdieu's theory of cultural production to understand social dynamics in online fields. *Information Systems Research*, 25(3), 468-488.

Lewin, A. and Henk W. Volberda, H. 1999. Prolegomena on Coevolution: A Framework for Research on Strategy and New Organizational Forms, *Organization Science*, 10 (5), 519-534

Liao, T. (2016). Is it 'augmented reality'? Contesting boundary work over the definitions and organizing visions for an emerging technology across field-configuring events. *Information and Organization*, 26(3), 45-62.

Lifshitz-Assaf, H. (2018). Dismantling knowledge boundaries at NASA: The critical role of professional identity in open innovation. *Administrative science quarterly*, 63(4), 746-782.

McInerney, P. B. (2008). Showdown at Kykuit: Field-configuring events as loci for conventionalizing accounts. *Journal of Management Studies*, 45(6), 1089-1116.

Meyer, A. D., Gaba, V., & Colwell, K. A. (2005). Organizing far from equilibrium: Nonlinear change in organizational fields. *Organization Science*, 16(5), 456-473.

Miller, F. A., & French, M. (2016). Organizing the entrepreneurial hospital: Hybridizing the logics of healthcare and innovation. *Research Policy*, 45(8), 1534-1544.

Murray, F., Stern, S., Campbell, G., & MacCormack, A. (2012). Grand Innovation Prizes: A theoretical, normative, and empirical evaluation. *Research Policy*, 41(10), 1779-1792.

Nicolini, D. (2011). Practice as the site of knowing: Insights from the field of telemedicine. *Organization Science*, 22(3), 602-620.

Nicolini, D. (2012). Practice theory, work, and organization: An introduction. Oxford. Oxford University Press.

- Nissilä, H., Lempiälä, T., & Lovio, R. (2014). Constructing Expectations for Solar Technology over Multiple Field-Configuring Events: A Narrative Perspective. *Science & Technology Studies*, 27(1).
- Olsen, A. Ø., Sofka, W., & Grimpe, C. (2016). Coordinated exploration for grand challenges: The role of advocacy groups in search consortia. *Academy of Management Journal*, 59(6), 2232-2255.
- Patton, M. Q. (2005). *Qualitative research and Evaluation Methods*. Thousand Oaks, Sage Publications.
- Power, D., & Jansson, J. (2008). Cyclical clusters in global circuits: Overlapping spaces in furniture trade fairs. *Economic Geography*, 84(4), 423-448.
- Powell, W. W., & Sandholtz, K. W. (2012). Amphibious entrepreneurs and the emergence of organizational forms. *Strategic Entrepreneurship Journal*, 6(2), 94-115.
- Rock Health (2017) 2017 Year End Funding Report: The end of the beginning of digital health. Report, Funding, Rock Health, San Francisco, CA.
- Santos, F. M., & Eisenhardt, K. M. (2009). Constructing markets and shaping boundaries: Entrepreneurial power in nascent fields. *Academy of Management Journal*, 52(4), 643-671.
- Schüssler, E., Rüling, C. C., & Wittneben, B. B. (2014). On melting summits: The limitations of field-configuring events as catalysts of change in transnational climate policy. *Academy of Management Journal*, 57(1), 140-171.
- Scott, W. R. (1994). Conceptualizing organizational fields: Linking organizations and societal systems. *Systemrationalität und partialinteresse*, 203-221.
- Teddlie, C., & Tashakkori, A. (2009). *Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences*. Thousand Oaks, Sage.



Terwiesch, C., & Ulrich, K. T. (2009). *Innovation tournaments: Creating and selecting exceptional opportunities*. Cambridge, Harvard Business Press.

Thiel, J., & Grabher, G. (2015). Crossing boundaries: exploring the London Olympics 2012 as a field-configuring event. *Industry and Innovation*, 22(3), 229-249.

Von Hippel, E. (2005). *Democratizing innovation*. Cambridge, MIT press.

Wacquant, L. J. (1989). Towards a reflexive sociology: A workshop with Pierre Bourdieu. *Sociological theory*, 26-63.

Yin, R. K. (2017). *Case study research and applications: Design and methods*. Sage publications.

Zietsma, C., Groenewegen, P., Logue, D. M., & Hinings, C. R. (2017). Field or fields? Building the scaffolding for cumulation of research on institutional fields. *Academy of Management Annals*, 11(1), 391-450.

Zilber, T. B. (2014). Beyond a single organization: Challenges and opportunities in doing field level ethnography. *Journal of Organizational Ethnography*, 3(1), 96-113.

Zilber, T. B. (2011). Institutional multiplicity in practice: A tale of two high-tech conferences in Israel. *Organization Science*, 22(6), 1539-1559.

Zilber, T. B. (2007). Stories and the discursive dynamics of institutional entrepreneurship: The case of Israeli high-tech after the bubble. *Organization Studies*, 28(7), 1035-1054.

## CHAPTER FOUR

### Transforming configurations of practices for the production of a digital health agencement

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#### Abstract

*Digital technologies are reorganizing the way healthcare innovations are produced by generating new connections between actors that are not usually aligned, intersecting different value systems, as well as revising existing configurations of knowledge, resources and devices. Building on a comparative case study of the post-hackathon longitudinal development of MHcardio and MHspeech, two prototypes that were created by interdisciplinary and interorganizational groups, we explore the local negotiations that occur when devices like those related to company incorporation, intellectual property agreements and research grants were introduced. To better address the deeper dynamics of these negotiations and their consequences, we adopt a practice-based approach built on the concept of agencement taken from Actor-Network Theory. This perspective helps us highlight the contrasting innovation approaches of each project, with MHcardio reproducing a “linear model of innovation” that is built on the sequencing of innovation activities, from scientific discovery to commercialization, and MHspeech creating a new “open model of innovation” that combined and intersected these activities into a new form of agencement for digital health. We show that producing a digital health project involved profound transformations in actors’ practices and identities whereas MHcardio reproduced actors’ differences that led to the production of a scientific project. Doing so, we unpack the performative effect of these models of innovation to explain the observed projects’ outcomes.*

**Keywords:** Practice-based approach, digital health, post-hackathon, Actor-network theory, agencement, open innovation.

## 4.1 Introduction

Telemedicine and digital health have been presented as ways of improving the quality and efficiency of health services (Topol, 2010), revolutionizing modern medicine (Topol, 2012) and health science (Lang, 2011) while driving the expansion of a promising market for startups, tech companies and private investors. In this article, we explore the processes (and their outcomes) related to producing projects for digital health innovation by focusing on the local negotiations that occur when market devices (Callon et al., 2007; Muniesa et al., 2007) such as company incorporation, collaboration agreements, intellectual property agreements and research grants, were introduced in projects' development. We aim to better understand digital health innovations and the challenges related to the transformation of existing configurations of knowledge, resources, devices and modes of evaluation. Open innovation approaches use different sources of knowledge and resources by engaging in the joint development of new products and services with different actors such as private firms, universities, users, communities and public organizations (e.g. Chesbrough, 2003; 2006; West and Gallagher, 2006; Henkel, 2006; Dittrich and Duysters, 2007; Van de Vrande et al., 2009) to create new market opportunities (Chesbrough, 2003c).

Open innovation scholars have studied the role specific tools and instruments (such as IP instruments and business models) play in firms' capacity to exchange knowledge and resources, and capitalize on their outputs (Hanel, 2006). For instance, they have looked to understand whether IP instruments for protection are good, effective or constraining for innovation (e.g. Pisano and Teece, 2007; Benkler 2006; Manzini et al., 2016). Others have looked at the challenges distinct visions of IP create for exchanging knowledge between different types of partners such as universities, private companies and public organizations (Hertzfeld et al., 2006; Cohendet and Pénin, 2006; Slowinsky et al., 2009; Mehlman et al., 2010; Somaya et al., 2011; Manzini et al., 2016). These differences also depend on the business models organizations and communities rely on (Paasi et al., 2010). Multiple researchers (e.g. Hienerth et al., 2011; Vanhaverbeke, 2006) argue that firms that open up innovation need to adapt their business models (Saebi and Foss,



2015) in conjunction with their partners in order to benefit all contributors (Chesbrough, 2006).

However, these considerations are built on what Muniesa et al. (2007) labeled a “bifurcation of agency,” with human actors on one side and instruments on the other, which does not account for the intricacies of knowledge, relations and devices that give these instruments their “agentic” effect (Callon, 1998). Introducing market devices connects actors that are new to one another and disconnects others, generating pragmatic issues related to the underlying interests, identities, relations and devices that are brought to bear when co-producing knowledge and innovations across different value systems. Understanding actors with devices and the processes involved in transforming these practices is essential for the production of digital health innovation.

To better address the pragmatic dimension of intersecting different configurations of practices and their consequences, we adopt a practice-based approach built on the concept of *agencement* taken from Actor-Network Theory (Gherardi, 2016). This socio-material perspective views actors’ competencies and practices as oriented, enacted and negotiated within configurations of knowledge, resources and devices (Callon, 1998; Suchman, 2000; Gherardi, 2010). This framework has been used by economic sociologists who have taken an anti-essentialist position for the study of the production of markets through the socio-material relations that constitute them (e.g. Callon, 1998; Hardie and MacKenzie, 2007). Few authors have recently called for more research in organization theories exploring detailed narratives of *agencement* to better understand how new practices take shape (Nyberg and Wright, 2016; Gherardi, 2016). This perspective offers a highly suitable approach to investigating innovation processes and how they are constituted because it recognizes human actors’ ability to traverse different practices while taking into consideration the equipment and empirical intricacies that orient the way they collaborate and innovate towards producing specific outcomes (Callon, 1998; Muniesa et al., 2007). This perspective helps show that open innovation models connect actors whose practices are built on and locked into different socio-material configurations. Co-producing innovative outcomes is thus inseparable from transforming existing configurations of devices, knowledge, methods and resources that

make actors' practices whole (Suchman, 2003). We draw on this framework to ask: *How can the shaping of a digital health project recompose existing configurations of practices?*

Our research is an inductive comparative case study of the post-hackathon longitudinal development of MHcardio and MHspeech, two prototypes that were created by interdisciplinary groups from different organizations during Hacking Health hackathons. Hacking Health is a non-profit organization that helps propel digital health innovation by organizing series of events such as hackathons. Hackathons were especially powerful but artificial contexts, removed from actors' usual organizational constraints, which sparked experimentation with new connections between actors, such as clinicians, researchers, coders, designers and entrepreneurs, and new combinations of their knowledge. Although both groups we observed won their respective hackathons, only one of them ended up producing a "digital health" project.

In the long run, the introduction of market devices following the hackathon was especially consequential for these projects as they not only gave rise to local negotiations, but sparked controversies that ignited strong reactions in regard to actors' different practices and identities, profoundly impacting project development. Our data, collected over periods ranging between 20 and 36 months, describes the processes of configuration of MHcardio as a "scientific research" project and of MHspeech as a "digital health" project. Comparing the outcomes of the two projects, we show that MHspeech, by producing a new agencement of a digital health project, involved profound ontological transformations in actors' practices, identities and the devices they rely on, while MHcardio reproduced existing practices of innovation of a scientific configuration. Our case studies are particularly interesting in exploring such processes because what constituted a digital health project and how to produce it were still undefined when our research began. Actors therefore had to identify which practices were intersecting and which were conflicting in existing configurations of practices to navigate across these differences and generate new connections in order to innovate.



We first present our conceptual framework, which aligns ANT's concept of agencement with practice theory, in a way that guides our analysis of the process of producing digital health innovation. This framework reveals the intersection of different configurations of practices that occur in the production of digital health innovation. We follow by detailing our methodological approach and case studies. We then present our findings section as two series of vignettes representing MHcardio and MHspeech's innovation processes. These vignettes focus the outcomes of local negotiations around specific market devices in terms of actors' relations and identities to explain how each project is produced and its orientation defined. This in-depth exploration of the intricacies involved in these local negotiations helps unpack the infrastructures (Hardie and MacKenzie, 2006) at play in the production of each project's agencement. In the discussion, we highlight the performativity of these infrastructures on the type of model of development that is generated from actors' interactions. These explain why some of MHcardio members got disconnected from the project, which ended up having a scientific focus, whereas MHspeech aligned clinical, scientific, technological and entrepreneurial configurations of practice to produce a digital health project.

#### **4.2 A Practice-Based Approach to Producing Digital Health Innovation**

A growing number of studies in organizational theory, under the umbrella of practice theory, now conceptualize organizations, markets and other realities as bundles of practices that are constantly enacted through recurring activities (Gherardi, 2016; Nicolini, 2012; Dionne and Carlile, forthcoming). According to Feldman and Orlikowski (2011, pp. 1241-1242), practice theory is built on three central principles: (1) situated actions are consequential in the production of social life that is also structuring actions, (2) dualisms are rejected as a way of theorizing and (3) relations are mutually constitutive.

First, situated actions are consequential in the production and reproduction of social life (Feldman and Orlikowski, 2011). This means that practices produce outcomes that form the very structures guiding and stabilizing subsequent actions and orientations (Schatzki, 2001; Corradi et al., 2010; Feldman and Orlikowski, 2011; Nicolini, 2012). The material



and the social are considered inextricably linked (Orlikowski and Scott, 2008; Orlikowski, 2010) in enacting practices, making practices durable and helping connect practices with each other across space and time by accumulating the outcomes of previous practices that become the resources for subsequent actions (Nicolini, 2012; Carlile and Dionne, 2018). These works show how knowledge, technologies and organizations result from an interactive process between heterogeneous elements (humans, technologies, text, documents, symbols, etc.).

Second, dualisms are rejected as a way of theorizing (Feldman and Orlikowski, 2011). This principle means that practice does not only represent the doing of actors in their daily activities, but also the continuous doing of society (Corradi et al., 2010). Under such a theoretical approach, society and other social spaces such as communities (Corradi et al., 2010) and organizations (Nicolini, 2012), do not exist outside of the actors who perform it. Third, relations are mutually constitutive (Feldman and Orlikowski, 2011: 1241-1242). This relational epistemology is central in understanding practice as constitutive of actors' identities, competences, capacities and differences because actors – both social and material - only exist in relation to one another (Østerlund and Carlile, 2005; Orlikowski, 2007). These connected entities are interrelated and relationally positioned, which explains their orientation to act in specific ways (Schatzki, 2001).

#### ***4.2.1 Producing a New Agencement at the Intersection of Different Practices***

Building on these principles, we adopt a practice-based approach inspired by Actor-Network Theory (ANT). This practice-based approach invites consideration of organizations, and by extension innovations, as effects of the continuous work of assemblage of sociomaterial elements (Callon, 1998; Callon, 2017). Sociomaterial arrangement is a central idea to both a practice-based approach and ANT. An arrangement consists of multiple, heterogeneous human and non-human actors linked together to form a whole, for instance, a technology, an organization or an innovation. These arrangements are both guiding actions and are produced from actors' improvisations, negotiations and transformations.

This view leads to questions like, “How do things arrange themselves?” (Cabantous and Gond, 2015: 447), taking into consideration actors’ work in creating heterogeneous configurations of social and material entities (D’Adderio and Pollock, 2014). This invites examination of human actions and the materiality of practices such as texts, devices, instruments, activities and measures, while accounting for the effects these arrangements generate.

Following Gherardi (2016), we build on ANT’s central concept of *agencement*, which was recently applied, among others, to the study of markets (Nyberg and Wright, 2016: 620, Gherardi, 2016: 687; Callon, 1998). An *agencement* is “a sociotechnical arrangement of humans, tools and technical equipment with the capacity to act and give meaning to action (Nyberg and Wright, 2016: 620).” It is through actors’ practice that these connections are created, transformed and discontinued in a continuous process of *agencement* (Gherardi, 2016). This position helps us see practices of *agencement* as activities that establish or dismantle connections, which does not mean that practice theory did not account for such considerations, but that a focus on *agencement* thereby makes obvious what is produced from actors’ situated practices. It connotes a focus on describing and understanding what is connected in practice, for instance humans, artifacts, rules, technologies, knowledge, practices and resources, but also the way different realities are connected and temporarily stabilized (Gherardi, 2016). The investigation of the production of specific objects (such as innovations) and its effect on particular practices is made possible by observing this process of *agencement*. For Gherardi (2016), as researchers “we need to produce narratives of *agencements* that capture the materiality, the passions and beliefs, and the practices of attraction and engagement within these complex assemblages which underlie such nests of associations (Gherardi, 2016: 689).”

Economic sociology (Callon, 1998) builds on such considerations and offers pragmatic accounts of how markets are constructed at the same time as the knowledge to be exchanged. In this tradition, marketization is seen as the outcome of the dynamics of specific *agencements marchand* that produce particular connections, meanings, identities and products in a broader process of economization (Çalışkan and Callon,



2009). Economic sociologists use agencement to examine specific market-related outcomes in order to probe the intricacies of market construction and its related products. Beunza and colleagues (2006), for example, have shown that financial markets are not constituted of abstract economic agents but of assemblages of artifacts, embodied human beings and technological systems (Beunza et al., 2006: 739).

For Muniesa et al. (2007), the presence of economic devices for calculating prices or rules for organizing competition suggests that there is a process of economization going on. This process leads to the development of the “valuation network, pricing and construction of circuit of commerce (Muniesa et al., 2007: 3).” The investigation of these processes of economization focuses on actions and devices involved in the “conception, production and circulation of goods, their valuation, the construction and subsequent transfer of property rights through monetary mediation, exchange mechanisms and systems of prices” (Muniesa, Millo and Callon, 2007: 4). A variety of entities (human and material) and their roles must be taken into account and described in detail to understand the production of these market agencements (Çalışkan and Callon, 2010: 8).

Detailed depictions of economization processes have given us a profound understanding of the elements involved in the production of market agencements. For instance, *calculability* is presented as an essential element of the construction of markets (Cabantous et al., 2010; Callon and Muniesa, 2005). Goods must be made calculable, agency must be made calculative and organizations that support calculated exchange must be created (Callon, 1998). To produce calculable and calculative goods and people, a variety of calculative devices are assembled (Muniesa et al., 2007), such as accounting methods, benchmarking procedures, pricing techniques and property rights (Callon, 1998: 20), which means that they are engaged in agencements involving organized spaces of exchange and rules governing the relationship (Callon, 2013: 366). For Beunza and colleagues (2006), “actors’ equipment matters,” in terms of conceptual and material equipment, meaning that “human actors in financial markets are not “naked”: their equipment goes beyond their bodies,” it constitutes their practices and their identities.



Scholars from this tradition recognize that, besides the webs of connections involved in marketization processes, there are other forms of interwoven agencements. According to Eymard-Duvernay (2002), goods circulate and are qualified through different evaluation networks, which have different conceptions of value and modes of coordination than markets, and which therefore structure actions towards different orientations. These conceptions of value are overarching principles which actors from a shared practice use to assess other actors, their actions and products (evaluation practices), which orients the way they produce value (valuation practices) (Vatin, 2013; Centemeri, 2014). Therefore, innovation processes that cut across different conceptions of value raise pragmatic issues of valuation and evaluation in regard to determining value, establishing the criteria by which the value of different actions and objects should be assessed, and determining how these actions and objects stack up against those criteria (Lamont, 2012). From the perspective of agencement and of economic sociologists, this raises questions of how new forms of innovation, such as digital health innovation, are produced at the intersection of existing configurations of practices, and what does this process “produce”?

### **4.3 Methodology**

Our research builds on a comparative case study approach (Yin, 2017) of two projects' innovation processes for the production of digital health solutions. These projects were selected as illustrations of a broader study that involved observation of four comparable projects and of years of observing the growth of digital health within and across hospitals. We focused specifically on actors' practices in driving their innovation processes. This approach suited the practice-based inductive longitudinal case-study design of this research (Langley and Abdallah, 2011), which aimed to observe actors' local activities in constructing a project that emerged from an open innovation setting. Our approach recognizes that practice and materiality are central to the production of innovation (Feldman and Orlikowski 2011), and that it is through the negotiation of different practices that consequences are generated to produce innovative outcomes (Carlile and Dionne, 2018).

#### *4.3.1 Selected Cases*

This paper is part of a larger research project involving a four-year observation of the evolution of the digital health innovation ecosystem in Montreal and a 20-month participant observation focusing on the activities of Hacking Health, a non-profit organization that aims to transform healthcare by connecting health clinicians and researchers with designers, developers, innovators and entrepreneurs by organizing a variety of events. To do so, Hacking Health organizes hackathons, which are weekend-long competition-based events aimed at creating interdisciplinary groups to develop digital solutions to healthcare problems. We longitudinally observed the evolution of four projects that were created in different Hacking Health hackathons (2014 and 2016). We selected two of these projects (presented in table C) that demonstrated the difficulty of connecting a variety of actors who are in the midst of supporting and producing their innovation. We selected one successful case (which produced and sustained a digital health project) and one failure (which failed to align the required configurations of practice in order to produce a digital health project) to provide material for analytical comparisons (Barley, 1990; Bechky, 2011).

We selected the projects based on criteria related to project group size, interdisciplinarity, interorganizational contexts and implementation in a research hospital. These projects involved interdisciplinary and interorganizational groups of coders, clinicians, health researchers, designers and entrepreneurs who developed a mobile application linked to a web platform that connects patients with medical support. The first case, MHspeech, was developed with Hospital A during the 2014 hackathon and is the success story. The second case, MHcardio, emerged from the 2016 hackathon with Hospital B. Although they were created at different times, the two settings are comparable because both hospitals were making their first attempt at developing solutions from ideas that came out of hackathons. These groups, after creating an abstract prototype in the artificial context of a hackathon, had to create the connections that produced their innovation. One project's development failed following major issues with negotiating the terms of collaboration and reverted to the more traditional path of building a research project, and one successfully changed existing practices to create



new sustainable connections that resulted in a more inclusive project in regard to actors' different practices and interests.

