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A Contingency Approach to Open Innovation Intermediaries: The Management Principles of the "Intermediary of the Unknown"

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Abstract: *Research has improved our understanding of the managerial challenges inherent in exploratory intermediation. For instance knowledge brokers help to solve well-defined problems based on existing competences. But what if the relevant actor networks are not known, if there is no clear common interest, or if there are only ill-defined, wicked problems and no legitimate common place where they can be discussed? The aim of this paper is to explore these management principles for intermediation of the unknown. Can intermediaries be active when the degree of unknown is high? And if so, what can they do and how can they manage and drive collective innovation? We first build on a review of the literature to highlight common core functions of the different types of intermediaries. Then, we introduce the "degree of unknown" as a new dimension for analyzing the role of intermediaries, and we discuss whether the core functions of the intermediary could be fulfilled when the degree of unknown is very high. Our analysis is based on four different empirical case studies in Sweden, France, and Germany where these functions have been tackled in particular because of the low level of pre-existing knowledge. We describe the managerial challenges these intermediaries face in the unknown and we demonstrate examples of how they have been handled. We conclude by discussing the theoretical and empirical perspectives raised by this work. The paper contributes to the theory of innovation intermediaries by exploring the properties of a form of intermediary for which the degree of unknown is a key contingency variable, and describes management principles for such intermediaries. In this way we characterize a new role –the "intermediary of the unknown" – that may be well spread in practice but scarcely analysed in the literature.*

Keywords: innovation intermediaries; open innovation; collaborative innovation; degree of unknown; innovation management

1 Introduction

Scholars have recognized the role and the growing importance of intermediaries in innovation (Howells, 2006). Increasing technological complexities, maturing markets, and global competition require that knowledge and creative brainpower is not merely sought internally within a firm but also externally in creative communities and from external experts. The rationale for intermediaries' intervention is thus manifold. Similarly, intermediaries come into play when transfer to the market is the only means for commercialization because internally developed knowledge or ideas cannot be utilized for the company's proprietary products or services hence. Intermediaries then "connect companies to external sources or recipients of innovation and mediate their relationships with those actors" (Nambisan et al., 2012). Moreover, innovation often involves many heterogeneous but interdependent actors. The importance of intermediaries in supporting the creation and coordination of networks that connect such actors has been acknowledged in systemic innovations (van Lente et al, 2003), as they act as agents improving connectivity within and among innovation networks (Stewart & Hyysalo, 2008).

The functions of intermediaries have been conceptualized at different levels. They can either support brokering for problem solving (Hargadon & Sutton, 1997, Gianiodis et al., 2010) or for technology transfer (Bessant & Rush, 1995). They can also play an active role in networking among dispersed but complementary organizations (Klerkx & Leeuwis, 2009). Importantly, recent literature has stressed that the role of intermediaries can be critical to explore new opportunities and to develop new ways to address shared issues (such as environmental issues). Intermediaries can for instance initiate change (Lynn et al 1996; Callon 1994), build networks (McEvily & Zaheer, 1999) and determine "where to look in the first place" (Howells, 2006, p. 723).

Research has improved our understanding of the managerial *challenges* inherent in exploratory intermediation. For instance, there is a need to build trust among participants and to rally contributors when the outputs of the collaboration are uncertain, just as in other types of collaborative innovation (Fawcett et al., 2012). Similarly, there is a need to organize specific learning processes and make sure there is enough consensus among partners (van Lente et al, 2003) when the needed knowledge does not pre-exist. Research has also underlined that these challenges are not easily met by intermediaries (Birkinshaw et al., 2011; Sieg et al., 2010). For instance brokers help to solve well-defined problems, based on existing competences. But what if the relevant actors are not known, if there is no clear common interest or clear conflicting interests, or if there are only ill-defined, wicked problems and no legitimate common place to work together?

Previous works have led to identify intermediation management rules that are relevant in cases where the "**degree of unknown**" is not exceedingly high. Such situations for example occur when actors in collaborative innovation endeavours are attracted by a clear common goal which an intermediary can express and communicate or when conflicting stakeholders can work together because the necessity and expectations are sufficiently high for all. But what if there is no common goal or the common vision that raises high expectations? Worse: What if the intermediary alone cannot identify such a common goal, not even a common problem? And even worst: What if there is not legitimate place for an intermediary to invite some potential stakeholders to begin to work together to create a common goal?

In such extreme cases, usual solutions appear at their limits. Are we therefore doomed to "orphan innovation" and "waiting games" (Agogué et al., 2012a; Robinson et al., 2012)? Recent works have exhibited strange forms of intermediaries like "architects of the unknown" (Agogué et al., 2012b) or "colleges of the unknown" (Le Masson et al., 2012). They suggest

that under circumstances of high degrees of unknown, specific management principles for intermediation might exist.

Our goal in this paper is to explore these management principles for intermediation of the unknown. Can intermediaries be active when the degree of unknown is high? And if so, what can they do and how can they manage collective exploration? How can they support, foster, and even push innovation processes?