#### 4.3.2 Data Sources

Our research draws on participant observation techniques and sources of data: virtual (group chatroom, virtual meetings, emails) and traditional observations, interviews, and document analysis. Our dataset was constructed over a three-year period with MHspeech and 20 months with MHcardio. We observed a total of 66 group meetings and followed groups' activities with various partners, for example, with lawyers, hospital partners and research centers. We also conducted informal "ethnographic interviews" (Patton, 2005) after critical events related to the negotiation of consequential arrangements to understand each actor's vision. We conducted virtual observations, mostly on the chatroom software *Slack*, which is specifically designed for communication within project groups, and through email exchanges. We also carried out 42 extensive in-depth conversational interviews (Patton, 2005) throughout the projects' evolution with group members and other project contributors. Finally, we had access to copious sets of material data, such as funding applications, collaboration agreements, research project proposals and IP contracts. These sources of data are exclusive to this specific manuscript and exclude hundreds of additional observation hours and dozens of interviews with other projects and Hacking Health.

**Table C: Project Description and Data**

	<b>MHspeech</b>		<b>MHcardio</b>
<b>Project description</b>	MHspeech is a mobile application and platform built to improve the interactions between speech therapists and patients by capturing the child's speech-language with video recording and sending it to the Speech-Language Pathologist (SLP) before their first appointment. The project was created in Hacking Health's February 2014 hackathon.		MHcardio is a patient follow-up mobile application and platform that allows patients with heart failure and their clinicians to track the evolution of their condition on a daily basis. The project was created in Hacking Health's October 2016 hackathon.
<b>Core group composition</b>	<i>During the hackathon</i> 1 clinician 3 designers 2 developers	<i>After the hackathon</i> 1 clinician 1 researcher 1 developer	<i>During and after the hackathon</i> 1 physician/scientist 2 clinicians 1 designers 2 developers
<b>Observation</b>	From February 2014 to July 2018		From October 2016 to July 2018



<b>period</b>	From project inception to pilot project	From project inception to research project
<b>In-depth interviews</b>	<p>We conducted 31 conversational interviews with actors involved in the development of MHSpeech at different stages. Some individuals were interviewed on multiple occasions. These interviews typically lasted from 45–90 minutes. The interviews were conducted over a longitudinal period on a regular basis.</p> <p><i><b>Distribution of interviews (31 interviews)</b></i>  1 clinician (17 interviews)  1 designer (2 interviews)  2 developers (13 interviews)  Hospital direction (3 interviews)</p>	<p>We conducted 8 conversational interviews with actors involved in the development of MHSpeech at different stages. Some individuals were interviewed on multiple occasions. These interviews typically lasted for 45–90 minutes. In addition, we conducted 6 interviews that began as informal conversations during field visits but, during the conversation, turned out to be valuable sources of data on specific incidents. The interviews were conducted over a longitudinal period on a regular basis.</p> <p><i><b>Distribution of interviews (14 interviews)</b></i>  2 clinicians (3 interviews)  1 clinician-researcher (2 interviews)  1 designer (2 interviews)  2 developers (4 interviews)  Hospital direction (3 interviews)</p>
<b>Observation</b>	<p>We had the opportunity to observe weekly team meetings, work sessions, and engaged in many informal ethnographic interviews.</p> <p><i><b>Distribution of observations</b></i>  19 meeting observations  • Team meetings (16)  • Presentations and Partner meetings (3)</p>	<p>We had the opportunity to observe weekly team meetings, work sessions, partners' meetings, and engage in many informal conversations.</p> <p><i><b>Distribution of observations</b></i>  50 meeting observations  • Team meetings (33)  • Presentations and Partner meetings (17)</p>
<b>Material data</b>	We had access to copious sets of material data, for instance, funding applications, collaboration agreements, research project proposals and IP contracts.	We had access to copious sets of material data, for instance, funding applications, collaboration agreements, research project proposals and IP contracts.
<b>Virtual communications</b>	We conducted virtual observations through email exchanges and Google Drive interactions.	We conducted virtual observations on Slack chatroom software, which is specifically designed for communication within project groups, and through email exchanges.

#### 4.3.3 Data Analysis

The first round of analysis involved the selection of a more specific set of data that was representative of the arrangements that were central in producing each innovation. To do so, we initially analyzed the same small portions of data from interviews and meetings to derive empirical observations and theoretical lessons from our empirical material (Miles and Huberman, 1994) prior to a series of meetings aimed at comparing these

lessons and select what to focus on in the mass of accumulated data. It should be noted that despite our initial interest in understanding the production of innovations, our focus on the construction of sociomaterial arrangements and the impact their outcomes had on the orientation of projects emerged inductively from this process of data analysis.

In this analysis process, we were all struck by the passionate responses specific episodes generated in all observed projects. These critical episodes happened when group members had to discuss and negotiate business models, non-disclosure agreements, research grant applications, incorporation, intellectual property agreements and collaborative agreements. In our second round of analysis, we therefore focused on the negotiation around these arrangements and the transformation of existing arrangements during these critical episodes that explains how value was produced and reshuffled in producing digital health innovations. We focused specifically on real-time practices that occurred during these critical episodes (Latour, 1987, Pickering, 1993) that lead to the construction of connections. In a third round of analysis, this helped us to highlight the configurations of practices that were intertwined in these critical episodes and the challenges that connecting actors from these different configurations raised for digital health innovation. The following subsection presents the four consequential configurations of practices we observed.

Our last round of analysis showed how MHspeech was able to change existing configurations of practice through the production of a new agencement while MHcardio reproduced an existing agencement. Our findings are presented as a series of vignettes that are representative of the collected ethnographic data and the chronology of events in projects' evolutions, while specifically focusing on a comparable set of these critical events that were consequential in each case. The selected case vignettes are exemplars of the difficulties faced by the observed projects and the concepts we discuss (Carlile, 2002; Stake, 1995) and to show the context in which these events occurred (Swan et al., 2007). These vignettes are built on a thorough analysis of actors' material and discursive activities. Appendices 1 and 2 present our data analysis approach in more detail. These tables first present actors' activities by staying closer to our empirical observations (data). This data was collected by observing actors' meetings and conducting interviews.



We then place these activities in the context of different practices that either intersect or do not in order to understand the situated nature of actors' activities and challenges as they look to connect different resources (recontextualization). Thirdly, we link these activities with their outcomes with respect to projects and actors' identities as well as their impact on connecting or disconnecting actors from different practices (what is produced). This analysis helps track actors' effort of agencing different configurations of practices and the resulting construction of a new agencement (MHspeech) or the reproduction of an existing one (MHcardio).

#### ***4.3.4 Research Setting: Relevant Aspects of Configurations of Practices Intersecting for the Production of Digital Health Innovation***

In the next paragraphs, we offer a summary description of the nature of processes of digital health innovation by providing specific details on the four configurations of practices in play. Digital health innovation intersected different configurations of practices, which we characterized based on language that was used in the observed projects' conversations and negotiations to describe what we qualify as scientific, clinical, technological and startup configurations of practices. Depending on the configuration of practices in which digital health innovation is taking place, unique configurations are mobilized. We present the different devices, conventions, modes of evaluation, actors' identities and resources that drive actors' specific activities and that is constitutive of these actors. Saying that a practice is scientific, clinical, technological or a startup means that its configuration equips and orients actors' action towards the establishment of outcomes that are specific to each practice. Next, we elaborate on the configurations of practices pertaining to our case, which are also summarized in Table D. This table presents objective elements that were observed in the field, except for the conventions that emerged from a discursive analysis of actors from the different practices. We therefore complement Table D with Appendix 4.3 that highlights some of the excerpts from our fieldwork that revealed these conventions.

First, the *scientific* configuration of practice is very common in innovation in healthcare. Because clinicians can't operate without having scientific evidence of the efficacy of specific actions and technologies, scientific research is used to validate clinical



hypotheses and diffuse best practices. Scientific health research is typically conducted with great rigor and with approaches that provide valid proofs in order to protect patients from distress and malpractice. The gathering of this type of scientific evidence involves dozens of interlocked smaller activities that allow scientific teams to produce good research and attract sufficient resources to do so. Second, the *clinical* configuration of practices is where innovation in health is implemented, but also where it is happening on a daily basis. While important changes to clinical activities need scientific proofs and are transferred through professional training and evidence-based protocols of actions, clinicians continuously improve their activities to improve efficiency and to better adapt to the specific context of their environment and patients in order to meet administrators and patients' expectations. However, clinician activities are highly regulated from government bodies and professional colleges because regulators want to avoid unnecessary danger to patients.

Third, as healthcare is opening up to a digital transformation, the *technological* configuration of practice has an increasing impact on the way innovation is conducted in health. For the purpose of this paper, this configuration of practice is assimilated to the coding world. This configuration is built on its own rules and iteration cycles with a language that is truly specific to actors from that practice. Despite the products of this configuration (software, hardware, etc.) being used in different areas of social life, the specifics of this configuration of practices still make it challenging for actors from other configurations to get aligned with the way innovation is conducted from a technological standpoint. For instance, validation cycles are shorter in this configuration compared to the scientific and clinical practices. Fourth, the digital turn in healthcare opens up market opportunities for actors from the *startup* configuration of practices. A startup is a company that is in the first stage of its operations that attempts to develop a new product. A startup builds on a comprehensive business plan outlining its mission statement, future vision and goals as well as management and marketing strategies. Startups need to consider what legal structure best fits their orientation. Partnerships are the typical legal structure for businesses that consist of several people who have joint ownership. Establishing this structure is usually straightforward for actors who are part

of the same configuration of practices. In addition, because of its orientation towards scalability and exponential growth, a startup approach typically requires additional funding from venture capitalists.

**Table D: Relevant Aspects of Configurations of Practice Intersecting for Digital Health**

	Scientific	Clinical	Technological (coding)	Startup
<b>Devices</b>	Research grants Research protocol IP as a protection and recognition device Declaration of invention	Report cards	IP as an openness device Patents API	ROI analysis Business models Company incorporation IP as a marketization device Loans
<b>Convention</b>	Rigor Precision Secrecy Validity	Usability User-friendliness Efficiency Patient-centric Accessibility	Efficiency Functionality Dependability Freedom Integrable	Profitability Growth Competitiveness Control Viability
<b>Evaluation</b>	Scientific committees Public research agencies	Administrators Patient experience Professional college	Automated software testing Other coders	Venture capitalists Clients
<b>Resources</b>	Research funds	Health Ministry Philanthropy	Open source code (features)	Private funds
<b>Activities</b>	Scientification Scientific development Validate scientific hypothesis Scientific conferences	Evidence-based practices Service provision Professional training	Bug fixing Create new features Iterative code writing Validate code Integrating code	Marketization Technological and market development Validate commercial hypothesis
<b>Actors</b>	Researchers Students University Public funding agencies Research center Mature partner firm as suppliers Patients (research participants) Firm dedicated to protecting and	Clinicians Managers Nurses Doctors Patients	Coder Architect User	Private lawyer Entrepreneurs Venture capitalists Banks

	commercializing IP			
<b>Products to be validated</b>	Functional products	Clinical service Decision-making tool to support services	Lines of code Code library	Minimum viable product Business model
<b>Produced outputs</b>	Publications Invention Medical legitimacy	Healthcare services Patient treatments	Technological features	Commercial products Sustainable revenues

A digital health project connects and combines these different configurations to enroll different actors, devices, knowledge and resources and generate different forms of value, for example in offering better health services to the population while turning investments into financial profits. These practices, however, carry strong meanings and specific intended outcomes that produce different identities and orient subsequent activities, pulling projects in their respective directions. While these practices are recognized here as existing, stabilized and recurring configurations of actors (human and non-human), skills and resources that give meaning to actors' activities, focusing on agencements helps understand how innovations can traverse and change these practices to connect with actors and resources to give shape to new forms of digital health projects. We look at innovation processes wherein actors try to build new projects at the intersection of these practices, specifically tracking who is doing things, why and where it is problematic, what evaluation principles are mobilized or not mobilized, and how they contradict each other. This perspective helps with being more specific about how a digital health project is produced by focusing on what is intersecting, how things intersect, how they are transformed and what this produces. As Callon and Çaliskan (2005) argued, “(re)configuring an agency” means (re)configuring the socio-technical agencements constituting it, which requires material, textual and other investments” (Callon and Caliskan 2005, pp. 24-25).

#### **4.4 Findings: Vignettes on Producing an Agencement for Digital Health**

In this section, we present the development of two projects, MHspeech and MHcardio, following their creation during the 2014 and 2016 Hacking Health hackathons. We track



their development by focusing on the introduction of market devices that led to difficult negotiations about the projects' identity, who is important for the project, and how to further develop the project. We address these specific moments as representative depictions of the negotiations that went on during the most consequential periods of development of the two project groups as they were constructing their respective innovation approaches to produce their projects. In addition to the vignettes presented in this section, Appendices 4.1 and 4.2 are tables that provide a more detailed analysis of actors' activities (Tables 1.1 to 1.5 and Tables 2.1 to 2.4) so that each vignette is supported with more data.

In the following section, we present MHcardio, whose project, after 20 months of development, discontinued collaboration with group members focused on developing technological and commercial features and became a scientific project. In the following subsection, we present the development of MHspeech, which constructed an approach to resolving actors' differences to produce a digital health project.

#### ***4.4.1 MHcardio: Reproducing a Scientific Agencement***

This section is about MHcardio, which emerged from the 2016 Montreal Hacking Health hackathon. It was the creation of an interdisciplinary and interorganizational group that has attempted to implement its solution in Hospital B. This series of vignette shows that the group gradually split and evolved into a purely scientific project as it stopped digital development 20 months after the hackathon. We focus specifically on three events that are particularly revealing of the construction of MHcardio and of the outcomes of this process. The first vignette represents the process of creating a shell company and the second describes fixing the differences in IP treatment within and across Hospital B's boundaries. These two processes resulted in the disconnection of external members (coder, designer, architect-entrepreneur) from internal members (physician-researcher, nurses) to produce a scientific project.

##### *4.4.1.1 Creating an empty shell and dormant company (February to April 2017)*

This first vignette details the negotiations that led to the incorporation of MHcardio three months after producing its prototype in the 2016 hackathon. The group had to

decide on the form its project would take to connect to the variety of actors and practices contributing to its project. This story shows the difficult process of balancing the project's ability to connect with actors from the startup world – for instance, venture capitalists – and from the scientific world – such as public funding agencies and public hospitals' research centers. The group hesitates between incorporating and driving its own innovation process or being a shell company that would leave open opportunities from both worlds. During this process, MHcardio meets with its lawyers, whose services are offered freely for one year by the hackathon first prize, and with Hospital B's representatives to decide on the arrangement to be created.

*The group MHcardio meets its two appointed lawyers (Bryan and Phil) at their firm's 37th floor downtown office. Pierre opens the conversation by presenting MHcardio for a couple of minutes, and then asks "since we are all coming from different horizons and since we signed a small IP contract when we won the hackathon (...), how should we legally get organized to continue working?" This IP contract was signed before the hackathon finals and held that each member owned its own intellectual property, notwithstanding the three members of Hospital B who had to rely on their hospital's employment policy. Bryan, after asking a few probing questions, says "as a lawyer who works in this kind of environment [the startup world], based on what I understand of the project, I would put 100% of the property in the company." Bryan continues to explain that "our [firm's] contractual structures are always built for companies that will have to raise capital in the short or medium term to continue their growth." Pierre reminds him, however, that the group must consider that he wishes to apply to a public research grant and that a researcher can't be part of the company with which he partners.*

The participation contract that was first signed during the hackathon was written by HH to create a structure that would sustain sufficient flexibility for creative combinations of knowledge while offering protection for participants. However, this indirectly connected external actors with Hospital B because clinicians were directly attached to their hospital's employment policy and the group's prototype was collectively created with these clinicians. This contract generated a first differentiation among the group, between



“external” and “internal” members, based on their different IP treatment. In addition, the group’s lawyers identify with the startup agencement, which orients the type of devices (a company that owns 100% of the group’s IP) they think should be produced to generate value to attract “*capital*” from venture capitalists. This device would produce a specific market orientation of continuous “*growth*,” orienting subsequent practices by types of associations to create and resources to draw in. However, Pierre reaffirms his interest in doing research and clarifies that there is more than a commercial orientation to the project. He draws in a scientific agencement by talking about the research grant application device, which produces other practices to be aligned with the project’s development. This generates a differentiation between him and external actors, clarifying Pierre’s identity as a scientist who collaborates with a new company.

*Two days later, in a meeting with MHcardio’s core members, Pierre suggests some possible ways to structure the project. The first two options are to either create a company or develop a research project, but Pierre proposes “build[ing] a mixed approach. So the first part of this solution is that IPfirm takes the intellectual property of the three members [of Hospital B]. The three externals don’t put their IP in IPfirm and we create a company.” Pierre continues, “since we have enough money [granted by a pharmaceutical company for research] to pursue until September, this pushes back the decision to September until we know what happens (with the research grant).” Some members of the group ask questions to make sure they have clearly understood what is implied with this solution. Francine asks “When you say that us [from Hospital B] use IPfirm, this means that the company is only composed of the external members?” Pierre interjects “No! The company is still created by us six, but until we know where our IP should land, IP remains out of the company.” Then Fred says “since IP is in IPfirm for you and externals’ is not in the company either...” Pierre cuts him off “You are free electrons.” Fred continues on his idea “Yes, so [with that option], you [from Hospital B] can still apply [for a grant] because there are no formal ties [with the company].” This approach would allow Pierre to apply as principal investigator for the research grant while enjoying the benefits offered by the hackathon prize. “And then if we receive the grant, the three*



*external members put their IP in IPfirm and we mature the application under the umbrella of IPfirm, and when we reach a certain maturity, IPfirm gives the license to the company we have created. And if we do not receive the [the research grant], we put all the IP in the company." Pierre concludes the meeting by explaining why he thinks the group should create its company now: "It would be unfortunate to have to cover [the costs of incorporation] while we had this service for free. (...) And this leaves us a lot of flexibility for the next three to six months, without closing any door.*

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After meeting again with their lawyers two weeks later, MHcardio sets up its empty shell company and leaves its members' IP out of it, with "internals" IP being assigned to IPfirm and "externals" remaining their own. This strengthens clinicians and researchers' embeddedness within Hospital B's scientific configuration of practice while reaffirming other group members' identities as external contributors, creating a divide with the external actors that are not yet knitted to the project. Creating the empty shell company helped postpone the decision of their project orientation and the connections they would build their project upon. Although this was intended to allow them to remain flexible in regard to the potential contingencies of receiving a research grant or attracting venture capital interest, this generated a less stable association between scientific, technological and commercial practices. In addition, while the decision in terms of project orientation was postponed, the money from the pharmaceutical company that Pierre deemed sufficient to continue the project was specifically intended to drive the research project forward, meaning that it couldn't be applied to developing the technological and commercial features. It therefore produced a linear approach to project development and a prioritization of the scientific activities over other activities, gradually orienting the project towards becoming a scientific project and strengthening "internal" researcher identities.

The opposition between the scientific and commercial orientations is maintained at this point. The complexity of orienting the project in one direction or the other arises from their different underlying approaches to producing value and the different forms of value they generate, although they both contribute to increasing the project's worth. Pierre

understood this when he said during the aforementioned meeting, *“once we have done the first part of the research on patient experience, the mobile app’s design has been validated and we have validated our market, I may be wrong, but I think that it would be worth a lot more to potential investors.”* However, the devices they created generate an either/or situation where the group postponed its decision to either develop inside Hospital B as a scientific project or outside the hospital as a commercial project depending on whether or not they receive the research grant.

#### *4.4.1.2 Fixing differences in IP treatment within and across Hospital B’s boundaries (April to August 2017)*

This second vignette is built on two intertwined issues related to managing intellectual property between “internal” members, and between “internal” and “external” members. These issues emerged one month after the creation of the shell company. A week prior to the meeting presented below, Pierre met with the director of Hospital B’s research center to discuss a potential structure to connecting the research center with MHcardio. The director informs Pierre that his colleagues, Francine and Jessica, were not recognized under the research center’s IP policy but rather by Hospital B’s clinical wing. According to the latter’s policy, Jessica and Francine’s contributions all belonged to the hospital while, as part of the research center, Pierre would be awarded 50% of his intellectual property. The first issue presented in the vignette relates to “internals” and Hospital B’s IP policies, which did not recognize clinicians’ contributions to innovative projects like it did for researchers. The group organizes a meeting with a specialist in valuation and intellectual property to better understand this situation.

*Camille is an employee of the valuation center (IPfirm) of Hospital B. Pierre explains the situation to Camille and at the same time updates Jessica and Francine about his most recent conversations with the director of Hospital B’s research center. “I discussed the problem of Hospital B versus research center staff’s intellectual property. And the research center’s director told me that she was going to solve the problem by giving Francine and Jessica researcher status.” Francine quickly responds: “to hear this five months later! Having known that from the outset, I would*



*have never embarked on this journey.” Pierre, trying to reassure Francine, tells her that the direction of the research center had not been involved in preparing the hackathon participation contract that stated that everyone kept their intellectual property according to their respective institutions’ employment policies. “I understand, but try to understand the way I feel too. I trusted the organization when I entered the hackathon,” says Francine. Francine and Jessica are deeply disappointed by the situation. All the effort they have invested in the project may not be recognized.*

This conversation highlights a clear tension between Hospital B’s clinical staff (Francine and Jessica) and their institution. Existing devices, for instance employment policies, generated a profound distinction in treatment between Pierre and the group’s nurses. Francine and Jessica then felt mistreated, which could have hindered their willingness to collaborate with the project. To deal with this tension and attach clinicians to the project, the research center offers provisional researcher status to Francine and Jessica for the specific project related to MHcardio. This was a quick fix to recognize clinicians under the umbrella of the research center’s intellectual property policy so they can continue developing the project based on their knowledge. This solution changes the clinicians’ identities and status as both researchers and clinicians, stabilizing Jessica, Francine and Pierre as “internals” with the same IP treatment as each other, but different from the “external” MHcardio members. The next part of the discussion at this meeting focuses on how stitching technological contributions of external members and the scientific/clinical contributions was dealt with.

*After discussing Francine and Jessica’s concerns in regard to their IP, Pierre brings back his ideas in regard to managing externals’ and internals’ contributions: “So the idea of the project is to ensure that all research and development remains at Hospital B. And everything that is business-related is in the company. So there would be a kind of MHcardio lab and MHcardio Inc. The MHcardio lab nourishes MHcardio Inc. through research and development. The underlying idea is to solidify the tie between the hospital and the company, since what creates value for the company is access to patients.” Pierre continues to explain the research center representatives’*



*view of their project: "They [the hospital research center] consider that [MHcardio] is not a mobile app. They qualify it as a decision-making tool, and that's the intellectual property of Hospital B. (...) So what she told me is that the three other group members, the programmer, the designer and the architect, they can't claim any intellectual property on this tool. On the other hand, we [internals] can't claim the intellectual property of the code, the design and the architecture either."*

This vignette shows that the group is gradually creating distance between internal and external members. This divide started appearing in the previous vignettes but was solidified by constructing two separate entities: MHcardio lab and MHcardio Inc. External actors' identities are therefore recast as business partners from an external company with strong ties to an internal research lab and as potential licensees of the value that is generated through scientific research. This also strengthens internal members' identities as researchers and prioritizes researchers and clinicians' practices as well as their access to patients above other practices.

This device is built on Hospital B's research center qualification of the project as "a decision-making tool" that can only be built on internal members' knowledge and practices. This implies that internal and external members' contributions, which is based on their individual expertise rather than on their interdependencies, can stand on their own, producing value that can be clearly identified, divided, sequenced, connected and disconnected. Instead of profoundly revisiting existing practices at Hospital B's research center, the group creates a divide between externals and internals to connect a commercial practice to the research center's already existing ways of innovating. This clarifies internals' roles by freeing them from dealing with commercial and technological challenges, which are now relegated to MHcardio Inc. while external actors' identities are qualified from their specific expertise as technologists and entrepreneurs.

#### *4.4.1.3 Outcome: Disconnecting external from internal members to do the Research project (January to May 2018)*

This last story from the MHcardio case stems from the outcomes presented in the previous vignettes, which led the group to focus on the scientific project at the expense of other areas of development. MHcardio had just learned that their research grant proposal had been declined because the scientific committee thought that “*it appeared underdeveloped [in regard to] economic model, data security, integration into the EMR and the importance of the private partner's commitment among other things* (Pierre).” In this last period, we started observing changes in the use of language, for example replacing “*collaboration*” and “*we*” for “*suppliers*” and “*you*,” respectively. Members of Hospital B were clearly differentiating themselves from external contributors. Ultimately, group members ended up differentiating between their respective contributions to the solution, and the division that surfaced in the first vignette caused the project to unravel.

*A couple of months earlier, en route to a scientific conference, Pierre had coincidentally met the CEO of a digital health company (Healthfirm) on a plane who was interested in collaborating with MHcardio by conducting a research project with Pierre's research laboratory. Meetings were organized between MHcardio and Healthfirm to talk about the integration mechanisms of their respective platforms, but they never reached the stage of concrete development despite the goal of producing a functional version to be validated in the research project for April 2018. Antoine was questioning Healthfirm's capacity to integrate MHcardio's platform, and Jessica was not so sure of the licensing business model the collaboration entailed. “Do you know how many patients we would need to have on our platform to make just a few thousand dollars?” said Jessica.*

*At the beginning of May 2018, MHcardio didn't have a sufficiently developed version to begin the research project as planned. Despite the many versions that Antoine prepared over a one-year period, they did not meet Pierre's expectations to start the*

*research-validation project. "He (Pierre) was looking for more than that", said Antoine. Pierre starts a conversation on MHcardio's Slack channel:*

*Pierre [8:28 AM] "for reasons of time and commitment with students and the university, we will proceed to build a [public research grant] with Healthfirm (they committed \$20,000). The goal is to have a functional app for the first test of our clinical management rules (...). "*

*Antoine [9:04 AM] "In short I can understand that you are going with Healthfirm without MHcardio! Yes or No?"*

*Pierre [9:37 AM] "Yes for now because in the short term it's the only solution that seems viable to us to keep our commitments to our students and the university. Currently I urgently need money and a company formally organized with a functional prototype. (...) But it's up to you to demonstrate your ability to commit yourself."*

This *Slack* conversation reflects the cumulative effect of the previous stories and ends up disconnecting MHcardio's external actors while connecting more strongly with other actors and resources - students, university, research grant, functional prototype and a formalized company (Techfirm) - that are part of a scientific agencement. Under this agencement, it is valuable to give the project specific resources that can't come from MHcardio's external members at this point. The configuration of practices and resources from the scientific agencement was specifically tailored for doing research, which required a sufficiently developed mobile application to be validated through scientific methods and sufficient funding. The level of development of the MHcardio Inc. mobile application and the company were therefore evaluated based on scientific evaluation criteria, which explains why the app developed by MHcardio's coders did not seem sufficient. This *Slack* conversation prompts the scheduling of a group meeting two days later.

*Phil starts the conversation by presenting the discussions he had with other MHcardio external members: "One of the questions we had was in regard to the level of exclusivity (with Techfirm), is it something that has been established or that*



*remains to be established with them?" Pierre answers: "It's not impossible that there would be none, because they are not interested in paying royalties in the long run. From the moment that they don't want to pay royalties, well, there is no reason to create exclusivity. (...) They are more interested in accessing patients and validating their own business, their own application that is worth what it's worth (said in a cynical tone). (...) But the difficulty I find myself in now is that I need the project, the clinical validation to start (...) although you're not theoretically very far behind (Pierre)."*

*After listening to Pierre, Antoine, who had been critical of the partnership with Techfirm for the past few months, has already made up his mind. He answers promptly to Pierre, "When we met, we met to collaborate on the MHcardio project. Personally, now that the MHcardio lab is forced to start something, and it decides to go with Healthfirm, I see no point in keeping MHcardio. I don't have any interest in giving my energy and my concentration to this firm, so I personally choose to quit (Antoine)." After a long silence, Fred asks "And if we decided to continue, how does it work in relation to the MHcardio project, the development, all that, is it something that can be kept, or not?" Antoine answers in a cold and serious tone: "The code is mine because I am the developer, the owner because it was developed before the creation of MHcardio. The clinical management rules belong to Jessica." Pierre then adds, "To answer Fred's question, (...) I don't care who the developer is, the research center will sign an agreement with MHcardio. (...) The principle of Jessica's clinical management rules, this remains the property of the research center (Pierre)."*

This story represents the broader outcomes of previous activities as well as the connections and disconnections they produced. They gradually created a separation that was materialized into two different structures - MHcardio lab and MHcardio Inc. - during the previous period, making it easier to divide and disconnect external members to replace them with another external company. Internal members, rather than continuing with MHcardio Inc., opted for a partnership approach with an existing tech firm, which was only interested in validating its own product, but who could invest money in the project to apply for a research grant to fund a specific scientific-validation

project. This approach reproduces innovation models that are typically used at the research center.

This new connection with Techfirm recasts MHcardio's external members' identities as competitors to Techfirm, and therefore as entrepreneurs building a digital technology company that could sign a partnership with Hospital B's research center in the future if they were to sufficiently develop their product and business. This brought up questions between external members like "*do we really want to be business partners?*" (Antoine) and "*what is the level of exclusivity*" (Phil) compared to the earlier more collaborative group meetings focused on developing better health services. This explains Antoine's strong reaction against contributing to a "*firm*" rather than to a "*collaboration*," and his business-like reaction to who gets to keep the produced IP once group members part ways. Based on this division, the value generated was mostly technological (Antoine) and clinical (Jessica), and with their disconnection, the digital (technological) health (clinical) project ended up not materializing, which led them to enroll actors specific to a scientific agencement.

#### ***4.4.2 MHspeech: Creating a New Agencement for Digital Health***

This story details MHspeech's successful construction of a project aligning diverse practices, and its implementation as a pilot project. The following vignettes represent intertwined situations that were dealt with over an 18-month process. The first concerns reaching a collaboration agreement with Hospital A that assigned how intellectual property and commercialization rights would be managed. The second vignette is about the process of aligning the scaling approach to marketize the project. The third vignette represents the outcomes of the previous processes that were materialized into a cohesive sociomaterial arrangement connecting different actors and practices so that they coexist for the project. The specificity of this case is that these devices are negotiated in relation to each other, as interlaced devices, producing a new form of agencement for digital health.

#### *4.4.2.1 Constructing a collaboration and IP agreement with Hospital (August 2014 to July 2016)*

At this point, MHspeech's group is composed of Dinah, a speech therapist working at Hospital A, Robert, a programmer working for Telco and Thomas, a programmer working in the research center of Hospital A, which is a different department than Dinah. After being selected by Hospital A as a promising project to be further supported, MHspeech received a first collaboration agreement draft sent by the hospital's innovation manager. The innovation manager told Dinah: "*we will renegotiate when the project is done. We will evaluate the contribution of every actor and split the IP afterward.*" However, this was not representative of some of MHspeech's member's orientations, which prompted reactions from Robert and Thomas.

*In the following weeks, MHspeech meets with an external legal advisor, Peter, who is Robert's friend, to come up with a counter-proposition. Hospital A's lawyer agrees to meet with the group to discuss the terms of the collaboration and IP agreement. Peter suggests that the hospital could be the sole owner of MHspeech's intellectual property in exchange for MHspeech having the exclusive development and commercialization rights to reap the benefits of the IP that's been created. The hospital lawyer, however, did not see eye to eye with Peter and seemed shocked by the proposal. She replies, "I don't know that there is anything to discuss here. There is no IP yet to protect. You should continue the project and we will see at the end what each of you contributed." After this meeting, MHspeech's group stays at the hospital a little longer to share their impressions of what happened in the meeting. The atmosphere is tense. Robert is frustrated. No one dares to speak for a few seconds. Robert, explaining why he and Peter thought that this suggestion would lead to a better way of collaborating, says: "This approach would greatly simplify our future relationship with the institution. We would no longer have to establish who owns the intellectual property when someone from [Hospital A] contributes to our project."*



Peter and Robert consider IP in a different light than Hospital A's practices would indicate that they do. They proposed creating a new kind of IP agreement that involves two discrete aspects: intellectual property and commercialization rights. Underlying their proposal is the idea that the creation of knowledge is not only valuable through a scientific agencement from MHspeech's standpoint but rather that value is built on securing and producing the means to commercialize that knowledge. This therefore clarifies the distinction between two evaluation networks and transforms the role of IP from a protection and recognition device, as is usually the case in scientific practices, to a device meant to produce commercial value. It would also create a stronger tie with Hospital A, generating a more open collaboration that goes further than MHspeech's specific goals at this point in time to potentially include other actors from the hospital.

The reaction of Hospital A's lawyer shows that the organization's traditional practices are built on a linear approach to development that is focused on creating scientific knowledge that could later be evaluated for its scientific (through publication and research grants) and commercial (through licensing) worth. This approach also connotes value as being produced by individual experts whose specific knowledge can be clearly defined to divide their contributions. In Hospital A's practices, IP is stuck in a scientific agencement that aims at recognizing and protecting inventors for the knowledge they created. This, however, does not recognize Robert's commercial orientation and the challenge of connecting it to the project. The day after this meeting, the group receives an email from Robert saying that he is quitting the project, sparking an intense email exchange:

*From: Robert (September 17 2014 9:31 AM)*

*"I regret to announce that I am quitting the MHspeech project. [...] I do not see how this project could work without major changes to the corporate culture in the hospital."*

*From: Dinah (September 17 2014 9:42 AM)*

*"After all the efforts we have made, I think it is important to finalize at least phase one, which is feasible with little budget."*

*From: Robert (September 17 2014 10:17 AM)*

*"I would like to finish phase one but [...] without us to make it work, it can't work. The other problem is that MHspeech will probably not be a commercial success in phase one, so there will be no money to sustain it. [...] It would be impossible to market it with the kind of agreement the hospital proposes."*

*[...]*

*After exchanging a few emails trying to remedy to the situation, Anthony, Hacking Health's director, is put in the loop to help the group figure out a way to deal with Hospital A to continue its development and keep Robert connected to the project.*

*From: Anthony (Hacking Health Director and Co-founder) (September 18 2014 03:37 PM)*

*"The situation can certainly be frightening since you are trying to set a precedent at the Hospital. However, it's essential to revisit the existing collaboration agreement at the hospital because it is not consistent with startup situations."*

*From: Robert (September 18 2014 04:04 PM)*

*"(...) I would be very happy to reconsider my participation if we had favorable conditions and clear rules."*

This email exchange highlights the role that existing practices ("*corporate culture*") play in helping or hindering connections for the production of specific forms of value. In this case, the existing collaboration agreement can't connect with actors oriented towards producing value through a startup practice. In addition, Dinah's answer shows that she is interested in improving her own clinical activities for her needs and that of her patients. However, Robert's perspective takes into account the more complex issue of sustaining the project rather than producing a quick fix to Dinah's needs. Anthony

presents himself as the spokesman for the startup world, confirming that Hospital A's practices are not consistent with the conditions necessary to produce startups. He also explains that changing this agreement involved profound transformations for the hospital ("*setting a precedent*"). A few days later, Anthony meets with the hospital CEO and lawyer to argue Robert's case.

*Anthony argues that from Robert's perspective, the IP agreement that was suggested by the hospital was very upsetting. The lawyer did not understand why, arguing that every actor is protected with her approach. Anthony explains that Robert could lose all the work he invested in the project if an agreement was not ultimately reached with the hospital. "This explains why Robert wants to sign an agreement before continuing to work (on this project)," says Anthony. The lawyer responds, "But no, he would keep his IP!" Anthony tells the lawyer that Robert would indeed keep his IP, "but without the clinician's IP, Robert's IP isn't worth a dime since it can't become a commercial product." The hospital lawyer starts realizing that MHspeech's situation is different from the ones she usually deals with.*

In this last part of the vignette, Anthony becomes the spokesman for Robert's interests. He justifies Robert's concerns, which are based on his position as an outsider to Hospital A and the scientific practice. This explains why the value of Robert's contribution does not lie within his practice but comes from its hybridization with clinical and scientific contributions. These considerations were, however, not recognized by any devices that are usually attached to Hospital A and the scientific practices. This breakdown forced a negotiation of existing practices, helping Hospital A's lawyer realize Robert's concerns. Finally, this vignette shows how consequential reorganizing this IP device is for connecting actors and pooling their value to produce innovation across practices.

#### *4.4.2.2 Aligning Scaling approaches to marketize the project (December 2015 to July 2016)*

This second vignette builds on the outcomes of the previous one that touched on issues concerning the commercialization process of MHspeech's project. At this point, the



group, which now includes Robert, Dinah and a new peripheral member, Andrea (health researcher), is still in the process of negotiating a collaboration agreement with Hospital A. Dinah and Robert registered the company as equal partners to prepare for signing the collaboration agreement once it's accepted by both parties. This story, however, is about Dinah and Robert having different perspectives on how the project should be marketized to reap benefits. We show them negotiating between two scaling approaches that prioritize either technological or clinical development.

*With the project slowed down by the process of building a collaboration agreement with Hospital A, Robert, who has decided to stay with the group, is trying to come up with new ways to commercialize their product. He is convinced that MHspeech, as designed in the hackathon, is too specific to be commercially profitable and that this could not attract venture capital funding. Rather than developing the MHspeech product for speech-language pathologists, Robert is proposing to develop a platform (Telemed) that provides tools to clinicians to intuitively create a mobile application for their services. Dinah resists the idea. At one of the group's weekly meetings, she argues with Robert: "But I'm telling you, Robert, (...) there are doctors who came to me asking 'could we record 5-minute clips of children at home to evaluate their behavioral development?' We can make derivatives of MHspeech, like in our Telemed platform model, and create derivatives for autism for example, but always from MHspeech's foundations." Once again, Robert seems only half convinced by Dinah's arguments. At the next weekly meeting, he says "there is no commercial potential with MHspeech alone. I did some ROI [return on investment] analysis, and I don't see how MHspeech alone could [turn profits]." Dinah confides to me later: "This [the development potential for other health disorders], Robert doesn't see it. But it's okay because he's not a clinician. "*

This vignette shows the difference between Robert and Dinah's orientations. Robert aims to construct a project that can connect with venture capitalists' resources while Dinah is focused on developing across different clinical practices. Dinah sees opportunities to scale the project based on her clinical and disciplinary knowledge and her relations with other "users" from different clinical practices while Robert sees it

through his technological and commercial knowledge and prior experience with working in a tech business. This produces different scaling orientations, one of which was based on using the project's existing technological features to expand to other clinical practices (Dinah), while the other was based on technological development of the Telemed platform (Robert). Robert uses a ROI analysis to evaluate their project's current potential worth and its capacity to connect to a more commercial path. This ROI approach, which is related to commercial practices, could not calculate the potential of scaling through Dinah's approach, meaning that different forms of evaluation practices, and then different devices, had to be involved in validating the project's worth. This differentiation between Robert and Dinah strengthens their relative identities as technological entrepreneur and clinician respectively, with both of them feeling the other doesn't understand their perspective.

*A couple of weeks later, Robert and Dinah meet with health technology specialists - experienced entrepreneurs and engineers - associated with Hacking Health. Despite the progress in developing MHspeech's mobile app in the last few weeks, Robert comes back with his idea of the Telemed platform, explaining that he thought there was more commercial potential to attract investors' attention. Etienne, one of the health tech specialists, intervenes: "for investors, [developing a platform] is not as good as staying in the MHspeech niche and you become the standard for speech pathologies and maybe autism if you potentially develop MHspeech horizontally. You have this expertise and it differentiates you from others." Dinah and Robert stay together after the meeting to talk it through. Dinah tells Robert that they could start by developing MHspeech to sell to clinicians, and "then create screening features to sell it directly to patients." Robert replies smoothly "I really liked our conversation, it made me reflect on the project. In fact, I don't mind one way or the other, I just want to go to a wider market than speech therapy." He then starts grilling Dinah with questions about what clinical screening is. After Dinah's explanation, he says, "It's really impressive." Dinah replies, "I know! That's what I've been telling you from the outset!"*



This last part of the vignette represents a meeting with experienced health technology entrepreneurs. Etienne (one of these entrepreneurs) explained that venture capitalists would value a product developed from a basis of profound and specialized clinical expertise that become standard in a “niche” market. It therefore identifies the project as a service for speech pathologies, which differentiates the company from others on the digital health market. Etienne translated Dinah’s perspective of expanding to other clinical practices into commercial language, valuing and connecting her orientation with a commercial orientation. Dinah even told me later that evening: *“finally someone who is able to put my reluctance [to focus on Telemed] into words.”* This translation had a strong impact on Robert’s perspective, opening his mind to other development approaches, despite his continuing interest in constructing a project *“to go to a wider market.”* This brought Dinah and Robert’s clinical and commercial practices closer, explaining why Robert ends up showing a growing interest in learning about *“clinical screening.”*

#### *4.4.2.3 Outcome: Signing the collaboration agreement to start the Pilot Project (August and September 2016)*

This story occurs a couple of weeks after the meeting represented in the previous vignette and shows that the accumulation of previous outcomes led to the construction of an agencement that linked Robert, Dinah and Andrea’s technological, startup, clinical and scientific practices to produce a digital health project.

*During their weekly meeting, Dinah, as usual, shares new information she gathered from Hospital A. “Jan (the hospital’s associate director) wants us to sign. She said that our research protocol is good, and that the collaboration agreement (which relied on some aspects of the business model) we presented was good too.” This implies that, in order to sign the collaboration agreement with the hospital, the project had to be aligned with the hospital in terms of their research and business model, and therefore that all these devices had to be attached. The collaboration agreement involved an IP agreement built on the new conceptualization suggested by Robert and Peter, which separated IP as recognition (scientific) and as a*



*commercialization (startup) device. "So when we sign, we can start the research project. [...] Yet, we should really think about whether there are people who are interested in buying the service. And we do need a publication at some point, regardless of the type of publication (Dinah)." Robert seems reassured. His fear of ignoring the commercial aspects is dissipating. "Yes, it's important to validate our business model as well" says Robert. The process they constructed helped validate technological and commercial development while doing the clinical validation research. At the end of the meeting, Dinah tells me about the type of publication she has in mind: "We will publish in a journal, probably a very clinical journal, which is less scientific. Scientific committees are less demanding in these more clinically oriented journals."*

This story shows that the different devices that were synchronically negotiated – for instance, the collaboration and IP agreement, research protocol, and the scaling approach - connected different actors, resources and knowledge to the project. This produced an agencement at the intersection of different practices, creating the means to begin the “*pilot project*” to validate the underlying scientific, clinical, commercial and technological hypotheses of the project while meeting these different practices’ evaluation criteria. To do so, each actor agreed to adapt the evaluative principles related to the practices they identify with. For example, Dinah, despite her initial interest “*in the scientific aspect more than the commercial aspect*” (Dinah) agreed to publish in a clinical publication with “*less demanding scientific committees*” rather than engaging in a more scientific process that would not have been consistent with the project's stage of technological and commercial development. This means that the scientific features of the project were subjected to less rigorous evaluation criteria from a scientific standpoint to leave some room for other practices to coexist in the project. The pilot project is also used as a means to validate the technological features of the project and the commercial value of the product. On the other hand, Robert agreed to orient the project towards a trajectory that did not necessarily suit his market evaluation based on a ROI analysis. In the end, their pilot project is a means to validate the project’s value under a variety of practices, from clinicians and medical teams, entrepreneurial actors and researchers’

practices, generating a more open model of innovation. The new devices developed by MHspeech changed the linear model of innovation that is embedded in Hospital A's existing configuration of practices, actors and devices. This means that signing the collaboration agreement actualized the new connections and the new model of innovation that have been progressively constructed throughout the process of producing MHspeech as a digital health project.