The paper is organized as follows: We first build on a review of the literature on intermediaries to highlight common core functions of the different types of intermediaries. Then we introduce the "degree of unknown" as a new dimension for analyzing the role of intermediaries, and we discuss whether the intermediary core functions could be fulfilled when the degree of unknown is very high. We then present four empirical cases where these functions have been tackled by intermediaries not despite of but *because of* the low level of pre-existing knowledge. We proceed by describing the managerial challenges these intermediaries face in the unknown and we develop some examples of how they solve them. We conclude by discussing the theoretical and empirical perspectives raised by this work.

Our study contributes to the theory of innovation intermediaries by introducing the degree of unknown as a key *contingency variable*. We characterize a set of management principles for intermediaries in situations where the degree of unknown is high. This set of principles is coherent with previously described intermediaries like architects of the unknown and colleges of the unknown. In this way we characterize a role – namely the "intermediary of the unknown" that may be well spread in practice but to our knowledge not described or analysed in any structured way in the academic literature.

2 Background: A Typology of Innovation Intermediaries

The roles of intermediaries have been established in different contexts and from many different theoretical perspectives. We can derive from the literature three distinct profiles of innovation intermediaries, occurring in different settings and facing different problems or challenges. Innovation intermediaries can play an active role in:

- Brokering for problem solving,
- Brokering for technology transfer,
- Networking or bridging in innovation ecosystems.

In the following section, we review these different types and we demonstrate that they all share some core functions:

1. They connect actors,
2. They involve and mobilize stakeholders,
3. They solve (or mitigate) conflicts among stakeholders,
4. They stimulate innovation.

2.1 Type 1: Broker for Problem Solving

There are many actors that play the same role as brokers for problem solving, for example:

- Consultants (Bessant & Rush, 1995)
- Knowledge intensive business services or KIBS (Klerkx & Leeuwis 2008, 2009)
- Knowledge brokers (Hargadon, 1998; Hargadon & Sutton, 1997)
- Innovation marketplaces (Lichtenthaler & Ernst, 2008)
- Idea scouts or technology scouts (Nambisan & Sawhney, 2007)

The intermediary "broker for problem solving" comes into play when a company lacks knowledge or skilled resources for solving a specific problem, or for developing new innovative ideas. The intermediary then offers access to external knowledge, either by establishing bridges to external experts (e.g., in the case of marketplaces), or by bringing in knowledge from their own experiences (e.g., in consulting activities). Figure 1 below illustrates this first type of intermediation. In previous studies on intermediation, actors such as Evergreen IP (Nambisan & Sawhney, 2007), InnoCentive (Sieg et al., 2010; Surowiecki, 2004; Diener & Piller, 2010), NineSigma, Yet2.com or IDEO (Hargadon, 1998) have been described.

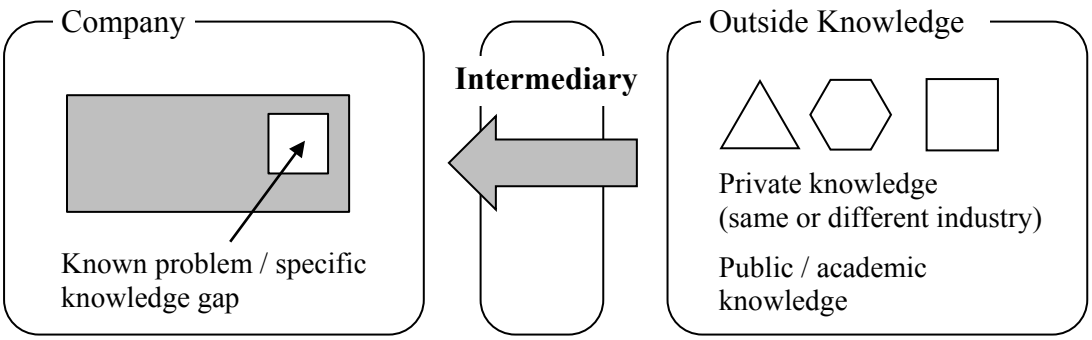

Figure 1. Intermediation as brokering for problem solving

In this configuration, the function of the intermediary is clearly to connect seeking companies with problem solvers. The literature describes important conditions (which are dealt with either by the intermediaries themselves or by the client companies) for this configuration:

- Not only should potential solvers be mobilized, but also problem seekers. Hence, there is a need to "enlist scientists" (Sieg et al., 2010, p. 285) that are not used to submit their problems to external parties
- Knowledge transactions both require that problems are articulated to external actors and that the "problem recipients" can make sense of the defined problem. As Sieg et al.

(2010) have shown, the client company needs to carefully select the right problem and thereby manage the conflict (or trade-off) between seeking the "Holy Grail" solution and offering solvable tasks to externals experts. One success factor would be to select problems at early stages in the innovation process when the solution space is still large enough and when internal scientists have not gotten dulled in complexity issues and technical jargon.

- Finally, the intermediary will fulfil its role only if innovative solutions can be found, which often requires the stimulation of special learning processes. It has been shown that the role of the intermediary is not only to scan and transfer information, but also to organize the articulation, combination and manipulation of knowledge (Bessant & Rush 1995). Thus, this type of intermediary is also concerned with building own innovation capabilities (Howells, 2006, Klerx & Leuwis, 2008). The way problems are decomposed and formulated is recognized as critical success factor for innovation brokers.

The above described four main functions of this type of intermediary are summarized in the following table:

Table 1. Main functions of an intermediary as a broker for problem solving

Main Functions	**Examples**
Connect	Connect seeking companies with problem solvers (e.g., Nambisan & Sawhney, 2007)
Involve / commit / mobilize	Enlist scientists by defining common rules supported by internal "champions" (Sieg et al., 2010)
Solve / avoid conflict	Define the right problem; avoid the conflict between overdrawn expectations ("Holy Grail") and limited solution capacities (Sieg et al., 2010)
Stimulate innovation	Articulate and combine knowledge (Bessant & Rush, 1995), re-engineer knowledge (Klerx & Leuwis, 2008)

2.2 Type 2: Broker for Technology Transfer

Secondly, we find in the literature various labels, such as technology / IP brokers; university technology transfer offices, or liaison departments (Hoppe & Ozdenoren, 2005), technology-to-business centres, out-licensing agencies (Shohet & Prevezer, 1996), business incubators (Pollard, 2006; Nambisan & Sawhney, 2007), and venture capitalists (Nambisan & Sawhney, 2007). All these actors are recognized to help knowledge or technology to be transferred across firm or sector boundaries.

Such intermediation is required when new technologies have been invented and developed, but the inventor cannot commercialize it because of either a lack of resources, a lack of business or market knowledge, or noncompliance with their business model and business strategy. In this situation, intermediaries offer support in bringing the technology to the market, by providing for instance access to potential users of the technology with sufficient resources, legal and IP knowledge, or venture capital opportunities. Intermediaries such as Ignite IP (Nambisan & Sawhney, 2007), Forthright Innovation and the Lanarkshire Business Incubator Centre (Pollard, 2006), or the Siemens Technology-to-Business Centre and Technology Accelerator units (Gassmann & Becker, 2006) have been studied in this light of intermediaries as brokers for technology transfer (see figure 2).

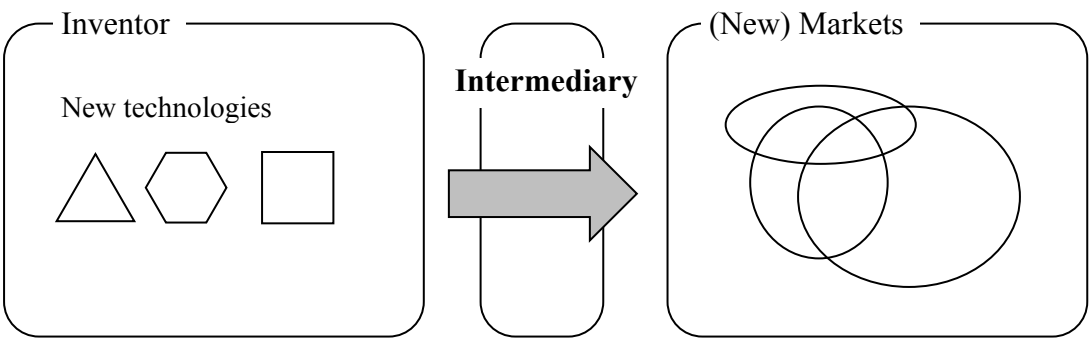

Figure 2. Intermediation as brokering for technology transfer

In this configuration, the function of the intermediary is to organize new connections between distant academic or industry based science and industry players in search for new opportunities (Turpin et al., 1996). However the role of this intermediary is not limited to liaison services:

- Technology providers and potential users have to be convinced and mobilized. The intermediary needs to perform various marketing activities in order to make its own function and also the technologies visible to potential investors (Thursby et al., 2001).
- A special attention should be paid to potential conflicts of interests. The intermediary is positioned in between the inventor (or research unit) and the companies interested in the new technology. Thereby it needs to consider the interests of inventors, which are often not limited to financial aspects (e.g., academic publications, or competition aspects), as well as the interests of investors who seek to gain as much knowledge about the technology and its profitability prospects before the actual transaction takes place (Shohet & Prevezer, 1996).
- Finally, new uses of the technology have to be explored in order to value the technological potential beyond the evident and trivial applications. The intermediary here often gets deeply involved also from a technical perspective, supporting the identification of potential technology applications, and providing assistance in structuring and "moving" the knowledge from the inventor to the investor (Becker & Gassmann, 2006).

Hence, the four main functions of this type of intermediary can be summarized as follows:

Table 2. Main functions of an intermediary as a broker for technology transfer

Main Functions	**Examples**
Connect	Establish connections between academic or industry science and external players in the market (Turpin et al., 1996)
Involve / commit / mobilize	Perform marketing activities in order to attract potential investors (Thursby et al., 2001)
Solve / avoid conflict	Balance heterogeneous (conflicting) interests of stakeholders, in particular financial and non-financial objectives (Shohet & Prevezer, 1996)
Stimulate innovation	Actively engage in the exploration of new technology uses and the transfer of knowledge (Becker & Gassmann, 2006)

2.3 Type 3: Networker or Bridger in Innovation Ecosystems

Thirdly, the literature has described another situation where intermediaries can play a crucial role in creating dynamic innovation: when intermediaries facilitate collaboration in innovation projects at larger scale and for a longer time-horizon, i.e. in entire "*innovation systems*". The reason is that innovations are not only relevant for companies, but also on macro-economic level for nations and their government. Collaborative innovation is fostered by technology policies and organizations (intermediaries) which support the innovation system. We find various occurrences of this kind of intermediaries: Science / technology parks (Löfsten & Lindelöf, 2002), geographical innovation clusters (McEvily & Zaheer, 1999), regional technology centres, technical committees, task forces, standards bodies (van Lente et al., 2003), and "brokers in innovation networks" (Winch & Courtney, 2007).