#### **4.5 Discussion**

The purpose of this article was to highlight the “bifurcation of agency” (Muniesa et al., 2007) that underlies existing considerations for the effect of material instruments, such as IP and business model instruments, in open innovation research. As we discussed, this separation from the socio-material configurations of knowledge, actors, relations and other devices that make actions and instruments whole can't explain the full picture of what is disrupted when opening innovation to connect actors, knowledge and resources that are built on and locked in different socio-material configurations. Co-producing innovative outcomes across different agencements is then inseparable from reshuffling, aligning and transforming different agencements built on different resources, devices and practices. We then set out to investigate *“how is an existing configuration of resources, devices and practices transformed for the production of a new digital health agencement?”*

In this section, we first present our view of the infrastructure that was uncovered when examining the socio-material configurations at play during the critical moments MHcardio and MHspeech faced in their development. We then draw on such considerations and the findings of the preceding section in order to explain how each project ended up producing different models of innovation (Godin, 2006; 2017) - a linear model of innovation in the case of MHcardio and an open model of innovation for MHspeech - that ended up producing a scientific research project and a digital health project, respectively. We contrast the reproduction of this “linear model of innovation” that is built on a rigid sequencing of activities, from scientific discovery to commercialization, which ends up producing a scientific project to the creation of an



“open model of innovation” that reshuffled and combined existing agencements for the production of a new form of agencement in the form of a digital health project.

#### ***4.5.1 Infrastructuring Models of Innovation for Digital Health***

This research has helped us bring to light what was hidden underneath the surface of Hospitals A and B’s models of innovation and that needed to be changed for the production of a digital health project. Just like Hardie and MacKenzie (2006) used the notion of agencement to highlight the “conditions of possibility of economic actors: the often-ignored infrastructure that enables them to be the actors they are,” the notion of agencement helped us uncover what oriented MHcardio towards becoming a scientific project and MHspeech towards becoming a digital health project.

Infrastructures are black-boxed artifacts and actors upon which other actions and actors are constructed, to the point that they become invisible (Star and Ruhleder, 1996) when they are “smoothly-functioning” (Hardie and MacKenzie, 2006). These infrastructures are fundamental for actors’ activities (Bowker and Star, 2000; Hardie and MacKenzie, 2006) and then are highly consequential to the way they innovate and collaborate. According to Nicolini et al. (2012), “Although they are often forgotten, numerous ‘boring objects’ (Star 1999) combine, structure, anchor, and enable collaborative work.” Infrastructures operate under the surface and only become visible when a breakdown occurs in practice (Star, 1999), mostly when different agencements are connected because they each rely on different “invisible” infrastructures that generate friction when they are intersected. Connecting new actors to each other generates new relations that can create frictions and breakdowns related to their respective agencement’s infrastructure. For instance, Camille, a patenting expert from IPfirm, when talking about the complexity of constructing the means to help the project progress by moving from the hackathon to the hospital, had this to say during a meeting with MHcardio represented in the second vignette about this group project:

*“(…) the contextual complexity that creates obstacles like the ones we are trying to solve now emerge because there are not so many [projects from digital health hackathons] that are carried out to the end. (...) if we account for [the hospital’s*



*internal] complexity, and add that a structure (Hacking Health) that is completely external to the hospital and that doesn't have all the legal information either, well it creates glitches between organizations, between contracts that may contradict each other a little. And it's by observing these glitches and the related struggles that we will perhaps improve structures for future projects."*

This quotation highlights the power of agency of devices ("contracts") upon which organizations and innovation models are built and that bear their respective meaning that can be difficult to reconcile for the production of new agencements. Indeed, existing contracts at Hospital B were meant to orient a specific approach to innovation that was different than the one implied by the Hacking Health hackathon participation contract. As a lawyer involved in writing the latter contract said:

*"(...) a hackathon, by definition, involves creation under conditions of chaos (...) with a great mix of ideas from everyone. (...) So we were walking a fine line not to impede the creative process and our big fear (...) of predetermining the way to go, which isn't good for the creative process. So we prepared something to be signed to minimally regulate the process, and then we told ourselves we'll see what happens."*

This participation contract was tailored to foster a collective process of creative combination of different actors' knowledge and ideas by leaving flexibility in regard to the form the project would become. This flexible and collective process that was meant for intersecting multiple agencements was, however, profoundly different from that of Hospital B. This explains why creating these new intersections of actors and resources, and therefore different agencements, generated breakdowns that were difficult to predict because of the transparent nature of the infrastructures at play (Star, 2010). For example, in the second vignette about MHcardio, we showed that the breakdown between the hackathon participation contract and Hospital B's IP policies revealed the problematic difference in IP treatment between researchers and clinicians that was materialized in clinicians' employment policies. This brought to light an infrastructure that was taken for granted at Hospital B and that was foundational to the model of innovation

traditionally used at the hospital, which gave primacy to scientific discoveries from the research center.

These considerations emerged from the comparison of the outcomes of (1) MHcardio, which failed to produce its digital health project and ended up reproducing a linear model of innovation for the production of a scientific research project and (2) MHspeech, which created and interlaced different agencements, transforming existing devices to produce an open model of innovation and a digital health project.

#### ***4.5.2 Reproducing a Scientific Agencement***

In the case of MHcardio, our vignettes highlight the progressive orientation given to the project to become a scientific project. In the first vignette, we showed a startup configuration of practice that was at odds with a scientific configuration when the group tried to incorporate as a company. Under the commercial agencement, the incorporated company needed to own 100% of the intellectual property produced, with a shareholder agreement that would be “*completely neat, and that can’t leave venture capitalists wondering* (MHcardio lawyer).” This model was based on a concept of companies that can rapidly scale by building on venture capital funding. However, assigning the produced IP to the company would have identified the researchers as entrepreneurs, which would have blocked Pierre’s ability to apply to a research grant as the lead researcher. The group therefore created an empty shell company (without assigning its members’ individual IP to the company) as a placeholder to potentially sign a collaboration agreement with Hospital B’s research center and look for venture capital funding. However, to do so, Jessica, Francine and Pierre assigned their IP to IPfirm, which protected the IP of researchers from Hospital B’s research center during their research before commercializing it by licensing it out to external companies. IPfirm is thus an infrastructure operating in the background, supporting the linear scientific model of innovation. Assigning “internals” IP to IP firms created the first separation within the group, which allowed them to apply to a research grant to fund their research project, but oriented the project towards a scientific orientation.



In the following critical event related to dealing with the differences in IP treatment, Francine and Jessica were given provisional researcher status to be recognized under the research center's IP policy, which assigns 50% of the revenue from IP to the research center. This distribution of IP shares is built on the concept that the risks that help generate researchers' discoveries is taken on by the research center, which provides the infrastructure, such as technicians, laboratories and access to patients. Assigning this provisional status generated a stronger association with the scientific configuration of the research center, which increased its agentic power to produce a scientific orientation for the project. In addition, the group split between MHcardio lab and MHcardio Inc., dividing the clinical-scientific and the technical-startup actors, with the scientific actor taking a primary role to generate value to be given later to the startup actor. The product was even qualified by the research center director as a "*clinical decision-making tool*" in the declaration of invention, clarifying that external group members could not have generated this. Researchers therefore aimed at validating clinical hypothesis through rigorous scientific methods to answer scientific evaluation criteria, which required producing an application robust enough to be experimentally validated. Whereas external members (coder, designer, architect) wanted to develop the product in a more iterative manner, internal members (within the scientific configuration of practice) needed to rely on a sufficiently developed version of the product in terms of "*economic model, data security, integration into the EMR and the financial contribution of the private partner.*" This explains why Pierre's "*only solution*" was to collaborate with Techfirm, who had the capacity to finance the research and whose product was more advanced. Pierre's action was oriented by the underlying infrastructure of "*the research grant, students and the university*" that made him a researcher.

In the end, MHcardio reproduced the scientific configuration of practice's model of innovation that was built into the research center's innovation infrastructures. This model of innovation was based on a specific conceptualization of innovation that was built on devices like a declaration of invention and IP policy, and actors like IPfirm and the research center as well as a specific sequencing of activities from scientific discovery to development and commercialization. This explains why MHcardio wasn't



able to attach its external members, who ended up leaving the project, turning it into a project that produces value specific to a scientific configuration.

#### ***4.5.3 Creating a new Agencement for a Digital Health Project***

In contrast, MHspeech's case highlights how different configurations of practice were aligned to produce a digital health project based on creating a new agencement. Infrastructures similar to those presented in MHcardio's case were also at play in MHspeech's connection to Hospital A. For instance, in the first vignette about MHspeech, we showed how consequential the IP device was as it almost pushed Robert out of the project. The complexity of changing this infrastructure is clearly stated in Anthony's email to MHspeech's group members:

*"The situation can certainly be frightening since you are trying to set a precedent at the hospital. However, it's essential to revisit the existing agreement at the hospital since it is not consistent with startup situations."*

This statement highlights the infrastructural potential ("trying to set a precedent") of the change Robert and Peter suggested to Hospital A, or more precisely the connection between the immediate and the longer term - what Ribes and Finholt (2009) labeled the "long now" - that the concept of infrastructure underscores. Changing this agreement could lead to the agencing of other projects under similar rules, relations and resources. In this quote, Anthony also stresses the breakdown that occurs around the construction of an IP agreement, which brings to light the different orientations of Hospital A's and startup's configurations. This format of IP agreement, however, was more than an issue of a contract as an instrument. This instrument was stabilized with other things and actors functioning under the surface, like other practices, a firm specialized in IP protection, licensing and commercialization (IPfirm), devices (IP and collaboration agreements) and human actors (for instance, Hospital A's lawyer). These infrastructures were invested in a specific model of innovation, just like in Hospital B's case. Indeed, Hospital A's IP policy was built on a model of innovation that relied on producing scientific knowledge and inventions before evaluating its commercial value, licensing it out for its development and then commercializing it. As such, the existing IP policy and

this whole configuration of socio-material relations was ‘black-boxed,’ producing specific activities related to innovation that needed to be changed to manage the breakdowns that occurred when introducing a new “startup” configuration of practice. Hospital A and MHspeech ended up creating a new IP agreement that accounted for the different actors’ interests from different configurations (clinical, scientific, technological and commercial).

Rather than maintaining the existing conceptualizations of IP of either startup or scientific configurations, Robert and Peter’s revised approach, which assigned IP as a protection and recognition device to Hospital A in exchange for exclusive rights of commercialization, created a new device that bridged scientific and startup interests. This created a new method for aligning the scientific and startup configurations, which were traditionally aligned in a linear fashion, to create a new model of innovation allowing for transformation to occur by generating new connections between different worlds that “makes possible new kinds of joint endeavor” (Star and Griesemer, 1989) for the development of new forms of value of digital health nature.

In addition, the selected scaling model (see the second vignette on MHspeech), which would be developed horizontally across different medical practices instead of a technological approach related to constructing a broader platform, helped connect the clinical, technological and startup configurations by reconceptualizing the scaling model taken from a technological-startup orientation. Robert tested MHspeech’s potential as a niche product for speech therapy to turn profits with a ROI analysis, which showed the project to be too specific to produce financial benefits under a technological-startup orientation. If the group was oriented by this device, MHspeech could have stopped its development process or changed its orientation towards the technological development of a platform that would later be implemented in hospitals. However, by translating Dinah’s clinical scaling model (*“We can make derivatives of MHspeech (...) for autism for example, but always from MHspeech’s foundations.”*) into commercial language (*“for investors, [developing a platform] is not as good as if you stay in the MHspeech niche and you become the standard for speech pathologies and maybe autism if you potentially develop MHspeech horizontally. You have this expertise and it differentiates*



*you from others.*"), Etienne provided a new conceptualization of a scaling model at the intersection of Dinah's clinical orientation and Robert's technological-startup orientation. This contributed to Robert and Dinah enrolling in a new agencement that aligned clinical, technological and commercial configurations of practice.

In the end, MHspeech produced a pilot project rather than a scientific research project, to *"really think if there are people who are interested in buying the service,"* which means validating the startup hypothesis of the project, while producing *"a publication at some point, regardless of the type of publication (Dinah),"* recognizing the need to scientifically validate the project. Changing the way to value a project, and therefore the orientation of activities to produce value, profoundly changed existing relations for the creation of a digital health project that connects and aligns actors, devices, knowledge and resources from different configurations. For instance, the type of publication that was selected was based on less rigorous scientific evaluation criteria, which helped produce a pilot project that gave some room to validating the clinical, technological and commercial hypothesis while the scaling model was meant to develop across different medical practices rather than through more technological development. The pilot project was the materialization of the hybrid form of digital health project that was produced because of the creation of a new agencement that aligned different configurations of practice.

#### **4.6 Conclusion**

In this article, we have explored the process of producing a digital health project and its deeper impact on the socio-material configurations behind actors' practices. We tracked the progressive creation of two projects to explain the challenges of changing existing models of innovation and better see how a digital health project is produced while considering its impact on existing configurations of practice. The increasing role digital technologies play in health is leading to interactions between actors that are new to each other, which generates profound pragmatic issues. To address this pragmatic layer, we used a practice-based approach built on the concept of agencement that helped unpack the performative effect of specific devices as well as the way they were changed to



produce a new model of innovation that allowed for more transformation in actors' practices for the production of a digital health project.

Our comparative case study approach was especially revealing of the challenges these processes entailed since it allowed us to track the construction of projects from the alignment of existing configurations of practice. What stood out in our analysis is that for a digital health project to be produced, its contributors had to profoundly change their practices to create an agencement specific to their digital health project while taking into consideration evaluation criteria from other configurations (e.g. scientific, commercial, technological and clinical). These changes involved a redefinition and reconfiguration of the underlying infrastructures that shape the specific orientations that are traditionally mobilized in health for the creation of a new forms of agencement that had yet to generate its own configuration of actors, devices and knowledge. This perspective explains why MHcardio ended up reproducing a scientific project while MHspeech became a digital health project.

Our research helps understand how digital health is changing the practices of modern medicine (Topol, 2012) and health science (Lang, 2011) while it also changes commercial and technological practices. It however also shows why the digital turn in healthcare is so difficult to produce. We pinpoint the different evaluation criteria, devices, actors and practices at play that need to be revised for digital innovation to have an impact in health. This impact, however, is deeper than the visible actions of innovators and of the outputs in the form of the products they implement. It also, and more importantly, produces transformations in existing configurations.

## References

- Barley, S. R. (1990). Images of imaging: Notes on doing longitudinal field work. *Organization science*, 1(3), 220-247.
- Bechky, B. A. (2011). Making organizational theory work: Institutions, occupations, and negotiated orders. *Organization Science*, 22(5), 1157-1167.

- Benkler, Y. (2006). *The wealth of networks: How social production transforms markets and freedom*. New Haven, Yale University Press.
- Beunza, D., Hardie, I., & MacKenzie, D. (2006). A price is a social thing: Towards a material sociology of arbitrage. *Organization studies*, 27(5), 721-745.
- Bowker, G. C., & Star, S. L. (2000). *Sorting things out: Classification and its consequences*. Cambridge, MIT press.
- Cabantous, L., & Gond, J. P. (2015). The resistible rise of Bayesian thinking in management: Historical lessons from Decision Analysis. *Journal of Management*, 41(2), 441-470.
- Cabantous, L., Gond, J. P., & Johnson-Cramer, M. (2010). Decision theory as practice: Crafting rationality in organizations. *Organization Studies*, 31(11), 1531-1566.
- Çalışkan, K., & Callon, M. (2009). Economization, part 1: shifting attention from the economy towards processes of economization. *Economy and society*, 38(3), 369-398.
- Çalışkan, K., & Callon, M. (2010). Economization, part 2: a research program for the study of markets. *Economy and Society*, 39(1), 1-32.
- Callon, M., & Caliskan, K. (2005). New and old directions in the anthropology of markets. *Wenner-Gren Foundation for Anthropological Research, New York*, 9.
- Callon, M., & Muniesa, F. (2005). Peripheral vision: Economic markets as calculative collective devices. *Organization studies*, 26(8), 1229-1250.
- Callon, M., Millo, Y., & Muniesa, F. (2007). *Market devices* (No. halshs-00177891).
- Callon, M. (1998). Introduction: the embeddedness of economic markets in economics. *The Sociological Review*, 46(S1), 1-57.
- Callon, M. (2013). Qu'est-ce qu'un agencement marchand. *Sociologie des agencements marchands*, 325-440.
- Callon, M. (2017). Markets, marketization and innovation. In Bathelt, H., Cohendet, P., Henn, S., & Simon, L. (Eds.). (2017). *The Elgar Companion to Innovation and Knowledge Creation*. Cheltenham, Edward Elgar Publishing, p. 589-609.

- Carlile, P. R., & Dionne, K. E. (2018). "Unconventional yet consequential" in Bryman, A., & Buchanan, D. A. (Eds.) *Unconventional Methodology in Organization and Management Research*. Oxford, Oxford University Press, p. 233-254.
- Carlile, P. R. (2002). A pragmatic view of knowledge and boundaries: Boundary objects in new product development. *Organization science*, 13(4), 442-455.
- Centemeri, L. (2015). Reframing problems of incommensurability in environmental conflicts through pragmatic sociology: From value pluralism to the plurality of modes of engagement with the environment. *Environmental values*, 24(3), 299-320.
- Chesbrough, H. (2003). The logic of open innovation: managing intellectual property. *California Management Review*, 33-58.
- Chesbrough, H. (2003). *Open innovation*. Cambridge, Harvard Business Press.
- Chesbrough, H. W. (2006). *Open innovation: The new imperative for creating and profiting from technology*. Cambridge, Harvard Business Press.
- Cohendet, P., Farcot, M., & Pénin, J. (2006). Entre incitation et coordination: repenser le rôle économique du brevet d'invention dans une économie fondée sur la connaissance. *Management International*, 10, 65-84.
- Corradi, G., Gherardi, S., & Verzelloni, L. (2010). Through the practice lens: Where is the bandwagon of practice-based studies heading?. *Management learning*, 41(3), 265-283.
- D'Adderio, L., & Pollock, N. (2014). Performing modularity: Competing rules, performative struggles and the effect of organizational theories on the organization. *Organization Studies*, 35(12), 1813-1843.
- Desrosiers, G. (1999). Le système de santé au Québec bilan historique et perspective d'avenir: Conférence inaugurale du 51e congrès de l'Institut d'histoire de L'Amérique française, octobre 1998. *Revue d'histoire de l'Amérique française*, 53(1), 3-18.
- Dionne, K. E., and P. R., Carlile (2019). "Opening innovation" across layers of practices: Developing an integrative view of the emergence of digital health in Berends,



H., Y., Sydow (Eds.), Managing Inter-organizational Collaborations – Process Views, Research in the Sociology of Organizations (RSO) Series, ed. by Michael Loundsbury.

Dittrich, K., & Duysters, G. (2007). Networking as a means to strategy change: the case of open innovation in mobile telephony. *Journal of product innovation management*, 24(6), 510-521.

Eymard-Duvernay, F. (2002). Les qualifications des biens. *Sociologie du travail*, 267-272.

Feldman, M. S., & Orlikowski, W. J. (2011). Theorizing practice and practicing theory. *Organization science*, 22(5), 1240-1253.

Gherardi, S. (2010). Telemedicine: A practice-based approach to technology. *Human relations*, 63(4), 501-524.

Gherardi, S. (2016). To start practice theorizing anew: The contribution of the concepts of agencement and formativeness. *Organization*, 23(5), 680-698.

Godin, B. (2006). The linear model of innovation: The historical construction of an analytical framework. *Science, Technology, & Human Values*, 31(6), 639-667.

Godin, B. (2017). *Models of innovation: The history of an idea*. Cambridge, MIT Press.

Gulbrandsen, M., Hopkins, M., Thune, T., & Valentin, F. (2016). Hospitals and innovation: Introduction to the special section. *Research Policy*, 45(8).

Hanel, P. (2006). Intellectual property rights business management practices: A survey of the literature. *Technovation*, 26(8), 895-931.

Hardie, I., & MacKenzie, D. (2007). Assembling an economic actor: the agencement of a Hedge Fund. *The Sociological Review*, 55(1), 57-80.

Henkel, J. (2006). Selective revealing in open innovation processes: The case of embedded Linux. *Research policy*, 35(7), 953-969.

Hertzfeld, H. R., Link, A. N., & Vonortas, N. S. (2006). Intellectual property protection mechanisms in research partnerships. *Research Policy*, 35(6), 825-838.

- Hiennerth, C., Keinz, P., & Lettl, C. (2011). Exploring the nature and implementation process of user-centric business models. *Long Range Planning*, 44(5-6), 344-374.
- Lamont, M. (2012). Toward a comparative sociology of valuation and evaluation. *Annual review of sociology*, 38, 201-221.
- Lang, T. (2011). Advancing global health research through digital technology and sharing data. *Science*, 331(6018), 714-717.
- Langley, A., & Abdallah, C. (2011). Templates and turns in qualitative studies of strategy and management. In *Building methodological bridges* (pp. 201-235). Emerald Group Publishing Limited.
- Latour, B. (1987). *Science in action: How to follow scientists and engineers through society*. Cambridge, Harvard university press.
- Manzini, R., & Lazzarotti, V. (2016). Intellectual property protection mechanisms in collaborative new product development. *R&D Management*, 46(S2), 579-595.
- Mehlman, S. K., Uribe-Saucedo, S., Taylor, R. P., Slowinski, G., Carreras, E., & Arena, C. (2010). Better practices for managing intellectual assets in collaborations. *Research-Technology Management*, 53(1), 55-66.
- Miles, M. B., Huberman, A. M., Huberman, M. A., & Huberman, M. (1994). *Qualitative data analysis: An expanded sourcebook*. Thousand Oaks, SAGE.
- Muniesa, F., Millo, Y., & Callon, M. (2007). An introduction to market devices. *The sociological review*, 55(2\_suppl), 1-12.
- Nicolini, D. (2012). *Practice theory, work, and organization: An introduction*. Oxford, Oxford University Press.
- Nyberg, D., & Wright, C. (2016). Performative and political: Corporate constructions of climate change risk. *Organization*, 23(5), 617-638.
- Orlikowski, W. J., & Scott, S. V. (2008). 10 sociomateriality: challenging the separation of technology, work and organization. *The academy of management annals*, 2(1), 433-474.

Orlikowski, W. J. (2007). Sociomaterial practices: Exploring technology at work. *Organization studies*, 28(9), 1435-1448.

Orlikowski, W. J. (2010). Practice in research: phenomenon, perspective and philosophy. *Cambridge handbook of strategy as practice*, 23-33.

Østerlund, C., & Carlile, P. (2005). Relations in practice: Sorting through practice theories on knowledge sharing in complex organizations. *The Information Society*, 21(2), 91-107.

Paasi, J., Luoma, T., Valkokari, K., & Lee, N. (2010). Knowledge and intellectual property management in customer-supplier relationships. *International Journal of Innovation Management*, 14(04), 629-654.

Patton, M. Q. (2005). *Qualitative research and Evaluation Methods*. Thousand Oaks, Sage Publications.

Pickering, A. (1993). The mangle of practice: Agency and emergence in the sociology of science. *American journal of sociology*, 99(3), 559-589.

Pisano, G. P., & Teece, D. J. (2007). How to capture value from innovation: Shaping intellectual property and industry architecture. *California management review*, 50(1), 278-296.

Ribes, D., & Finholt, T. A. (2009). The long now of infrastructure: Articulating tensions in development. *Journal of the association for information systems*, 10(5), 375-398

Saebi, T., & Foss, N. J. (2015). Business models for open innovation: Matching heterogeneous open innovation strategies with business model dimensions. *European Management Journal*, 33(3), 201-213.

Schatzki, T. (2001). Introduction: practice theory. *The practice turn in contemporary theory*.

Slowinski, G., Hummel, E., Gupta, A., & Gilmont, E. R. (2009). Effective practices for sourcing innovation. *Research-Technology Management*, 52(1), 27-34.



- Somaya, D., Kim, Y., & Vonortas, N. S. (2011). Exclusivity in licensing alliances: using hostages to support technology commercialization. *Strategic Management Journal*, 32(2), 159-186.
- Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, Sage.
- Star, S. L. (1999). The ethnography of infrastructure. *American behavioral scientist*, 43(3), 377-391.
- Star, S. L., & Griesemer, J. R. (1989). Institutional ecology, translations and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social studies of science*, 19(3), 387-420.
- Star, S. L., & Ruhleder, K. (1996). Steps toward an ecology of infrastructure: Design and access for large information spaces. *Information systems research*, 7(1), 111-134.
- Star, S. L. (2010). This is not a boundary object: Reflections on the origin of a concept. *Science, Technology, & Human Values*, 35(5), 601-617.
- Suchman, L. (2000). Organizing alignment: A case of bridge-building. *Organization*, 7(2), 311-327.
- Suchman, M. C. (2003). The contract as social artifact. *Law & Society Review*, 37(1), 91-142.
- Swan, J., Bresnen, M., Newell, S., & Robertson, M. (2007). The object of knowledge: the role of objects in biomedical innovation. *Human relations*, 60(12), 1809-1837.
- Topol, E. J. (2010). Transforming medicine via digital innovation. *Science translational medicine*, 2(16).
- Topol, E. J., & Hill, D. (2012). *The creative destruction of medicine: How the digital revolution will create better health care*(p. 2). New York: Basic Books.
- Van de Vrande, V., De Jong, J. P., Vanhaverbeke, W., & De Rochemont, M. (2009). Open innovation in SMEs: Trends, motives and management challenges. *Technovation*, 29(6-7), 423-437.

Vanhaverbeke, W. (2006). The interorganizational context of open innovation. *Open innovation: Researching a new paradigm*, 205-219.

Vatin, F. (2013). Valuation as evaluating and valorizing. *Valuation Studies*, 1(1), 31-50.

West, J., & Gallagher, S. (2006). Challenges of open innovation: the paradox of firm investment in open-source software. *R&d Management*, 36(3), 319-331.

Yin, R. K. (2017). *Case study research and applications: Design and methods*. Thousand Oaks, Sage publications.

## Appendix 4.1: Tables Analyzing Data from MHcardio

### 1.1 Creating an empty shell and dormant company (1 of 2)

Data	Recontextualization	What is produced
<p><i>"as a lawyer who works in this kind of environment [the startup world], based on what I understand of the project, I would put 100% of the property in the company." (...)</i></p> <p><i>"our (the firm's) contractual structures are always built for companies that will have to raise capital in the short or medium term to continue their growth."</i></p>	<p>This suggests that the lawyer is part of the startup agencement that produces a specific understanding of the way the project should be constructed. This agencement generates an understanding of intellectual property and company incorporation as devices tailored for raising financial capital from venture capitalists. This is the beginning of the construction of a "market agencement" towards the marketization of this project</p>	<p>Group members are identified as entrepreneurs aiming to generate growth potential to attract venture capital funding. With the construction of this agencement, group members would become partners of a company built to orient subsequent actions towards connecting with resources and actors from the startup world.</p>

### 1.2 Creating an empty shell and dormant company (2 of 2)

Data	Recontextualization	What is produced
<p><i>"So the first part of this solution is that IPfirm takes the intellectual property of the three members [of Hospital B]. The three externals don't put their IP in IPfirm and we create a company. (...)</i></p>	<p>Hospital B is entangled with IPfirm whose role is to patent, protect and commercialize IP produced by university scientists. This service is paid for by Hospital B's research center, which aims to help its own professionals. This entanglement produces specific practices to producing inventions and commercializing it.</p>	<p>It connects clinicians and the researcher with Hospital B and disconnects external and internal group members. This strengthens clinicians and the researcher's identities as members of Hospital B while reaffirming coder, designer and architect identities as external contributors. This increases the differentiation between external and internal.</p>



<p><i>"Since we have enough money to work until September, this pushes back the decision to September until we know what happens."</i></p>	<p>This money comes from a pharmaceutical company and is embedded in a scientific agencement, which Pierre and Jessica are part of. The money was moved from the company, through the research center (which received its traditional 30% share), to Pierre's research funds. This money was redirected to begin a research project to validate patients' experience of the developed mobile application and to postpone the decision on the orientation that the project will take in the long run.</p>	<p>These resources are specifically intended to drive the research project forward, and can't be applied to developing the technological or commercial features of the project. It therefore produces a linear approach to project development, from developing scientific knowledge towards commercializing the produced IP. It also creates a hierarchy, with the research side of the project taking precedence. This is where the project starts being qualified as a research project.</p>
<p><i>Then Fred says "since the IP is in IPfirm for you and the externals' is not in the company either..." Pierre cuts him "You are free electrons." Fred continues on his idea "Yes, so [with that option], you [from Hospital B] can still apply [for a grant] because there is still no formal tie [with the company]."</i></p>	<p>The research agency Pierre wanted to apply to did not allow researchers to be part of the company they were collaborating with. The device that is produced connects with practices specific to research. By applying to a research grant, one would therefore produce a research project.</p>	<p>External actors are not yet stitched together with the hospital and its members while internal actors are not stitched to the company.</p> <p>Because the IP is not in the company yet, the company does not belong to the startup world.</p> <p>This MOU is a temporary fix that creates a less stable association with different potential orientations for future connections with either scientific actors or actors from the startup agencement. It opens different opportunities for connection and generates fuzzy identities for group members as internal/external and external/internal.</p>

### 1.3 Fixing differences in IP treatment within and across Hospital B's boundaries (1 of 2)

Data	Recontextualization	What is produced
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<p><i>"The research center's director told me that she was going to solve the problem by giving Francine and Jessica researcher status (Pierre)."</i></p>	<p>This is the way this type of situation is usually dealt with at Hospital B. This is meant to create a quick fix so that clinicians are recognized under the umbrella of the research center's intellectual property to continue contributing to developing knowledge.</p>	<p>This is an example of a patch, which is specifically designed for a single use. It only bridges two actors at a time.</p> <p>This reshuffled clinicians' identities as both researchers and clinicians, although in practice, their resources provided under their employment agreement only allows them to work in clinic.</p> <p>This created the means for clinicians to be recognized for their contributions. This stabilized the group of clinicians and the researcher as "internals" because they now receive the same IP treatment. However, they have a different one than "externals," which creates a differentiation among MHcardio group members.</p>
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#### 1.4 Fixing differences in IP treatment within and across Hospital B's boundaries (2 of 2)

Data	Recontextualization	What is produced
<p><i>"So the idea of the project is to ensure that all research and development remains at Hospital B. And everything that is business-related is in the company. So there would be a kind of MHcardio lab and MHcardio Inc. The MHcardio lab nourishes MHcardio Inc. through research and development. The idea behind this is to maintain the tie between the hospital and the company, since what creates value for the company is access to patients (Pierre)."</i></p>	<p>Hospital B does not manage business-related issues in its projects and usually partners with external firms or leaves the commercialization of knowledge to IPfirm. Creating MHcardio lab is a way to diverge from these existing practices to establish a new way for MHcardio Inc. and its members to access and contribute resources. Research and commercial practices would therefore be connected.</p>	<p>This is an accumulation of previous activities that created differentiation among group members. The boundaries between actors and their different identities are made clearer by constructing two separate entities. External actors' identities are recast as members of a company and collaborators/licensees of the value that is generated by researchers through accessing patients. Internal actors' identities are solidified as researchers.</p>

		This shows an orientation that presents the value as being produced from researchers, clinicians and access to patients. It positions researchers and clinicians above other group members.
<p><i>"They [the hospital research center] consider that it [MHcardio] is not a mobile app. They qualify it as a decision-making tool, and that's the intellectual property of Hospital B. (...) So what she told me is that the three other group members, the programmer, the designer and the architect, they can't claim any intellectual property on this tool. On the other hand, we can't claim the intellectual property of the code, the design, the architecture either (Pierre)."</i></p>	<p>This shows the different elements that are part of producing digital health: clinical, scientific, technological, commercial.</p> <p>It presents each group's contributions as existing on their own and as producing their respective value that can be separated, identified, connected and disconnected.</p> <p>It also shows that the research center is stuck in a scientific agencement that sees what is valuable in a specific way and therefore they orient their practices of protecting and dividing IP based on the actors' respective expertise.</p>	<p>This qualification divides actors' contributions rather than creating a hybrid of their collective contribution.</p> <p>This divides actors' identities and roles based on their expertise.</p>

### 1.5 Disconnecting external from internal members to do the Research project

Data	Recontextualization	What is produced
<p><i>"for reasons of time and commitment with students and the university, we will proceed to build a [public research grant] with Healthfirm (they committed \$20,000). (...) The goal is to have a functional app for the first test of our clinical</i></p>	<p>The internals decided to disconnect, at least temporarily, from the rest of the group to partner with an external firm that can provide resources to support their research practices.</p> <p>This shows that the internals were part of a</p>	<p>This produces an association of actors around the research project and therefore recasts MHcardio as a research project. This clarifies the roles of clinicians and researchers and how they contribute to this research while disconnecting "externals"</p>



<p><i>management rules (...)."</i></p>	<p>scientific agencement including other actors that produced what seems to be the only possible orientation.</p> <p>Products have to be validated through scientific approaches. This means that the app developed by MHcardio programmers does not suit the research purpose.</p> <p>Priority is given to the research project and the criteria of what constitutes a functional app are based on scientific agencement. The app itself is produced to test the clinical management rules, while the technological features of the app are not considered important.</p>	<p>from the project.</p> <p>This positions coding and designing as of secondary importance to research since the goal of developing the mobile application is to test the clinical management rules.</p>
<p><i>"One of the questions we had was in regard to the level of exclusivity [with Techfirm)], is it something that has been established or that remains to be established with them? (Phil)"</i></p> <p><i>"It's not impossible that there would be none, because they are not interested in paying royalties in the long run. (...) They are more interested in accessing patients and validating their own business, their own application that is worth what it's worth [said in a cynical tone] (Pierre)."</i></p>	<p>This questions whether or not the connection between the research project and Techfirm has completely disconnected the MHcardio external group members and therefore, if there is commercial value in continuing to work with MHcardio lab.</p> <p>This is a patch to allow a temporary exchange of resources between two clearly defined partners to exchange specifically defined resources.</p> <p>Pierre opens the door for MHcardio to compete against Techfirm saying that their product is close to theirs.</p>	<p>MHcardio external members are now out of the decision-making process, making them a totally external entity. They become competitors of Techfirm and therefore entrepreneurs trying to draw in the research group's interest in collaborating.</p> <p>Researchers become validators of the patient experience of Techfirm's product so that this firm may validate its business and technological value.</p>

## Appendix 4.2: Table Analyzing Data from MHspeech

### 2.1 Constructing a collaboration and IP agreement with Hospital A (1 of 2)

Data	Recontextualization	What is produced
<i>Peter suggests that the hospital could be the sole owner of MHspeech's intellectual property in exchange for MHspeech having the exclusive development and commercialization rights to reap benefits from the created IP.</i>	IP at Hospital A is stuck in a scientific agencement. In this agencement IP is meant to protect and recognize the inventor of the produced knowledge. Peter's suggestion aims at dissociating this practice of recognizing the inventor from the commercialization of what is produced. This means that what is valuable to sustain the project is not IP itself (in the sense of recognizing who produced knowledge) but the means to commercialize that IP, with a clear intent from the outset of how IP is going to be generated.	This creates a new conceptualization of what IP is and what it is for. This transforms the role of IP as a protection and recognition device to a device meant to produce commercial value. It introduces a startup agencement in the practices of Hospital A with the clinician in the project becoming an entrepreneur.

### 2.2 Constructing a collaboration and IP agreement with Hospital A (2 of 2)

Data	Recontextualization	What is produced

<p>Anthony explains that Robert could lose all the effort he invested in the project if an agreement was not ultimately reached with the hospital. "This explains why Robert wants to sign an agreement before continuing to work (on this project)," says Anthony.</p> <p>"But no, he would keep his IP!" responds the lawyer. Anthony says to the lawyer that Robert would indeed keep his IP, "but without the clinician's IP, Robert's IP isn't worth a dime since it can't become a commercial product."</p>	<p>Producing knowledge in itself is not valuable for Robert. The value of his effort lies in the potential to commercialize what he produces. This means that the value of Robert's contribution and knowledge does not lie within his practice but comes from its hybridization with clinical contributions/practices.</p> <p>Hospital A's lawyer's answer shows the traditional practice, which is valued by the hospital and which suggests a linear developmental approach built on developing scientific knowledge that could afterward be evaluated for its worth.</p>	<p>This shows a differentiation in terms of what is of value for Hospital A and the scientific agencement compared to Robert and in the startup agencement: being recognized versus making profits with what is produced.</p>
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2.3 Aligning Scaling approaches to marketize the project

Data	Recontextualization	What is produced
<p>"There are doctors who came to me asking 'could we record five minute clips of children at home to evaluate their behavioral development?' We can make derivatives of MHspeech, like in our Telemed platform model, and create derivatives for autism for example, but always from MHspeech's foundations."</p>	<p>This means that the clinician is thinking about opportunities to scale the product, but from the perspective of her clinical practice, which is different than that of the coder. She sees opportunities to scale based on her disciplinary knowledge and her relations with other "users" from different clinical practices.</p>	<p>This produces a different developmental orientation; one of which was based on more technological development (through creating a platform with the digital tools to assist clinicians wanting to produce their own digital solution), while this one is based on using the already developed technological features to expand to other medical practices. This generates a differentiation between the technologist and the clinician.</p>



<p><i>"I did some ROI [return on investment] analysis, and I do not see how MHspeech alone could do it. This phase will never be profitable."</i></p>	<p>Here we see that Robert relies on a "device" involved in startup agencement. This means that Robert has some previous experience as an entrepreneur and that he uses such devices to evaluate their project's potential and value. This orients it towards a more commercial path to produce sufficient connections with venture capitalists to attract resources from them. This device orients the project towards a startup agencement.</p>	<p>This produces another set of evaluation criteria to evaluate the project's worth based on an entrepreneurial orientation.</p> <p>This makes the project scalable as a startup with other means to calculate its value than just the clinical practice.</p> <p>This produces a differentiation between the clinician and the coder; the coder presents it as if the clinician can't think of scaling because of her "specific" user orientation while he positions himself as an entrepreneur.</p>
<p><i>"For investors, [developing a platform] is not as good as if you stay in the MHspeech niche and you become the standard for speech pathologies and maybe autism possibly if you develop MHspeech horizontally. You have this expertise and it differentiates you from others."</i></p>	<p>This means that the commercial potential that VCs value for digital health is related to a deep and precise clinical expertise rather than a project built on technological features.</p>	<p>This translates Dinah's vision of expanding to other medical practices into commercial and entrepreneurial language. This makes her clinical orientation valuable for the commercial development and connects them together.</p>

## 2.4 Signing the collaboration agreement to start the Pilot Project

Data	Recontextualization	What is produced
<p><i>"So when we sign, we can start the research project. (...) Yet, we should really think if there are people who are ready to buy the idea. And we do need a publication at some point, regardless of the"</i></p>	<p>Projects must be made validated from different standpoints, that of the commercial and scientific practices. This means that actors need to know how to validate, prototypes must be validated, etc., and that, from different practices. They also have to</p>	<p>The different practices related to business and research are knitted together to produce a new form of hybrid project.</p> <p>This means that signing actualizes the connections</p>

type of publication (Dinah)."	produce specific outcomes to be made valid from the different agencements' standpoints.	that have been progressively knitted throughout the project's evolution.
"We will publish in a journal, probably a very clinical journal, which is less scientific. Scientific committees are less demanding when it's more clinical."	The clinical agencement is a better compromise between the startup and the scientific agencement because it relies on devices from the scientific agencement (journal article) but with a less rigorous process.	This means the scientific features of the project will be subjected to less rigorous evaluation criteria from this scientific practice to leave some room for other practices to coexist in the project. Yet, this legitimates the project for clinicians and medical teams to see its value for their practices.