These intermediaries support networking (bridging) within industries and within geographic clusters. They create common visions, define common objectives, invite different actors, and provide governance (illustrated in figure 3):

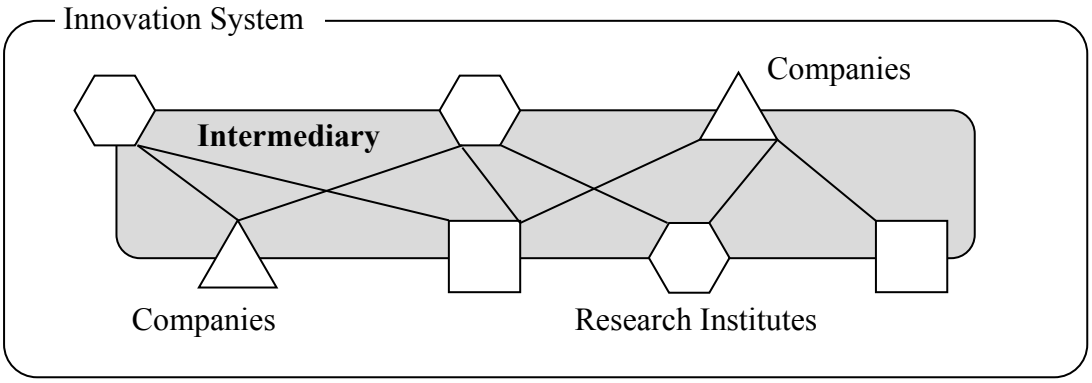

Figure 3. Intermediation as networking or bridging in innovation ecosystems

In this last configuration, the function of the intermediary is still to connect people and organizations. But the connection is all the more complicated because the relevant stakeholders are not always identified ex ante, and also because successful intermediation requires *ongoing* multilateral exchange to be fostered within the network, in opposition to singular mission complete ("problem solved" or "technology transferred") objectives in the first two intermediary configurations. Intermediaries have to initiate linkages and facilitate accessibility to resources and knowledge. This includes building infrastructures, sustaining networks, and facilitating exchange between the actors (van Lente et al., 2003).

Here again, other functions are equally important:

- Technologies providers and potential users have to be convinced and mobilized. Convincing is a matter of framing a common issue that is considered as a problem by potential actors in the innovation system. Sufficient exogenous incentives (e.g., market growth potential and economic factors) are required but can be complemented with resource mobilization activities (e.g., competence and human capital, financial capital, and complementary assets) provided or organized by the innovation intermediary (Bergek et al., 2008).

- The need for collaboration clearly implies a necessity to avoid sources of conflicts. The introduction of new technologies often implies a need for change to which established market actors resist. The intermediary can help to form an "advocacy coalition" which puts new objectives on the agenda and creates "legitimacy for a new technological trajectory" (Hekkert et al., 2007, p. 425). For instance, in the case of environmental care, opposing interests of different actors and resulting conflicts could not be resolved without the intervention of a legitimized intermediary.
- Finally, the role of the intermediary is to stimulate innovative approaches. According to van Lente et al. (2003, p. 256), the intermediary supports the "learning processes, by enhancing feedback mechanism and by stimulating experiments and mutual adaptations". More generally, the challenge is to develop and offer good conditions for learning and experimenting, i.e. to create a place for collective innovation.

Hence, the four main functions of this type of intermediary can be summarized as follows:

Table 3. Main functions of an intermediary as an ecosystem bridger

Main Functions	**Examples**
Connect	Create and maintain a network for ongoing multilateral exchange (van Lente et al., 2003)
Involve / commit / mobilize	Mobilize resources: Human capital, financial capital, and complementary assets (Bergek et al., 2008)
Solve / avoid conflict	Create legitimacy for a new technological trajectory, create a common agenda for actors with different (opposing) interests (Hekkert et al., 2007)
Stimulate innovation	Support learning processes, foster feedback, stimulate experiments and mutual adaptations (van Lente et al., 2003)

2.4 Synthesis

Different types of innovation intermediaries have been analyzed and described in previous studies. Overall, we distinguish between three distinct types of intermediaries: (1) For

problem solving, (2) for technology transfer, and (3) as coordinator of networks in innovation systems. Previous studies have, based on their literature reviews, come up with different structures for roles and functions of intermediaries (e.g., Howells, 2006). We build on these studies. In particular we identify four core functions which seem to be fulfilled by all types of intermediaries in the context of innovation: Connecting actors; involving, committing, and mobilizing actors; solving, avoiding, or mitigating potential conflicts of interests; and also (actively) stimulating the innovation process and innovation outcomes.

As we have indicated in the introduction section, common to all types and functions is that the intermediaries come into play and offer their services when situations are rather well defined. In the following, we focus on our research question and investigate whether intermediaries can be active when the degree of unknown is high.

3 Exploring Type 4: The Intermediary in the Unknown

The role of intermediaries of the unknown has not been systematically analysed. By "unknown", we mean the absence of knowledge. This is different from risk or uncertainty. Types 1-3 are all characterized by different degrees of uncertainty. It is the coordination failure of a pure market solution that creates the need for the intermediaries and the level of uncertainty at which the different intermediaries operate. The intermediaries handle the market failure in different ways. In type 1, those in need of knowledge are helped to find those that possess it. In type 2, those possessing knowledge are in need of finding problems to solve. In type 3, an actor with a need of a solution combines different sources of knowledge to lay the puzzle to create the solution. In all circumstances, there exists both a kind of goal, problem or vision, and an uncertainty regarding the possibility to solve the issue at hand. Knight (1921) introduced a distinction between risk and uncertainty. The latter referring to

events whose probabilities could not be attributed. In financial theory, uncertainty and risk are the same thing, but one differentiates between systematic (factors are calculable), unsystematic (factors known but not calculable), and ambiguous (factors are unknown) situations. For instance the probability that it snows in summer is very low – we know what snowing means, but this event is unlikely to happen in summer. In contrast, the possible form of life on exoplanets is unknown – in the sense that we can hardly conceive of the large variety of forms it can take: The *nature* of this life is unknown. This distinction between not knowing about future events (uncertainty) and not knowing about the nature itself of these events has been intensively developed and grounded in design theories, as the design process usually starts when something, still unknown, is desired. In this situation, the knowledge that is needed, the technologies that should be developed and the relevant stakeholders are not known in advance. They will be rather some outputs of design processes.

Different lines of research have chosen to use different terms. For example, in knowledge management, a common phrase to describe the unknown is “opaque”, or the degree of “opacity”. In other lines of research, for example chaos research and finance, authors refer to “ambiguity”. In this paper we discuss problem solving by collective actors, and in line with design theory we use “unknown” as a term (although it is arguably very close to “opacity” and “ambiguity”).

Following the approach, we ask what the role of intermediaries is if the objects, actors, vision/goals and the legitimacy of context do not exist. Can intermediaries be active in the unknown, and if so, what role do they have and how do they fulfil it? Table 4 lists questions that may be asked with reference to the main functions of intermediaries.

Table 4. A test to identify intermediary in the unknown

Main Functions	Can Intermediaries be Active in the Unknown?
Connect	Can they connect parties when relevant stakeholders are not identified?
Involve / commit / mobilize	Can they mobilize without a good reputation or a legitimate proposition?
Avoid / solve conflicts	Can they overcome conflict without pre-existing common interest?
Stimulate innovation	Can they stimulate innovation without pre-defined problems or research questions?

In the following section, we will exhibit empirical cases of intermediaries in the unknown. The presented cases describe distinct situations in Sweden, France, and Germany, where specific intermediaries have been found to be put in place for either enabling long-term innovation projects involving different actors, or for even creating completely new innovation ecosystems.

4 Exploring the Contingency Variable: Do Intermediaries of the Unknown Exist?

4.1 Methodology and Data Collection

In order to investigate our research question, we have chosen a multiple case study research design (Yin, 2009). With regards to the questions posed in table 4 above, we could not expect to provide answers to all four questions from a singular case. In other words, a singular case would most probably not have been exhaustive for analyzing all core intermediary functions in conditions where there is a high "degree of unknown". Instead, our multiple case design provided an increased chance to find at least one of these conditions relevant for any of the intermediary main functions in each case (c.f., Yin, 2009, p. 59).

The case material is based on interviews which our research team conducted with numerous stakeholders in innovation ecosystems, and also from direct involvement of members from

our research team in particular innovation projects. Although the situations in each of the cases are rather heterogeneous (see section 4.2 below), we could extract similarities related to the presented core intermediary functions which allowed us to consolidate insights into the postulated role of an "intermediary in the unknown". In total we have conducted four case studies with four different innovation intermediaries (see table 5).

Table 5. Data analysis (case studies)

	Siemens	**SAFER**	**CEA-CEBC**	**I-Care**
Country	Germany	Sweden	France	France
Time of analysis	January 2011 – October 2011	September 2008-December 2012	March 2010-December 2012	September 2009 – August 2011
Data collected	Interviews with intermediary representatives Interviews with operating business unit managers involved in innovation projects	Interviews with participants, governance structure, partners Workshops, meeting observations, quantitative surveys	Interviews with stakeholders and intermediary representatives Workshop and meeting observation	Interviews with stakeholders Analysis of European funded projects Workshops observations

Next, we explain case by case the background, the actors, and the role of the intermediary. Thereafter, in section 5, we focus on the contingency variable and highlight for each case the major challenge in the unknown, and how the intermediary responded to this challenge in order to enable successful innovation.