### Appendix 4.3: Excerpts from the field highlighting digital health's intersecting practices' conventions

Practices	Excerpts highlighting practices' conventions
Scientific	<p><b>Rigor</b></p> <p><i>"I just don't want to break the enthusiasm in published research, but never forget that when we do research and test patient adherence or patient follow-up, the fact that it's already in a research protocol generates biases. In the sense that patients know that they will be followed, that they will not necessarily be able to do everything they would have liked to do if they were not supervised. So I would already say that participating in a research protocol may improve adherence a little bit. The other thing is that often in what is published, we talk about small populations, because it is expensive to set up, so we talk about groups of 100, sometimes 1000 patients, which in cardiology are small studies. What has a big impact in cardiology is 20,000 or 30 000 patients." (Pierre, meeting observation)</i></p> <p><i>There is clearly a lot of interest from many people. There are even people from the Ministry of Health in telehealth who have heard about what we are doing and are interested. So I think we shouldn't rush things and we should get good advice. (Pierre, meeting observation)</i></p> <p><b>Precision</b></p> <p><i>"But precisely, because we're not talking about a drug here, it's still new, my apprehension is that if we don't bring more scientific or medical data showing that we're doing as well as a pill, I don't think that a private entrepreneur would invest when, as you said before, many have already failed. Certainly our application is simple and easy to use, we think it will work, but we are still far from having demonstrated it."</i></p>



	<p><b>(Pierre, meeting observation)</b>  <i>I don't know, I imagine it that way, but we're going to have to be extremely precise with the ethics committee because the ethics committee question is going to be, when you bring them in a week later, who will pay for their parking. (Pierre, meeting observation)</i></p> <p><b>Validity</b>  <i>"To present the project you want to do, and to get feedback on how you should do it. For instance, the first part of your research project, you consider doing just 20 patients, you're going to lack sufficient power to really demonstrate what you want to demonstrate from a scientific point of view, you'd need twice as many." (Pierre, meeting observation)</i>  <i>"I started looking with someone who has a lot of experience in methodology in the research centre. When I said we have to try to do this in a year, he told me oh, it's going to be very hard. (...) So here, in January in particular, the meeting is about trying to be the most efficient in terms of research, to ensure that the most evidence is collected in a short time." (Pierre, meeting observation)</i></p>
Clinical	<p><b>Usability</b>  <i>"That patients use it appropriately on a daily basis, that the messages we send are well understood. And once all this is evaluated, and eventually a number of patches are made, the third step would be to demonstrate that the application is really useful." (Pierre, meeting observation)</i></p> <p><b>User-friendliness</b>  <i>"We develop an application that we think is close to a final version. It's possible to have access to iPods and give them to about ten patients from the clinic to do a test and then get their feedback on what they like about the application, what they don't like." (Pierre, meeting observation)</i></p> <p><b>Effectiveness</b>  <i>"Maybe it's because I'm used to working in an environment that is very standardized. The hospital is very hierarchical, organized and everything is as planned. Chance and spontaneity are not elements of our daily lives." (Veronique, interview)</i>  <i>"A good end point for us as doctors is to say to ourselves that we will reduce hospitalizations and consultations in the emergency room." (Pierre, meeting observation)</i>  <i>"They [clinicians] are just looking forward to it being developed because they say it's going to save them a lot of time. In the sense that right now, what MHspeech will do is collect a sample of language that is spontaneous, which they usually do in two or three meetings. So if it's done before the first meeting with a preliminary report, they can't wait for that." (Dinah, interview)</i></p> <p><b>Patient-centric</b>  <i>"Honestly I believe 100% that, with our team, I am able to bring the MHcardio project to meet the needs of patients with heart failure." (Jessica, meeting observation)</i>  <i>"We have already had experience in medicine and cardiology in particular, (...) where companies have launched new algorithms for</i></p>



	<p>interpretation. Things that on paper were extremely promising, but that were launched too quickly and disappointed users. And I would say that there is nothing more terrible in medicine than disappointing users because they are patients and they can tank strategies, techniques that if you had been a little more patient, would probably have really exploded." (<b>Pierre, meeting observation</b>)</p> <p><b>Accessibility</b>  <i>"It is a project that is dear to my heart, it is close to my heart because it will have a great benefit for the clientele and for improving accessibility to healthcare."</i> (<b>Dinah, interview</b>)</p>
Technological	<p><b>Functionality</b>  <i>"Since I could see that it was not going to progress if I didn't do purely technical work, well I put the focus more on that side to have something functional to show in the end."</i> (<b>Sylvain, interview</b>)  <i>"We prefer to go with a functional product, then we will come back to it if possible."</i> (<b>Antoine, meeting observation</b>)  <i>"A functional run through. So to have a video and audio recording platform, a server that communicates with it, either inside or outside Hospital A, possibly a manual transcription and communication with whatever software is going to be used to generate a report. And see if this report is in line with what we initially thought."</i> (<b>Thomas, interview</b>)  <i>"I know what it means to develop something in research, it's never functional. When you finish something in research, you have something that is almost realistic. In fact, the researcher is only interested in developing something new. Once it is developed, he doesn't have any interest in working on it. He will do the first 80% of the work, which is to develop the concept, but he will not bring it to a functional level."</i> (<b>Thomas, Interview</b>)</p> <p><b>Dependability</b>  <i>"Phil and I are going to predict an architecture a little bit because we want something that if you come with a need that says, we do this thing, we have to meet that need and that's it."</i> (<b>Antoine, meeting observation</b>)</p> <p><b>Freedom</b>  <i>"Phil, you made a very good remark that made me think of something. There are business Angels who are willing to invest, but do you lose control over the project afterwards. You won't have that freedom because we're not the ones who give money. Does that give you freedom with your project, do you remain the master of your project?"</i> (<b>Antoine, meeting observation</b>)</p> <p><b>Scalability</b>  <i>"I also believe that the application we are making is easily exportable. Moreover, when we met, Olivier, Antoine and I quickly realized that there are two dimensions that could grow. One, it is clear that in the cardiac field although there are clinics in Quebec and in other provinces. Then extend the application to other areas of chronic disease. Of course, I believe there would be a real possibility, and an opportunity to do so. Moreover, already in the architecture, it will be possible to export it to other clinical fields easily. So it was thought from the beginning, which makes it easier to do that."</i> (<b>Phil, meeting observation</b>)</p>

	<p><b>Integrable</b></p> <p><i>"At the platform level, we had some discussions with Antoine to advance this. I think that at our last meeting last week, there would be the possibility of integrating with the patient record that follows heart failure. There's a system for that. So Antoine and I, without saying that we're going to do it in the short term, we've looked at what are the normal ways to integrate at this level." (Phil, Meeting observation)</i></p> <p><i>"So I think that his hindsight [speaking of Robert], especially at the IT level, gives us a better idea of what will eventually be possible and how it can be used with the various tools that I have named." (Thomas, interview)</i></p>
Startup	<p><b>Profitability</b></p> <p><i>"Basically, what I'm saying is that I'm willing to invest money and time to move this issue forward, because from a business point of view, I see the opportunity and I believe in it." (Health entrepreneur, meeting observation)</i></p> <p><i>"I agree with you that it's really the key to be able to develop, not just develop from a computer point of view, but develop the application so that it's something that's eventually profitable." (Phil, meeting observation)</i></p> <p><i>"By the way, angel investors do not necessarily invest in tech, but they will invest for marketing and growth. This is typically their kind of investment." (Phil, meeting observation)</i></p> <p><b>Growth</b></p> <p><i>"MHcardio, the way it's been thought about so far has really been in an institutional environment and then making sure that heart failure clinics were able to follow up with their patients more closely than they can now. But there is a much broader field that goes outside the institution for chronic disease management and treatment adherence management that is currently really not addressed and could be addressed with simple applications, based or built on the same model as MHcardio." (Health entrepreneur, meeting observation)</i></p> <p><i>"Beyond the follow-up of patients with heart failure, his [the health entrepreneur's] opinion is that the same concept could be applied to other chronic diseases such as diabetes, chronic respiratory failure, hypertension, etc. And so he would be interested in eventually developing the MHcardio concept towards other diseases and ensuring that the private payer in the health system finances this development. (Health entrepreneur, meeting observation)</i></p> <p><b>Competitiveness</b></p> <p><i>"There is an opportunity to develop an offering that does not currently exist that meets the client's needs in terms of being supported in their adherence to treatment, and that therefore makes sense for the insurer and the employer." (Health entrepreneur, meeting observation)</i></p> <p><i>"I would also add that insurers are at a point where they want to differentiate their offerings to employers. They are looking for solutions that would allow them to do so and they are in a context where they may not be looking for evidence as much as you [Pierre] are." (Health entrepreneur, meeting observation)</i></p> <p><b>Viability</b></p> <p><i>"But it is up to the startup, the new company to take charge, to make it evolve beyond what you can cover in the MHcardio project. Because I don't think otherwise there would be a possibility of viability." (Health entrepreneur, meeting observation)</i></p>

**Control**

*"Of course, the investor is there to capitalize. He's not here to get in the way. He is there to help us, except that typically in investment contracts, there are results to be achieved, and if the results do not happen, well, there may be clauses saying that the investor can automatically take control. So this can happen. That's why I'm telling you that it's another kind of dynamic by bringing in investors and having a financial goal in the project we currently have."* **(Phil, meeting observation)**

*"I spoke to him briefly about [the health entrepreneur], I told him [the IP specialist] that he was not there that day and that he had finally sent us a contract that we had to sign to be able to look at his business plan. He said for sure that it smells like a scam. He told me clearly that because he can't have access to your intellectual property, he's going to get you to sign something that's going to force you into doing business with him because you're always going to look like you're copying, and then he's going to sue us. And that we wouldn't have a chance to do business with anyone else."* **(Pierre, meeting observation)**



# CHAPTER FIVE

## Discussion: Reassembling the Thesis Body

### 5.1 Introduction

In this section, we revisit the overall contributions that emerged from the three articles constituting the core of the thesis. The articles offered a progressively deeper view of the concept of *opening innovation*, which was first presented in the introduction of the thesis. *Opening innovation* was introduced and defined in more detail in Chapter Two of the thesis as “a practice-based framework that views opening up for innovation as a set of activities that increases the number and variety of actors and resources that can be applied to the problem at hand.” This process can have major consequences on existing relations and practices, creating the need to develop new relational practices (Ness, 2009; Manning, 2010) that help manage the boundaries between newly connected actors (Carlile, 2002; 2004; Kaplan et al., 2017). Without efforts to adapt and transform these relational practices, opening up for innovation can generate negative outcomes, both in terms of the developed products and of reshuffling actors’ practices for the worse. This perspective on opening innovation offered the means to answer the generic research question that I set out to explore at the beginning of the thesis:

*How do actors “open innovation” to increase the number of new contributors and resources to apply to their evolving innovation challenges, and what do these processes produce?*

Focusing on practice as the central unit of analysis (Nicolini, 2012) was particularly helpful in exploring phenomena related to “opening innovation” by taking into consideration the distributed, complex and dynamic nature (Feldman and Orlikowski, 2011) of the situations related to opening innovation. Indeed, when opening up for innovation, multiple coexisting practices are at work, and must be dealt with, but

sometimes compete with other practices. A practice-based approach therefore helps one explore the relational dynamics involved in opening up for innovation without having an *a priori idea* about the prominence of one of these practices or bundles of practices over the others, as if they existed in and of themselves. It refocused the analysis around the practical challenges actors faced in their attempts to produce digital health innovation, which helped me see the complexity of such processes in greater depth.

This practice-based orientation led to the construction of the three coherent and complementary articles that are the thesis body. Article 1 of the thesis proposed a generic understanding of the processes related to opening innovation by bridging the literature of open source, open innovation and interorganizational collaboration, representing different layers of practices that ought to be considered when opening up for innovation. This conceptualization of the literature paired with a brief analysis of some empirical cases offered us a framework to present a first overview of the challenging process of opening innovation for digital health. Article 2 then focused on Hacking Health's events as ways of dealing with such challenges by pulling in a variety of individual actors, who set out on different trajectories, changing their practices and constructing sustainable collective trajectories to produce the seeds from which the field of digital health emerged. Finally, article 3 offered a more detailed view of the production of digital health projects by focusing on the practices that construct and orient projects at the intersection of different agencements with different value systems.

## **5.2 Revisiting *Opening Innovation* in Light of the Thesis Articles**

This section aims to revisit the thesis body relative to its interrelations. I begin by providing a brief summary of each article, its intentions and contributions in order to explicitly shed light on the relations between the articles as a sociomaterial assemblage that produces and stabilizes the meaning of this thesis. It highlights the intentionally specific directionality of the design of the thesis from a broader perspective of the phenomena related to the processes of opening innovation, by focusing on the resulting emergence of the field of digital health and toward the more specific and detailed attempts and struggles related to locally producing digital health innovation. This

assemblage, however, deserves to be re-examined in greater depth to clarify the interrelations that jointly produce and clarify the central notion of opening innovation.

### 5.2.1 Article 1: Building an Overarching Framework for the Thesis

The first article “‘Opening innovation’ across layers of practices: Developing an integrative view of the emergence of digital health” builds a practice-based framework of opening innovation. This framework lets me revisit the similarities and differences of the literature on open source, open innovation and interorganizational collaboration. Emphasizing practice as the “unit of analysis” (Nicolini, 2012) helped engage with the empirical phenomena covered by each body of literature to better understand its scope of analysis and gradually bridge the different approaches toward the broader process of opening innovation. This article relabeled these literatures as user-centric, firm-centric and field-centric approaches to opening innovation based on their respective orientations, in the hopes of generating language that is helpful for creating better bridges across these traditions. Considering that these approaches potentially impact different layers of practices is thus essential because each approach is viewed as contributing in its own way to the progressive construction of the bundles of practices that both structure subsequent practices and help attract the required resources to stimulate and support innovation for digital health. Below, Table E presents three quotes taken from a meeting observed during the thesis fieldwork. These quotes are representative of the three approaches to opening innovation and their relation to the layers of practices, firms and fields related to opening innovation for digital health.

**Table E: The Three Approaches to Opening Innovation**

User-centric approach
<p><b>Quote:</b></p> <p><i>“My last question would be ‘how do you see this large-scale development happening with our team at this point?’ I mean, myself, Jessica, knowing Pierre, we don’t work on this project full time, we put it on top of everything we have to do in our jobs. How, with our team, can we make such a big deployment happen?”</i></p>
<p><b>Analysis:</b></p> <p>Jessica is a nurse-clinician in the MHcardio project and Pierre is a physician-researcher. The project was created to deal with an issue they faced in their daily clinical activities. This means that they were self-</p>



motivated individuals with a user interest in producing a solution that would improve their lives and those of their patients. They had sufficient resources, for instance their experiential and disciplinary knowledge, to generate the first creative sparks of this project. Yet their limited resources, both in time and money, hindered their capacity to materialize their ideas into a ready-to-deploy, sustainable product.

### **Firm-centric approach**

#### **Quote:**

*“This is where the corporate structure becomes essential. By that I mean you have a project that you built to meet your needs. This can’t be sacrificed. At the same time, there is intellectual property that has been developed that can be used in something bigger. We would collaborate with the CHUM on something that can be used in something bigger. And then we need a team that is stitched to your company, a team that will be mandated to bring this opportunity further. It would be impossible based on the resources you have what we are talking about. And then, it is possible that in the end there is a profit, for sure there will be profits that will result from your project that will accelerate the development of this project. So it’s a two way street. But it’s clear that you can’t do it with your existing resources.”*

#### **Analysis:**

In this quote, an entrepreneur tries to create an association with MHcardio. This entrepreneur recognizes the value of the prototype that has been generated from the user-centric approach that specifically focuses on users’ needs. The quote, however, suggests that to further develop the solution, the group would need to create a “corporate structure” that helps connect the project with more actors and resources. It highlights that the user-centric approach cannot generate sufficient resources to produce the solution, and that the firm-centric approach can help accumulate more resources by stitching additional actors to the production of the solution.

### **Field-centric approach**

#### **Quote:**

*“I think there is going to be a surprisingly positive reaction from public health departments, not in Quebec, I’m talking about the national level, when they start to understand that there is an opportunity to work with the private sector to ensure adherence to treatment and monitoring of chronic diseases. And I’m not talking about private care, I’m not there at all. I mean there’s a way to release part of the two-dollar cost that is provided by the employer for every dollar that is paid in the public to bring better disease management for our population.”*

#### **Analysis:**

This quote shows that digital health involves a variety of actors that are not yet aligned to provide the population with digital healthcare services. First, it moves from a Quebecois to a broader Canadian perspective. Second, it highlights the need to create shared meaning systems between the private sector and public health departments. This requires changing the meaning of healthcare toward a more preventive approach dealing with adherence issues, and the interpretation of the respective roles of the private and the public sectors in providing healthcare services. Therefore, producing innovation in digital health requires reshuffling and restabilizing relations and practices at the field layer.

The content of this table briefly highlights the three approaches that contribute to processes of opening innovation. The quotes and their analysis show the strengths and

weaknesses of each approach, which clarify their distinctions and interrelation for the production of complex innovations such as those related to digital health. Each approach offers a partial solution to opening up innovation to the point where the approach no longer allows actors to access and develop sufficient resources to deal with the problems at hand. At this point, the progress of opening innovation halts, creating a breakdown, which requires mobilization of a new approach to respond to the breakdown until this approach also reaches its functional limit. A user-centric approach rests on experiential and disciplinary knowledge to produce the creative spark for an idea to be developed. In cases where these ideas and solutions can be easily developed by their users and diffused to other users, for instance in the case of open source software, this approach can be sufficient to capture the created value (von Hippel and von Krogh, 2003; Lakhani and von Hippel, 2004). However, in the case of digital health, more resources were required to deliver on the produced value from the user-centric approach and further develop the generated prototype.

For instance, more resources were needed to do research projects that validate the underlying products' assumptions, develop the technological features, put in place a sustainable business model and create associations with hospitals to implement the developed products. For all these project elements, actors had to attract an increasingly diverse body of knowledge and resources that would contribute to scaling the project. In addition, in the case of digital health, value is not produced and captured by a limited number of users and firms. Multiple organizations from different sectors and various users all benefit from the innovations produced. For example, governmental bodies, hospitals, research centers, insurance and pharmaceutical companies, employers (keeping their workers healthy and productive) and technology firms could all benefit from digital health innovation. Therefore, multiple users, for instance clinicians, researchers and patients, could all capture value from the generated innovations. This view of *opening innovation* shows the reshuffling that is required at different layers for the production of complex innovations, such as those related to digital health.

This article was meant to categorize these layers of practices, and therefore the plethora of struggles encountered when producing complex innovations. It also highlights the



bundles of practices produced to deal with such challenges through a first generic reading of the four-year fieldwork, and helped create a coherent pipeline for the thesis. This article conceptualized the central framework of the thesis, namely *opening innovation*, helping position the thesis within a scientific conversation.

Although this article started doing the heavy lifting related to conceptualizing opening innovation and positioning the thesis, it did not deliver on its full potential of better understanding what actually happens at each layer of practices that allows for quantum leaps across layers. This article was meant to generate such questioning, opening the doors for the following articles' deeper and more detailed analysis that focused on the complexity of connecting different practices to generate sufficient accumulations for the production of these quantum leaps across layers.

### ***5.2.2 Article 2: Conceptualizing Actors' Differences to Understand the Role of Events in the Production of Digital Health Innovation***

The second article builds on a field perspective that emphasizes actors' practices and their resulting social position through Bourdieu's concept of trajectories. Actors' trajectories, i.e. the social tracing of actors' progressive positions in social space, are driven and constructed by the resources they accumulate through practices. With this conceptual apparatus, we explored the role of Hacking Health events (cafés, workshops, hackathons and bootcamps) as a sequence of field-configuring events (Meyer et al., 2005; Lampel and Meyer, 2008) contributing to the emergence of the field of digital health by changing actors' practices and therefore reorienting their trajectories. Throughout this paper, we show that these events helped open innovation by dealing with actors' distributed, distanced and dedicated trajectories to build on their respective resources for the production of digital health innovation. We show how the trajectories of clinicians, technologists, entrepreneurs and researchers, as they successively traverse different events, were connected and changed in their orientations, which allowed the first seeds for the field of digital health to emerge. The idea of a field as an abstract conception encompassing organizations and other actors (Zilber, 2014) is therefore replaced with a focus on the local negotiations transforming the practices that sustain



actors' trajectories to create the means to exchange and produce resources across different practices and fields. This article argues that a focus on the types of interactions that occur during events like hackathons is a missing piece in the academic conversation that can shed light on the role FCEs play in field emergence.

This article also expanded on Bourdieu's concept of social trajectory, which emerged from his observations of the struggles between social classes and their reproduction. We focused on understanding a context in which collaboration across practices was required. We take into consideration his view that "real groups of individuals [are] moved by the consciousness of the identity of their condition and interests, a consciousness which simultaneously unites them and opposes them to other classes," which helps explain the difficulty of uniting different trajectories. However, rather than contemplating such situations as stable and considering fields as closed (Silber, 1995), we show how Hacking Health events opened interactions across these differences, helped actors adapt their practices, and gathered a variety of resources to sustain their newly constructed collective interests. As we focused on a context where innovation is desired, and therefore where changes in practices must happen (Carlile, 2004), we were able to go beyond the stable to conceptualize the change. We ultimately propose the concept of *collective trajectories*, which creates shared orientations for actors' different practices to move along coherent paths.

This article demonstrates how actors moved along the different layers of practices identified in article 1. For example, it showed how firms (e.g. Hospital A) moved down the stack to the layer of practices to explore new connections with actors new to each other in events like hackathons during which existing institutional arrangements (Bathelt and Cohendet, 2014) are less constraining (see figure D in Article 1). This provided the means to experiment with new relational practices (Furnari, 2014) that helped connect actors and their resources across their different practices. However, we also showed that the collective interests produced around prototypes during hackathons were not sufficient to connect to the requisite amount and variety of resources that digital health products entail. For example, the hackathon created a collective interest in developing a prototype between clinicians and digital technologies. This interest was nonetheless

insufficient to align actors involved in the fields of research and startup. Yet, the projects needed to accumulate resources from these fields to generate more value for their projects in order to continue moving forward in their development. We show how bootcamps were constructed to support such processes by pushing actors to have conversations about accessing and developing more resources by associating with more actors, while taking into consideration their relative interests in contributing to digital health projects. Given that opening innovation deals with the progressive and situated processes of introducing new sources of difference, collective trajectories must be constructed on new relational practices to deal with the additional sources of difference that are gradually being added as projects look to accumulate and develop more resources.

Our research shows, however, that FCEs alone cannot assemble and configure an emerging field. Indeed, this last consideration of the progressive process of opening innovation means that longitudinal efforts are required to revisit and transform the norms, rules and sociomaterial arrangements structuring actors' practices and resources. FCEs should therefore be considered part of a constellation of practices that help connect, converge and commit actors to the practices of an emerging field. These events can gather resources, create the means and methods to pull them together, and generate rules and incentives to increase actors' interest in contributing to an emerging field. These are the stepping stones in guiding actors toward a specific set of activities that have the potential to accumulate and change actors' resources and practices for the creation of new disciplines (Kaplan et al., 2017), innovations and firms for a field to emerge. However, these events produce outcomes that are generally not sustained after these events when actors move back to their respective fields of practice, and therefore are not sufficient to create the required transformations for a field to emerge.

Therefore, despite our longitudinal focus on sequences of FCEs, the FCEs we analyzed seemed to have a more prominent role in dealing with the first two identified characteristics of trajectories (distributed and distanced). Some FCEs (hackathons and bootcamps) did provide new rules to structure the emerging field, but once actors went back to their respective fields, they were still influenced by their field's specific



evaluation principles. Although these FCEs could represent actors' different interests, they were insufficient to sustain their transformation in the long run. For instance, in Article 2, we show MHcardio creating a collective trajectory to include different group members' interests. Yet Article 3 shows that in the long run, when the group encountered additional devices and practices as they continued to open up their innovation process for the production of their project, some group members reverted to their traditional interests, which resulted in the project failing to sustain the development of its digital features. This aligns with Thiel and Grabher's observation (2015) that "Field configuration seems to take place in a complex mutual entanglement between ephemeral event, periods of preparation and legacy implementation and longer-term incremental transformation."

### ***5.2.3 Article 3: Understanding the Longer-Term Negotiations and Transformations for the Production of Digital Health***

Article 3 focuses on the longer-term transformations that follow the new combinations of knowledge and practices that were produced within hackathons by longitudinally tracking two projects: MHcardio and MHspeech. This article specifically examines the processes of producing a digital health project and the outcomes such a process entails for intersecting agencements. The comparative case study analysis shows that producing a digital health project, as opposed to the scientific project that resulted from the development process of MHcardio, involved profound transformations of actors' practices and identities. Analyzing critical moments helped us see what practices were actually at play and competing when specific devices, such as collaboration and IP agreements, company incorporation and research grants, were introduced for projects to accumulate more resources to produce their projects. We made use of relational ontology by building on ANT's concept of *agencement* (Gherardi, 2016), which was especially helpful in explaining the production, reproduction and transformation of actors' practices and identities.

Moving further with such considerations and with the socio-archeological perspective that underlies the concept of layers of practices from Article 1, the discussion section in



Article 3 explored the consequence of “infrastructure” (Star and Ruhleder, 1996; Star, 1999; Hardie and MacKenzie, 2007) on innovation projects in more detail. This concept of infrastructure focuses on the stabilization of the relational practices that sustain specific interactions with a set of actors and resources, and therefore stabilize existing configurations of practices. Article 3 specifically unpacks the underlying infrastructure of the linear model of innovation, which is built on the linear progression of specific activities, from scientific discovery to technological development in firms, to commercializing to the marketplace (Godin, 2006), which was embedded in the relations and practices of innovation in Hospitals A and B. The article also explains how MHspeech was able to change this configuration of practices to develop a new model of innovation that contributed to the production of a new form of agencement, namely a digital health project.

This perspective has resonances with Article 1’s concept of layers of practices. It explores in more detail the practical challenges related to different layers of practices and how quantum leaps across the layers occurred. For instance, the infrastructures related to the linear model of innovation were profoundly embedded, “sunk into, inside of, other structures, social arrangements” (Star, 2010), of the Hospital’s research centre (i.e. the firm layer) and of the field of scientific practices. We focused specifically on the performativity of these infrastructures on the reproduction of existing models of innovation in the case of MHcardio, and on the new relational practices and the artifacts produced by MHspeech because they dealt with issues related to the different layers of practices at play. We show how these layers and the devices and evaluation criteria they are built upon played out in practice and helped produce a digital health project that had to cut across different configurations of practice. The agencement perspective helped detail the socio-material connections that were constitutive of specific practices. It also provided a conceptual-methodological approach emphasizing the connections produced through actors’ practices, which helped us explore the complexity of producing a digital health innovation that cut across different practices. As one informant puts it:

*“To give a pragmatic answer to your question, Jessica, (...) the application, the system, it has to be used by the patient, supported by health professionals with*

*medical and scientific backing through studies and research pilots that will meet the requirements of insurers and employers so they too can reap benefits. I think it's this continuum that needs to be ensured. And Marc, correct me if I'm wrong, but I think that each actor is important. (...) If we only target insurers, we would have no scientific recognition, so all of this has to be tied together. (Phil, MHcardio)”*

This statement is related to the conversation presented in table E above. In this statement, a member of MHcardio explains the connections that are needed to produce a digital health project. It also explores the value that these actors can bring to a digital health project. By exploring the process of associating these actors, we showed the specific agencement each actor was stuck in and why, which explains the challenges MHcardio and MHspeech faced in dealing with new relational dynamics related to the different orientations actors prioritized in producing their projects. Indeed, dealing with actors' differences to create new language, methods, meaning and interests was especially difficult for digital health because actors' practices were engaged in profoundly distinct orientations in terms of value systems and approaches to producing value.

This is coherent with the perspective of the trajectories presented in article 2, which portrays actors as progressively moving in the social space and in their fields according to the resources they accumulated from relying on specific practices. For instance, Pierre had already invested (Carlile, 2002) time and effort in constructing his position as a physician-researcher. He got invested in the field of health research, however, which has specific “rules of the game” orienting actions in a specific direction for him to continue accumulating capital (relations, knowledge, financial resources, etc.) to improve his social positioning. He would therefore work with actors from a similar orientation more naturally and more easily, and therefore develop projects in line with these rules of the game. Continuous interactions with specific actors (human and non-human) strengthen actors' dependencies and stabilize specific activities and their definition of success, which influence the types of outcomes actors aim to produce. This explains the difficult



process of reorienting actors' trajectories by transforming their practices to produce a collective trajectory at the intersection of actors' different practice orientations.

The capacity to change these orientations appears to be an increasingly important aspect of today's innovation environment given that the dynamic nature, the complexity, the fluidity and the number of configurations of practices under which an innovation develops have grown considerably (Feldman and Orlikowski, 2011; Scarbrough et al., 2015). In contrast, the infrastructures that shape these orientations can be used for many years to support the production of value through specific configurations of practices. These configurations of practices, however, may need to be changed to offer opportunities for the recombination of knowledge and resources across practices that are generally not aligned in other situations. For instance, this thesis rests on an understanding that an innovation is created from the process of gradually connecting a variety of actors and resources. This can place new compatibility demands on existing configurations of practices by introducing new connections, perspectives and orientations not originally envisioned. Predicting the compatibility between configurations of practices and new practices gets even more complicated if they are embedded within different disciplines, organization and fields.

Because infrastructures support specific practices by operating under the surface (Star, 2010) and that their performative effect can only be detected through breakdowns that come with the introduction of novel relations, practices and resources, it is essential to develop the means to identify the problematic infrastructure and revisit existing relations within a configuration of practice. Events, like those presented in article 2, may be used as such to create a shock wave by opening existing configurations of practices to new practices and relations. Events can then help bring existing infrastructure and practices to the surface to raise questions about their value, who benefits from them, what they promote and what they prevent. For example, in article 3, we showed that a breakdown between Robert's startup orientation and the orientation underlying Hospital A's IP device revealed the profound difference between a scientific and a commercial approach to innovation that almost disconnected Robert from the project. This brought to light an infrastructure that was consequential in the hospital's capacity to open innovation to



other fields than that of research. Actors from Hospital A involved in innovation matters (innovation managers, lawyers, CEO, etc.), after observing this breakdown between two practices, actually opened a deeper process of questioning their infrastructures that were promoting a specific approach to innovating that entailed producing expert scientific knowledge. The IP agreements, as an infrastructure that shapes models of innovation, consequently no longer worked with innovation approaches built on open co-creation processes that could include clinicians (nurses, nutritionists, etc.), as well as external actors such as designers, programmers, patients, private firms, non-profit organizations and researchers.

By observing this local breakdown, Hospital A's members realized that their model of innovation did not promote their clinicians' contributions, and more importantly, that their model was not designed to commercialize clinical innovations that could not get patented from a scientific standpoint. This was especially salient in the existing employment policy (which included an IP policy) that did not recognize the contribution from employees other than researchers, as in the case of Hospital B. Hospital A then decided to hire a new lawyer who specialized in IP issues, albeit in a non-hospital environment, to produce a new IP policy. This led to deep reflection about the means to engage with a greater variety of actors from Hospital A's ecosystem. The new IP policy resulting from this process now accounts any participant in an innovation process, from patients to clinicians to researchers and private firms, in accordance with their respective practices and interests. Hospital A established a new method between different practices to create new relational practices in order to open innovation to a wider variety of actors and resources and thus produce "new kinds of joint endeavor" (Star and Griesemer, 1989).

The outcome of this process that was initiated by the breakdown concerning Hospital A's IP practices was entirely different than what happened after a similar breakdown occurred at Hospital B in the case of MHcardio. As Articles 1 and 3 suggest, the development of the new relational practices to support new approaches to innovation and therefore new forms of innovation is an outcome of the types of actors who were part of the process of dealing with this breakdown. In the case of MHspeech, the clinical

leader of the project was a clinician and therefore was involved with the legal team and innovation manager from the clinical wing of the hospital rather than the research centre, whereas MHcardio was partly led by a clinician-researcher whose IP treatment was related to the research centre. MHcardio then had to deal with this breakdown with members of the research center. In addition, as we discussed in Article 1, MHcardio was also oriented by an innovation unit that was composed of specialists from different disciplines within the scientific configuration of practice. This explains why at Hospital B, the new relational practices dealing with this breakdown were defined around scientific practices and value systems, which led to the production of a scientific project (see article 3).

In the end, the reproduction or the transformation of these infrastructures influenced the type of project that emerged from the observed innovation processes. In article 3, we have highlighted various devices that had an impact on the evolution of projects by reproducing or changing existing models of innovation. These infrastructures are essential in changing innovation approaches. Existing innovation approaches' infrastructures have to be transformed, in terms of roles, devices, practices and spaces, to develop new forms of innovation. Indeed, these infrastructures move activities in specific directions, determine the types of actors to include and the way to produce and evaluate value, which orients the form of a project.

### **5.3 Critically Examining the Outcomes of Opening Innovation for Digital Health**

This thesis would not be complete without a brief critical appraisal of the dynamics observed throughout this five-year doctoral process and their potential consequences. The object of the thesis relates to innovation matters, which is paired with a practice-based approach that focuses on the consequences of such innovation processes. This opens the door to a moral examination that has been somewhat absent in the previous sections of the thesis. Considering that opening innovation reshuffles connections, practices, methods and distribution of resources, it is bound to have consequences for the way things traditionally worked in healthcare, for better or worse.



This raises the question of what should have changed and what should have stayed the same? Now that changes have occurred, what are their potential risks? In the following pages, I explore such moral issues in the context of Quebec's public health system. Such questions call for a critical reading of the outcomes of opening innovation in the field of digital health that have caused disruptions to the established field of healthcare. I first present a brief contextualization of Quebec's public health system and then question the increasing role private economic capital is likely to play in the field of healthcare and how this may transform actors' practices.

### ***5.3.1 Quebec's Public Health System: A Field of Health as a Public Good***

This section is not meant to provide a profound historical analysis of the construction of Quebec's public health system, but rather to provide the contextual base for a critical analysis of the opening of innovation to new actors and their resources. In Canada, the 13 distinct provincial and territorial health systems provide similar publicly administered universal access to healthcare services despite their partial sovereignty. As a consequence, the Quebec healthcare system can be presented as a public good built on a single-payer system organized around a body of knowledge and techniques, material resources and specialized personnel assembled to provide services to protect, promote or restore the health of the population. The way this system has historically been organized was meant to protect the field of healthcare from market forces.

However, Quebec's health system has not always been organized that way. Up until the mid-20th century, it was the private sector, consisting of religious and charitable organizations, that provided healthcare services to the population. It is only in 1948 (Desrosiers and Gaumer, 2004) that the Government of Quebec started playing a major role in health after the establishment of the National Program of Health Grants, which provided grants to the provinces for the construction and development of state-owned hospitals, psychiatric services, hygiene and vocational training, in exchange for the organization of a single-payer system. These grants were given to provinces that followed strict rules regarding the reorganization of their healthcare system, orienting the way the field of healthcare has evolved in the following decades. This highlights the



decisive involvement of the federal government in funding and orienting the system (Desrosiers, 1999), but more importantly, the political nature of financial resources in shaping this field of practices. These resources led to the creation of the Health Ministry, the development of a structure of reimbursement for medical acts, of medical practices coherent with this structure, and so on. Whereas this system has structured the field of healthcare in Quebec, the increase in health spending in the past decade (French and Miller, 2012), partly caused by the aging population, has led to reforms in the organization of healthcare, increasing administrative control in order to reduce costs through rationalization efforts. This has led to chronic underfunding of healthcare services and even less access to financial resources for innovation activities.

### ***5.3.2 Setting the Fox to Guard the Henhouse***

This context of chronic underfunding of healthcare services and the practice of rationalization are inconsistent with the need to fundamentally revisit the way healthcare is provided in order to deal with contemporary healthcare challenges. Several hospitals are transforming their practices to emulate entrepreneurial hospitals (Miller and French, 2016) such as the Cleveland Clinic, which is built on the expansion of collaboration activities with commercial actors to gather the needed resources to maintain and improve healthcare services and to generate new business models out of their resources. Indeed, as French and Miller (2012) argued in their analysis of the tensions that occur in “entrepreneurial hospitals,” intersecting commercial and clinical practices “stands to significantly redefine both systems of care and the bonds of social solidarity” (French and Miller, 2012) that are foundational in the way the field of healthcare is structured in Quebec and Canada. Indeed, such profound change further reinforces the relative power of economic actors, which may lead to the subordination of the cultural capital, which corresponds to the specific activities of actors from the healthcare field, as well as to the external commercial criteria and the related economic capital.

As discussed above, Quebec’s healthcare field has been structured around the single-payer system to maintain its autonomy vis-à-vis commercial interests, which makes it less sensitive to economic principles of evaluation. Although creating new relational

practices helps connect the field of health with a greater variety of actors, as I have argued in articles 1 and 2 of this thesis, it also disrupts the field's equilibrium and may have a profound effect on the relational dynamics of healthcare as an autonomous field of practices. According to Mangez and Hilgers (2012), such change in the overall structure of capital, for instance the rise in the relative value of economic capital, reduced the autonomy of the educational and literary fields, among others. In line with Mangez and Hilgers' observation, the increasing role of the startup field in healthcare may lead to the erosion of its relative autonomy, progressively transforming the role, position and resources of actors within the field of healthcare by consolidating the relative value of economic capital and weakening subversive actors' capital (Bourdieu and Wacquant, 1992) and their subversive practices.

Regardless of the initial goals and struggles of opening innovation to new actors and resources to increase digital health innovation for the improvement of healthcare, and the resulting bridges that are built between actors, these actors still bear the marks of their respective fields. These fields, just like the actors within them, have different relative positions in the field of power according to the relative value of their capital. The introduction of new actors, such as those related to startup approaches to innovation, was meant to change existing structures of relations, resources and positions to increase the capacity to innovate in the healthcare field. While this initial purpose helped diverse actors converge toward the emerging field of digital health, actors' practices are still shaped by their earlier resource accumulations through their training, the relations they have forged, their career trajectories and the evaluation criteria that inform their daily activities. In that sense, commercial actors that wish to reap financial benefits could create profound transformations in the way the health field is configured to ensure that all the actors they need can assist them in this quest. With their financial resources, they could orient researchers and clinicians' practices by financing specific approaches to innovating that are more in line with their commercial orientation. Furthermore, the commercial value system, with its capacity to exceed innovative performances in other fields, tends to impose its own evaluation criteria upon existing fields that become "subjected to external evaluations and 'accountability,' required to



furnish indicators proving their utility and efficiency (...) helping to normalize 'new' practices [such as] (...) entrepreneurialism into the social field" (Hilgers and Mangez, 2014).

As I have argued repeatedly throughout the thesis, opening innovation generates new relations that can create profound pragmatic transformations, in actors' interests, for example, depending on new intersections of value systems, and therefore in the practices that lead to greater accumulation of resources. I have shown in article 2, for instance, that hackathons orient participants in the outcomes they aim to produce to compete against other groups and develop a valuable prototype according to the jury's evaluation criteria. This prize structure, with its embedded evaluation criteria, orients actors' activities and potentially changes their usual ways of innovating. I have also shown in article 3 that the new IP agreement generated from the negotiations between Hospital A and MHspeech includes commercial interests in addition to clinical and scientific interests. These two examples suggest that new orientations in the field of healthcare are progressively shaped by these commercial evaluation criteria as they reorient actors' trajectories.

This calls into question the somewhat utopian and abstract reasoning behind Mintzberg's new suggestions for "rebalancing society" (Mintzberg, 2014) based on the perspective that "a democratic society balances individual, collective, and communal needs." According to Mintzberg, this balance can be achieved by adopting a three-legged system built on the public, private and plural sectors rather than on a single leg, as communism has historically tried to do, or on the dualism between private and public sectors inscribed in our democratic political systems. While building a three-legged system appears to be an appealing solution, the Hacking Health experiment reveals some questions concerning the practical underpinning of such an idea. While Hacking Health managed to change existing configurations of practices by accumulating capital in the form of leadership (symbolic), relations (social) and knowledge (cultural), it lacked sufficient economic capital to change power relations to rebalance the opposing forces of society, and in our case, of healthcare. Throughout the thesis, I emphasized and



acknowledged the role of Hacking Health (which Mintzberg would call a “plural organization”) in transforming existing institutions. However, I use the present subsection to question this perspective and express some level of concern regarding the reconfiguration of healthcare through entrepreneurialism. Focusing on capital and on its repercussions highlights the challenge of producing a “balanced” society, which, according to my perspective situated in a Bourdieusian analysis, cannot achieve a perfect balance because of the very nature of capital that explains social positions and asymmetric power relations.

When I say that we’re asking the fox to guard the henhouse, I refer to allotting commercial interests as the guardians of healthcare as a public good, although these interests may orient and engage actors in the exact kind of behaviour the field of healthcare in Quebec was trying to avoid in the first place. This commercial orientation could change practices within the field of healthcare, for example by gradually leading to an increased focus on socially accepted mass products and services at the expense of new treatments that are riskier to develop in terms of financial investment, or to approaches and services meant to treat specific diseases that affect a smaller population size because of their incoherence with commercial interests. Although I did observe attempts to protect the integrity and autonomy of the field of healthcare and of its foundational values, I also observed the recurring tensions between commercial interests and those of actors from the field of healthcare. Despite these tensions, the power of attraction of financial capital sometimes seemed too great for actors to resist changing their behaviors according to its underlying financial criteria. Furthermore, once the required relational practices and infrastructures for different fields to converge are developed, they are difficult to change because they get used more and more and become stabilized as accepted constellations of activities. As a boundary organization in the emerging field of digital health, Hacking Health along with academic hospitals therefore managed to protect the integrity of the social foundations of the existing health system against some of the concerns presented in this section for now. But how long can they resist the power of economic capital?

# CHAPTER SIX

## Conclusion

### 6.1 A Practice-Based Approach to Opening Innovation

This thesis is built on a longitudinal qualitative methodology that aims to examine how digital health was produced from actors “opening innovation” to access and develop a greater variety and amount of resources. This led to the development of three different yet complementary theoretical lenses that generated a deeper understanding of the specific functioning and conditions of the production of digital health innovation. In addition to offering insight into the practical implications of opening innovation, the three perspectives also expand our collective understanding of processes and consequences of opening innovation, field emergence and the materiality of practices for innovation.

As we outlined in the thesis introduction section and developed throughout the thesis, this research is built on a strong practice-based orientation (Nicolini, 2012) that recenters open innovation on the “doing” of actors and on the constellation of activities that give it meaning. This orientation focuses on questions such as, why people are doing what they are doing? How are they making things work? With whom are they interacting, and why? In addition, the pragmatic stance of the analysis targeted breakdowns as learning points that point towards the deeper underlying reasons why these breakdowns happened and kept happening, who was part of the process when they occurred and who wasn’t, and what actors did or didn’t produce to deal with the new circumstances of these unfolding situations. People do things, and what they do generates consequences (Carlile and Dionne, 2018) for people around them, their organizations and their fields of practice. The practice-based approach that is at the foundation of this thesis has therefore helped question how innovation is opened rather

than considering openness as an organizing principle that can be implemented as is, as something that exists out there, external to actors' doing.

It was my belief from the beginning of this research that performing open innovation was something that required efforts from a variety of actors, which could lead to profound transformation in their practices. Five years later, at the end of this thesis, this assumption now appears judicious, reasonable and even prudent. Indeed, opening innovation for digital health has required tremendous and relentless work from multiple actors in a variety of localizations of practices - from Hacking Health, to financial institutions, venture capitalists, funding agencies and academic hospitals, not to mention all the individual coders, designers, clinicians, doctors, researchers and entrepreneurs - to actually produce digital solutions that have an impact in health. As an informant from Hacking Health told me during my fieldwork "*We thought it would go much faster!*" (Bryan).

This consideration has led to the definition of "opening innovation" as "a practice-based framework that views opening up for innovation as a set of activities that increases the number and variety of actors and resources that can be applied to the problem at hand. This process can reshuffle existing relations among actors and their practices, creating the need to change existing practices and develop new relational practices (Ness, 2009; Manning, 2010) to manage the relational boundaries associated in developing innovative outcomes (Carlile, 2002; 2004; Kaplan et al., 2017)." Despite studying Hacking Health as the main case study, the practice-based orientation of this thesis has decentered the role of this specific organization to track the multiple practices that were involved within and around Hacking Health's activities to open up innovation for digital health. "Practices thus [came] first, because it is only once we appreciate the set of practices involved in a scene of action that we can ask what sort of agency and 'actor-ship' is made possible by these specific conditions (Nicolini, 2012)."