4.2 Presentation of the four cases studies

4.2.1 The Siemens open innovation unit

Siemens has a long history of collaborative R&D (across business units and industrial sectors, along the value chain with suppliers and customers, and with external communities). However it became clear that new web-based technologies and developments in social

behaviours (e.g. user co-creation, social networking, and online collaboration) called for a systematic approach to open innovation. For this purpose, a dedicated "Open Innovation" (OI) unit was installed in Siemens headquarters. The OI unit develops processes, tools, and governance mechanisms for complementing other prevalent forms of (open) collaborative innovation. There are three focus areas that the OI unit supports:

- Collaborative idea generation (e.g. internal and external idea contests): Here, the OI unit supports the operative business units in defining the idea contest topic and in formulating the challenge. The OI unit also provides access to supporting technology (e.g., web-based idea contest platforms), and it supports the entire process from initiation until idea selection and subsequent follow-up activities.
- Collaboration with knowledge brokers (e.g. NineSigma, InnoCentive): In this area, the OI unit first of all promotes the opportunity of collaborating with these knowledge brokers across the (technical) business units, in order to create awareness of this alternative opportunity for solving complicated problems. The OI unit also fulfils a gate-keeping and quality assurance function in such collaboration exercises.
- Connecting Siemens experts around the world (TechnoWeb): The OI unit has implemented a new collaboration infrastructure, the Siemens TechnoWeb. This infrastructure enables internal technical experts around the world to share knowledge and ask for support. Collaboration is not limited to functional areas, as the head of the OI unit pointed out: Experts from the very diverse operational businesses engage in this network and thereby offer "out-of-the-box" solutions to industry-specific problems.

The OI unit can be seen as an internal innovation intermediary for the different sectors and business units. Specific is, that this intermediary is an entity within a large enterprise.

4.2.2 The collaborative arena SAFER

Southwest Sweden is home to several major automotive companies, for example AB Volvo, Volvo Car Corporation, Autoliv and others. It is in the interest of the different actors to collectively do research on vehicle and traffic safety in order to strengthen the automotive cluster. SAFER is set up to facilitate this work. It offers office facilities, meeting rooms, seminars and conferences etc. to their people from their institutional partners – companies such as AB Volvo, Autoliv, government agencies such as the Swedish Transport Administration, smaller technical consultancy companies, and universities such as Chalmers and Gothenburg University. SAFER is an association consisting solely of its partners. It is governed by an annual meeting of the partners and an elected board, and led by a director who, together with an assistant, is the only independent instance in this setting. SAFER does not have a judicial status in the regular sense (the economic administration is for practical reasons done through a special initiative from the Chalmers president's office). Without the partners there would be no organization. Around 170 people have access to the SAFER offices.

The projects at SAFER include a vast array of projects – from pre-studies to large-scale testing projects to method development. The collaborating partners pitch ideas on new projects to the other partners, in order to find collaborators. On some occasions, collaborators are found outside of the boundaries of SAFER, where the extensive network of SAFER can be of good use. SAFER provides a meeting space for matchmaking and networking, and offer neutral grounds for the projects to meet and work.

4.2.3 The agricultural cooperative CEA and the research centre CEBC

Agriculture has to cope with strong challenges of innovation to reach environmental sustainability. This is particularly at stake in cereal plains where intensive farming practices

cause important damages on biodiversity as well as water and soil resources. This case study located in the West of France is a pioneer situation where a small agricultural cooperative, CEA (*Cooperative Entente Agricole* – 400 farmer members), has set up a partnership with a research centre in ecology, the CEBC (*Centre d'Etudes Biologiques de Chizé*), in order to design solutions reconciling agriculture and environmental protection at a landscape scale. Such a collaboration is crucial to explore innovative solutions that take into account both economic *and* environmental issues. However it is challenging as the stakeholders have very different interests and are often in situation of conflict. Through this initiative, CEA and the CEBC seek to play the role of an innovation intermediary, bringing together a plurality of stakeholders.

As an initial step of the project, the cooperative and the research centre organized a collective design workshop in May 2011. Most participants were cooperative farmer members and technicians, but other stakeholders were invited as well. Thirty people participated. Following this workshop, the cooperative and the research centre set up a research-action project involving agronomy and ecology scientists as well as farmers and local authorities. This project will be run for four years and is co-funded by CEA, the CEBC and local authorities. It aims to provide missing knowledge on environmental-friendly farming practices and on governance challenges raised by territorial agro-ecological projects.

4.2.4 The I-Care cluster

The I-Care cluster, launched in 2009, aims to encourage collaborative projects between industry and research laboratories in the Rhône-Alpes region (France) in the field of health technologies. One field in particular has attracted investment and R&D efforts without any great result in terms of innovativeness: The need to improve the well-being of elderly people who face a loss of autonomy.

In France, the average age of the population is increasing; therefore innovations using ICT to help people in loss of autonomy are highly sought after. But the quality of proposed innovations had not met expectations. The I-Care cluster as intermediary therefore explored new ideas collectively with the totality of the stakeholders in several creativity workshops (60 participants). This intermediary influenced the nature of the interactions among these stakeholders by making visible paths of innovation that remain unexplored. To do so, the cluster developed a methodology based on a C-K theory framework (Hatchuel et al., 2011), which allowed them to unveil and evaluate the paths of innovation that were potential new ways to tackle the issue of autonomy. It therefore provided a means to objectify the distance between the expectations in terms of innovation regarding a specific milieu and what the actual innovation capabilities of the sector can, in fact, provide. It also provided means of action to stimulate new concepts to be explored by the different actors of the sector.