Tracking these practices has allowed me to expand the focus of this thesis to produce a much more expansive analysis including the processes of development of digital health innovations and the deeper consequences of these processes. This has helped to account



for the field of digital health emerging before my eyes throughout these four years of research. Anchoring this research on Hacking Health's activities therefore provided a clear window into the development of new relations, languages, methods and interests between a variety of actors from different practices (which was mostly visible during Hacking Health events) for the construction of the field of digital health. Tracking Hacking Health gave me the means to see what artifacts and practices were included and constructed first, where and when, and then what value systems were intersecting and competing through actors' interactions. Hacking Health is not solely responsible for the production of digital health, however. Multiple actors needed to engage with new practices to accumulate capital that bears the marks of the emerging field of digital health. Despite not accessing all involved actors, this research did map out a variety of contributors to the production of digital health innovation and the resulting field of digital health.

The practice-based orientation of this thesis was supported by "a commitment to an observational orientation and the adoption of methods that allow an appreciation of practice as it happens (Nicolini, 2012)." Combined with a longitudinal approach that took into serious consideration the materiality of practices, this observational orientation allowed the examination of the accumulations that practices produced, to see what changed and what stayed the same, and to understand the deeper relational dynamics related to different socio-archeological layers of practices (Carlile and Dionne, 2018). For instance, the three articles of the thesis have shown the deeper dynamics involved in actors' interactions, be it between the layers of practices, firms and fields (Article 1), or between actors' trajectories and the emergence of a field (Article 2), or between actors' actions, existing configurations of practices that orient these activities and the agencements that transform such meaning (Article 3). As Zilber (2014) argued, "ethnographic studies may yield indispensable insights about the social dynamics of the field, insights that cannot be discovered and analyzed otherwise." While most research on fields - especially those from the tradition of institutional fields - has focused on organizations as members of these fields, and therefore as units of analysis (Zilber, 2014), a practice-based and observational orientation offers the means to produce a

much more fine-grained analysis of “who interacts with whom, in what ways, and at what times” (David et al., 2013), to see organizations and fields for what they truly are: organizations as bundles of practices and fields as bundles of bundles of practices.

To do so, this research was built on a nested approach that first emphasized Hacking Health annual hackathons as quick, intense events where actors from the emerging field of digital health periodically assembled to spark the production of digital health outcomes in the form of new relations, resources, methods and prototypes. However, the research compensated for the short duration of these events by also observing some of the seeds that were sown in these hackathons, that is, some projects that emerged from these events. This combination of studying yearly hackathons for three years and the resulting projects was a way to observe the “similarities and differences between the various years [that] can teach much about processes of emergence and transformation” (Zilber, 2014) while observing the deeper, granular and incremental transformations that followed in different localizations of practices. This allowed me to see the new connections, devices, knowledge, resources and practices around digital health that actors developed to produce innovations and accumulate resources that resulted in the emergence of the field of digital health. It is through observing a variety of actors (both human and non-human), with an observational and ethnographic orientation focused on actors’ practices, that I was able to observe the creation of new relational practices that were drastically different from those of existing fields.

## **6.2 Contribution of the Thesis and Future Orientations of Research**

This thesis therefore makes important contributions, and even builds a whole orientation for a future research program. Article 1 offers a strong integrative framework that connects the open source, open innovation and interorganizational collaboration literature as each focusing on interrelated layers (of practices, firms and fields) that are intertwined in the process of opening up innovation for digital health. This article constructed the backbone of this thesis, the framework of “opening innovation” that clarified this thesis’ practice-based approach. This layered framework shows the deeper relational dynamics at play in actors’ practices when they are opening innovation.



Article 2 focuses specifically on the field configuration role Hacking Health events played in the development and transformation of practices that sparked the emergence of the field of digital health. To do so, this article developed the three D framework that presents actors' trajectories as distributed, distanced and dedicated. These three dimensions help outline the relational dynamics that define the challenges of generating a collective trajectory at the intersection of different individual trajectories as actors move both within and across fields to accumulate resources. This article offers a strong contribution to the recent literature on cross-field interactions (Furnari, 2014) and intersections (Furnari, 2016; Zietsma et al., 2017) that produce the emergence of new fields from new forms of interactions and initially inconsequential relations between fields. We have shown in detail the process of how resources are structured in social spaces to understand the complex and dynamic phenomenon of accumulating resources for a new field to emerge at the intersection of existing fields. I believe that this focus on resource trajectories could prompt an important "turn" in organization theories as it helps account for the past-present-future intricacies of actors' practices. I also think that it better suits the contemporary organizational and societal challenges of moving beyond sharing and coordinating to account for the evolving and transforming. For instance, as digital technology moves into new territories and as fields intersect more and more, actors and their practices face important transitions that require a deeper understanding of their orientations and what makes them move.

Article 3 is built on a comparative case study of the processes of two project groups that emerged from Hacking Health hackathons in their attempts to connect actors (human and non-human) for the production of their digital health innovations. This article highlights the progressive production of two forms of projects: a scientific and a digital health project. By focusing on consequential artifacts such as business models, company incorporation, and intellectual property agreements, which are conceptualized as devices that intersect different configurations of practice, this article showed the construction of two innovation projects (a scientific and a digital health project) that, in one case, reproduced existing practices while the other generated new practices and transformed existing ones. This analysis helped unpack innovation models' infrastructures and



highlighted the performative effect of material devices on the resulting innovative outcomes.

Taken together, these three articles provide rich and detailed insights into the inner workings of the production of a new form of innovation, the transformations it entails and the construction of an emerging field. By illustrating the specific practices at play in the production of digital health, and the way to deal with the differences this process brings to light, this thesis offers a pragmatic understanding of opening innovation at the intersection of different social spaces and of the construction of an emerging field. This means that this thesis presents an approach that takes into account actors' profound differences and ability to adapt to the novelty of certain situations when opening innovation. This was especially salient in our research as digital health intersected different social spaces (disciplines, organizations and fields) that built on their respective value systems, which were difficult to reconcile at times.

Finally, this research is built on four years of data collection that involved intense immersion in the field during hackathons (observing and taking notes for about 30 to 35 hours during each hackathon weekend), fluidity in terms of going to different localizations of practices (in different organizations, in coffee shops, in food courts, in incubators, etc.), constant availability for observing meetings (both of Hacking Health and project groups) and Hacking Health events (cafés, workshops, hackathons and bootcamps) that were mostly held late in the evening or during weekends, and flexibility in regard to the scheduling of project groups' meetings, which were often organized at the very last minute. This has sometimes generated a profound feeling of "putting my life on hold" for this research project, which I believe was essential to share my informants' realities as they were all contributing to digital health innovation outside their day jobs. More importantly, this has also led to building a highly valuable study in terms of its methodology, especially in regard to the number of interviews and hours of observation as well as its breadth and depth in accounting for multiple actors' practices involved in the production of digital health.

Like any research, this thesis has its share of limitations that open up the door to a future

research program. The focus on Hacking Health as the anchor of this research was both limited and limiting. First, in regards to its “limited” nature, this study did not emphasize the learning process of Hacking Health as its members developed new event formats and its capacity to connect actors from different organizations, disciplines and fields for the development of the field of digital health. Hacking Health is a chapter-based organization with its own innovation processes that deserve to be unpacked. Furthermore, this thesis did not offer sufficient comparative material to analyze in detail what happens during each type of event to better understand their functioning. This would be especially interesting for Hackathons and Bootcamps as they create new types of spaces of exchange at the interstice of multiple fields for the development of new practices. More work is needed to track the differences and similarities in these events’ formats in regard to the outcomes they produce while taking into consideration the variety of actors involved.

Second, concerning its “limiting” nature, despite the quality of the window Hacking Health offered to observe the different practices involved in the production of digital health, it still underplayed the role specific actors had on the development of this new field. For instance, while observing the post-hackathon development of project groups, one issue was especially salient for every observed project: once they were created, these projects were difficult to align with hospitals’ innovation processes. Hacking Health’s new approach to innovation in healthcare required profound transformations in the way hospitals organize their innovation processes, displacing who is part of the process, when they participate and how they contribute. Traditionally, innovation in healthcare was confined within siloed research centers that built on the expertise of a handful of researchers and scientists that would then go on to “translate” their results into clinical services. Despite considering the challenges of transforming this innovation approach in article 3, more work is needed to understand the transformations that take place within academic hospitals because of the central role they play in the production of digital health innovation and other forms of innovation related to healthcare (Gulbrandsen et al., 2016). Moreover, this thesis has alluded to issues of power in the construction of an emerging field. However, power has remained an omnipresent

subtext that is worthy of further exploration. Finally, the field of digital health has yet to stabilize and fully emerge. A continued involvement in this emerging field could lead to substantial improvement in our collective understanding of the full process of field emergence at the intersection of multiple existing fields.



## REFERENCES

- Adner, R. (2006). Match your innovation strategy to your innovation ecosystem. *Harvard business review*, 84(4), 98.
- Andrade, A. D. (2009). Interpretive research aiming at theory building: Adopting and adapting the case study design. *The qualitative report*, 14(1), 42-60.
- Bathelt, H., & Cohendet, P. (2014). The creation of knowledge: local building, global accessing and economic development—toward an agenda. *Journal of Economic Geography*, 14(5), 869-882.
- Bechky, B. A. (2003). Sharing meaning across occupational communities: The transformation of understanding on a production floor. *Organization science*, 14(3), 312-330.
- Benkler, Y. (2006). *The wealth of networks: How social production transforms markets and freedom*. New Haven, Yale University Press.
- Bourdieu, P. (1990). *The logic of practice*. Palo Alto, Stanford university press.
- Bourdieu, P., & Wacquant, L. (1992). *An Invitation to Reflexive Sociology*. Chicago und London: The University of Chicago Press.
- Carlile, P. R. (2002). A pragmatic view of knowledge and boundaries: Boundary objects in new product development. *Organization science*, 13(4), 442-455.
- Carlile, P. R. (2004). Transferring, translating, and transforming: An integrative framework for managing knowledge across boundaries. *Organization science*, 15(5), 555-568.
- Carlile, P. R., & Dionne, K. E. (2018). “Unconventional yet consequential” in Bryman, A., & Buchanan, D. A. (Eds.) *Unconventional Methodology in Organization and Management Research*. Oxford, Oxford University Press, p. 233-254.
- Chesbrough, H. (2003). *Open innovation*. Cambridge, Harvard University Press.

- Chesbrough, H., Vanhaverbeke, W., & West, J. (Eds.). (2014). *New frontiers in open innovation*. Oup Oxford
- Christensen, C. M., & Carlile, P. R. (2009). Course research: Using the case method to build and teach management theory. *Academy of Management Learning & Education*, 8(2), 240-251.
- Cook, S. D., & Brown, J. S. (1999). Bridging epistemologies: The generative dance between organizational knowledge and organizational knowing. *Organization science*, 10(4), 381-400.
- Dahlander, L., & Frederiksen, L. (2012). The core and cosmopolitans: A relational view of innovation in user communities. *Organization science*, 23(4), 988-1007.
- David, R. J., Sine, W. D., & Haveman, H. A. (2013). Seizing opportunity in emerging fields: How institutional entrepreneurs legitimated the professional form of management consulting. *Organization Science*, 24(2), 356-377.
- Desrosiers, G. (1999). Le système de santé au Québec bilan historique et perspective d'avenir: Conférence inaugurale du 51 e congrès de l'Institut d'histoire de L'Amérique française, octobre 1998. *Revue d'histoire de l'Amérique française*, 53(1), 3-18.
- Desrosiers, G., & Gaumer, B. (2004). Réformes et tentatives de réformes du réseau de la santé du Québec contemporain: une histoire tourmentée. *Ruptures, revue transdisciplinaire en santé*, 10(1), 8-20.
- Eisenhardt, K. M., Graebner, M. E., & Sonenshein, S. (2016). Grand challenges and inductive methods: Rigor without rigor mortis. *Academy of Management Journal*, 59(4), 1113-1123.
- Feldman, M. S., & Orlikowski, W. J. (2011). Theorizing practice and practicing theory. *Organization science*, 22(5), 1240-1253.
- French, M., & Miller, F. A. (2012). Leveraging the “living laboratory”: on the emergence of the entrepreneurial hospital. *Social Science & Medicine*, 75(4), 717-724.
- Furnari, S. (2014). Interstitial spaces: Microinteraction settings and the genesis of new practices between institutional fields. *Academy of management review*, 39(4), 439-462.

- Furnari, S. (2016). Institutional fields as linked arenas: Inter-field resource dependence, institutional work and institutional change. *Human Relations*, 69(3), 551-580.
- George, G., Howard-Grenville, J., Joshi, A., & Tihanyi, L. (2016). Understanding and tackling societal grand challenges through management research. *Academy of Management Journal*, 59(6), 1880.
- Glaser, B. G. (1978). *Theoretical sensitivity*. Mill Valley, Sociology Press.
- Glaser, B. G. (1998). *Doing grounded theory: Issues and discussions*. Mill Valley, Sociology Press.
- Glaser, B. S., & Strauss, A. (1971). A.(1967). The discovery of grounded theory. *New york*, 581-629.
- Godin, B. (2006). The linear model of innovation: The historical construction of an analytical framework. *Science, Technology, & Human Values*, 31(6), 639-667.
- Gulbrandsen, M., Hopkins, M., Thune, T., & Valentin, F. (2016). Hospitals and innovation: Introduction to the special section. *Research Policy*, 45(8).
- Hardie, I., & MacKenzie, D. (2007). Assembling an economic actor: the agencement of a Hedge Fund. *The Sociological Review*, 55(1), 57-80.
- Hilgers, M., & Mangez, É. (Eds.). (2014). Bourdieu's theory of social fields: concepts and applications. Abingdon-on-Thames, Routledge.
- Hine, C. (2000). *Virtual ethnography*. Thousand Oaks, Sage.
- Hodder, I. (1994). The interpretation of documents and material culture. *Sage biographical research*, 1.
- Howard-Grenville, J., Buckle, S. J., Hoskins, B. J., & George, G. (2014). Climate change and management. *Academy of Management Journal*, 57(3), 615-623.
- Kaplan, S., Milde, J., & Cowan, R. S. (2017). Symbiont practices in boundary spanning: Bridging the cognitive and political divides in interdisciplinary research. *Academy of Management Journal*, 60(4), 1387-1414.
- Kulik, C. T., Ryan, S., Harper, S., & George, G. (2014). Aging populations and management. *Academy of Management Journal*, 57(4), 929-935.



- Lakhani, K. R., & Von Hippel, E. (2004). "How open source software works: "free" user-to-user assistance." In Verlag G. (Eds) *Produktentwicklung mit virtuellen Communities*, p. 303-339.
- Lampel, J., & Meyer, A. D. (2008). Field-Configuring Events as Structuring Mechanisms: How Conferences, Ceremonies, and Trade Shows Constitute New Technologies, Industries, and Markets. *Journal of Management Studies*, 45(6), 1025-1035.
- Langley, A., & Abdallah, C. (2011). Templates and turns in qualitative studies of strategy and management. In *Building methodological bridges* (pp. 201-235). Bingley, Emerald Group Publishing Limited.
- Lawrence, T. B., Hardy, C., & Phillips, N. (2002). Institutional effects of interorganizational collaboration: The emergence of proto-institutions. *Academy of management journal*, 45(1), 281-290.
- Leonard-Barton, D. 1995. *Well Springs of Knowledge: Building and Sustaining the Sources of Innovation*. Harvard Business School Press, Boston, MA.
- Levina, N., & Orlikowski, W. J. (2009). Understanding shifting power relations within and across organizations: A critical genre analysis. *Academy of Management Journal*, 52(4), 672-703.
- Levina, N., & Vaast, E. (2005). The emergence of boundary spanning competence in practice: implications for implementation and use of information systems. *MIS quarterly*, 335-363.
- Lundvall, B. Å. (2017). *The Learning Economy and the Economics of hope*. New York, London, Anthem Press.
- Mangez, E., & Hilgers, M. (2012). The field of knowledge and the policy field in education: PISA and the production of knowledge for policy. *European educational research journal*, 11(2), 189-205.
- Manning, S. (2010). The strategic formation of project networks: A relational practice perspective. *Human Relations*, 63(4), 551-573.

- Marchington, M., & Vincent, S. (2004). Analysing the influence of institutional, organizational and interpersonal forces in shaping inter-organizational relations. *Journal of Management Studies*, 41(6), 1029-1056.
- Meyer, A. D., Gaba, V., & Colwell, K. A. (2005). Organizing far from equilibrium: Nonlinear change in organizational fields. *Organization Science*, 16(5), 456-473.
- Miller, F. A., & French, M. (2016). Organizing the entrepreneurial hospital: Hybridizing the logics of healthcare and innovation. *Research Policy*, 45(8), 1534-1544.
- Mintzberg, H. (2015). *Rebalancing society: Radical renewal beyond left, right, and center*. Oakland, Berrett-Koehler Publishers.
- Ness, H. (2009). Governance, negotiations, and alliance dynamics: Explaining the evolution of relational practice. *Journal of Management Studies*, 46(3), 451-480.
- Nicolini, D. (2012). *Practice theory, work, and organization: An introduction*. Oxford, Oxford University Press.
- Nicolini, D. (2017). Practice theory as a package of theory, method and vocabulary: Affordances and limitations. In Jonas, M., Littig, B., & Wroblewski, A. (Eds.) *Methodological reflections on practice oriented theories*. Cham, Springer, p. 19-34.
- Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization science*, 5(1), 14-37.
- Nooteboom, B., Van Haverbeke, W., Duysters, G., Gilsing, V., & Van den Oord, A. (2007). Optimal cognitive distance and absorptive capacity. *Research policy*, 36(7), 1016-1034.
- O'Mahony, S. (2007). The governance of open source initiatives: what does it mean to be community managed?. *Journal of Management & Governance*, 11(2), 139-150.
- Patton, M. Q. (2005). *Qualitative research and Evaluation Methods*. Thousand Oaks, Sage Publications.
- Pratt, M. G. (2008). Fitting oval pegs into round holes: Tensions in evaluating and publishing qualitative research in top-tier North American journals. *Organizational Research Methods*, 11(3), 481-509.

- Puranam, P., Alexy, O., & Reitzig, M. (2014). What's "new" about new forms of organizing?. *Academy of Management Review*, 39(2), 162-180.
- Randhawa, K., Wilden, R., & Hohberger, J. (2016). A bibliometric review of open innovation: Setting a research agenda. *Journal of Product Innovation Management*, 33(6), 750-772.
- Scarbrough, H., Panourgias, N. S., & Nandhakumar, J. (2015). Developing a relational view of the organizing role of objects: A study of the innovation process in computer games. *Organization Studies*, 36(2), 197-220.
- Schatzki, T. R. (2012). A primer on practices. In Higgs, J., Barnett, R., Billett, S., Hutchings, M., & Trede, F. (Eds) *Practice-Based Education: Perspectives and Strategies*. Rotterdam, Brill Sense, p. 13-26).
- Sharfman, M. P., Gray, B., & Yan, A. (1991). The context of interorganizational collaboration in the garment industry: An institutional perspective. *The Journal of applied behavioral science*, 27(2), 181-208.
- Silber, I. F. (1995). Space, fields, boundaries: The rise of spatial metaphors in contemporary sociological theory. *Social Research*, 323-355.
- Star, S. L. (1999). The ethnography of infrastructure. *American behavioral scientist*, 43(3), 377-391.
- Star, S. L. (2010). This is not a boundary object: Reflections on the origin of a concept. *Science, Technology, & Human Values*, 35(5), 601-617.
- Star, S. L., & Griesemer, J. R. (1989). Institutional ecology, translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social studies of science*, 19(3), 387-420.
- Star, S. L., & Ruhleder, K. (1996). Steps toward an ecology of infrastructure: Design and access for large information spaces. *Information systems research*, 7(1), 111-134.
- Sydow, J., Schübler, E., & Müller-Seitz, G. (2015). *Managing inter-organizational relations: Debates and cases*. Macmillan International Higher Education.



- Thiel, J., & Grabher, G. (2015). Crossing boundaries: exploring the London Olympics 2012 as a field-configuring event. *Industry and Innovation*, 22(3), 229-249.
- Timmermans, S., & Tavory, I. (2012). Theory construction in qualitative research: From grounded theory to abductive analysis. *Sociological Theory*, 30(3), 167-186.
- Tucci, C. L., Chesbrough, H., Piller, F., & West, J. (2016). When do firms undertake open, collaborative activities? Introduction to the special section on open innovation and open business models. *Industrial and Corporate Change*, 25(2), 283-288.
- Urban, G. L., & Von Hippel, E. (1988). Lead user analyses for the development of new industrial products. *Management science*, 34(5), 569-582.
- Von Hippel, E., & von Krogh, G. (2003). Open source software and the “private-collective” innovation model: Issues for organization science. *Organization science*, 14(2), 209-223.
- Von Hippel, E., & Von Krogh, G. (2006). Free revealing and the private-collective model for innovation incentives. *R&D Management*, 36(3), 295-306.
- Von Hippel, E. (2005). *Democratizing innovation*. Cambridge, MIT press.
- von Hippel, E., & von Krogh, G. (2003). Open source software and the “private-collective” innovation model: Issues for organization science. *Organization science*, 14(2), 209-223.
- Yin, R. K. (2013). Validity and generalization in future case study evaluations. *Evaluation*, 19(3), 321-332.
- Yin, R. K. (2017). *Case study research and applications: Design and methods*. Thousand Oaks, Sage publications.
- Zietsma, C., Groenewegen, P., Logue, D. M., & Hinings, C. R. (2017). Field or fields? Building the scaffolding for cumulation of research on institutional fields. *Academy of Management Annals*, 11(1), 391-450.
- Zilber, T. (2014). Beyond a single organization: Challenges and opportunities in doing field level ethnography. *Journal of Organizational Ethnography*, 3(1), 96-113.