4.2.5 Four actors as intermediaries

We can summarize our four cases regarding the different functions of intermediaries: The following table shows how the intermediaries in each case fulfilled these functions.

Table 6. Summary of the four case studies: Challenges in the unknown

Core functions	**Siemens**	**SAFER**	**CEA-CEBC**	**I-Care**
Connect	Connect people beyond local (physical) boundaries, especially by introducing new (web-based) collaboration platforms	Connect researchers and specialist in the vehicle and traffic safety field coming from partners who compete in the market	Connect agricultural professionals and naturalists (initially in conflict)	Connect companies, health organizations, research organizations, and specialists (for instance geriatricians)
Involve / commit / mobilize	Promote methods and tools across sectors & business units,	Create a legitimate place for meeting and innovating	Organize meetings and a collective design workshop: bring	Support the different actors by organizing joint creativity

	and offer employees to present their ideas in front of top management	(offices and lab environments). Collaborative activities for idea generation and knowledge sharing	issues on the table, create mutual understanding, and formulate a common goal	workshops and applying new creativity techniques
Avoid / solve conflicts of interest	Create legitimacy for employee participation by engaging top management to officially support the activities	Written rules of knowledge sharing, but in reality weighing off how much can be disclosed to enable productive work	Collectively explore possible solutions, make interdependences between stakeholders visible, and highlight common values	Open discussion during workshops on the potential future of ICT for autonomy
Stimulate innovation	Collect and share success stories, thereby motivate followers in the organization	Search collective funding, run workshops, exhibitions, publicly display success stories	Launch a research-action project with the different stakeholders, co-funded by local authorities	Make visible new paths of innovation by revealing and stimulate unthought opportunities.

5 The managerial challenges in the unknown and some insights on the ways intermediary solve them

We have seen that the intermediaries in all four case studies were engaged in the core functions which we had identified in the literature. However, we could find that the intermediaries in each of our cases were also faced with rather unusual, or challenging, situations – situations which had not been reported in previous studies. We now focus on each of these situations, explain the particular challenge in the context of one of the cases. We then illustrate how the intermediary in question coped with these challenges.

5.1 Connecting actors which have previously not been identified: Siemens

Siemens is one of the largest enterprises world-wide, with more than 350.000 employees operating in more than 190 countries. The business is very diverse and structured into 4

sectors (industry, energy, healthcare, and infrastructure & cities). Logically, without smart ICT technologies, there would be little collaboration and exchange across business units. “If Siemens only knew what Siemens knows” (head of the OI unit) – this phrase nicely depicts that there is a huge body of knowledge, but it is naturally hard to access outside local departments.

Every day, many people in Siemens encounter specific problems, often difficult engineering problems, to be solved. In the past, problem solving was limited to local teams (engineers could ask colleagues in their teams), and maybe some personal contacts from outside of the teams. But receiving problem solving proposals from “unknown” colleagues was not possible.

One of the activities initiated by the OI unit was the development and implementation of an open expert network, the Siemens TechnoWeb. This network is rather an infrastructure than a real network in a stricter sense, because the nodes (Siemens employees) are not actively participating on a continuous basis. The infrastructure rather enables employees across industrial sectors and various regions to build “ad-hoc” networks for specific problem solving challenges. Experts who operate in completely different industries can provide pieces of knowledge to problems which have been posted on this platform. For instance, one engineer in the Diagnostics unit was facing a problem and posted it on the platform. Within 40 minutes he had the first answer, and within 2 days he had received 25 answers from various different functional areas. Currently there are more than 30,000 people in Siemens registered for the TechnoWeb. So-called “urgent requests” are usually being treated by the community within just a few hours.

5.2 Mobilize joint innovation while being in competition: SAFER

The overall objective with the SAFER collaboration is to increase the competitiveness of the automotive cluster in southwest Sweden. The partners in SAFER have been self-selected. Most of them have worked together before in different constellations. The large organizations such as Autoliv and Volvo have several contact points to SAFER: Several different parts of them collaborate in different areas of expertise. This means that although the partner organizations are set, the stakeholders within those organizations that are relevant for different projects are not. There is a match making process that goes on between the organizations to put the relevant people to work together. Trust is created in the contact points between the organizations, and this involves sharing of information that goes beyond what is actually allowed of judicial reasons (IP). Because of the different specialization of the actors, they complement each other in competences, thereby creating a new organism in the space between the partner organizations.

Several of the partner organizations would engage in bilateral collaboration if SAFER did not exist. However, SAFER becomes a "safe haven" for collaborating in ways that otherwise would not have been possible. Most of the people involved agree that the existence of a physical space to meet, to create trust, drive projects, and thereby collectively share knowledge and develop new ideas is absolutely central to the success of SAFER. SAFER is neither a traditional university competence centre, nor a private research institute. Instead, it is an arena for collaboration which is "unregulated" as its partners work together in different forms to collectively pool resources, skills and capabilities in order to succeed in the safety area. If one of the actors would host the collaboration, it would not be as free. On the other hand, it is only the quality of the work in SAFER that legitimizes its existence.

5.3 Solving conflicts without pre-existing common interest: CEA-CEBC

Farmed ecosystems' stakeholders have generally contradicting interests for its resources, and the actions led by some actors have impacts on the others. As a consequence, conflicting situations are common, especially between farmers and naturalists or other citizens. The challenge to address potential conflict of interests is thus essential to overcome this situation and initiate a collective innovation process.

In the case study the ecologists proposed to develop the production of grasslands in the plain. Ecologists consider that grasslands regenerate regulations crucial for the ecosystem functioning (water storage, insect reproduction…) as they are more "stable" than cereal crops: they are not ploughed every year and require fewer pesticides. However cereal farmers initially did not see grasslands as an acceptable solution despite their ecological interests, as it was not profitable enough: indeed there was hardly any market for fodder.

The conflicting situation has been overcome here as the proposition "grassland" was not considered as a turnkey solution, but rather as the departure point of a design process (Berthet et al., 2012). CEA and the CEBC organised a workshop to initiate a collective design process departing from a common proposition: "designing grasslands for a sustainable agro-ecosystem". This initial proposition, formulated by the project core team, was sufficiently large to involve all stakeholders; then it was progressively specified by the participants of the design workshop.

The stakeholders first shared knowledge about grasslands, and then explored new possible functions of grasslands, such as regenerating biodiversity. They found out that providing ecological functions generally required further coordination between farmers as well as an expanded prescriptive role of the cooperative, for instance to manage their location

throughout the landscape. The exploration made visible interdependences between the stakeholders and brought to light new opportunities of creating value, such as producing high-quality dairy products with local forage from environmental-friendly grasslands. Thus innovative collective solutions were explored rather than mere compromises between production and preservation.

5.4 Stimulating innovation by unveiling unexplored paths of innovation: I-Care

In France (as in Europe) the average age of the population is increasing. The number of French citizens over 75 years of age will be multiplied by 2.5 between 2000 and 2040, reaching a total of 10 million people, and it is estimated that 1.2 million people will have lost their autonomy by 2040. Innovation using ICT to help people in loss of autonomy is highly sought after to provide means for elderly people to enhance their quality of life and to stay the longer possible at home. The mainstream path in the subject of autonomy addresses monitoring a person in their home with numerous and various high-tech devices (e.g., a medallion that can trigger a remote alarm if necessary). These types of projects have been on the market for over 15 years already (and there are plenty of these projects), however, none of them have had any commercial success. Thus, despite a well-expressed need, the innovativeness of the field appears to be stale.

The discussion that was initiated by the I-Care cluster with geriatricians led to the discovery of the concept of fragility. Fragility is described as an intermediate state between robustness and dependence. During this period of life, which affects, for example, a large proportion of seniors, the risk of falling or developing a disease is greater.

The problem of autonomy was then reformulated using this new concept. Shifting the focus from the concept of ICT for assisting the autonomy of seniors to the concept of fragility made

visible new interdependences among the actors as well as new actors to involve, and helped to understand the current staleness in the innovation processes.

Thus, the actions of the cluster and the proposed conceptual broadening helped to open the field to new stakeholders (e.g., in connection with fragility and the seniors' environment). Various actions performed by the cluster (e.g., a seminar reinforcing missing knowledge, a workshop for working collaboratively on original concepts, and meetings with involved entities) led to the appropriation of new alternative technologies by all of the ecosystem's stakeholders and engendered new modalities of interactions among these stakeholders.

6 Results and discussion: Perspectives on studying intermediation in the unknown

The set of cases lead to original management principles to deal with each of the four forms of unknown. These principles call for some comments:

- ***Connect unknown people***: Expert networks are well-known in the literature – and some very famous cases had been already precisely studied at Siemens (Voelpel et al., 2005). But these networks connect already identified experts. Interestingly enough, in the current Siemens case, we notice the capacity to build an "ad-hoc" network, related to an issue that can be new to the firm. Whereas as the implementation of expert networks in the general case often is based on technical skills and scientific disciplines, the building of the ad-hoc network in our case is driven by the innovation issue itself. The temporary organization is created and dies with the issue, and the intermediary makes this possible. The solution that the Siemens case provides goes beyond the classical "solver-solution", where actors are supposed to provide one solution. In intermediation of the unknown, the innovation issue is not supposed to be solved immediately by one expert. Instead the emerging network is supposed to collaboratively work to explore the issue. Finally one

should underline that building ad-hoc networks is not based on incentives – the motivation is intrinsically based on the innovation issue. Experts commit to the emerging network because of their interest in dealing with the issue and because they can help to solve an urgent business problem – which is a strong motivation, maybe even stronger than usual economic incentives (Pink, 2009; Glucksberg, 1962).

- ***Mobilize, interest, involve with a legitimate place***: SAFER was initiated because different market players shared a common interest - vehicle and transport safety. By creating SAFER, the different stakeholders also created a legitimate place for collaborative research and innovation. In the case of SAFER, the stakeholders do not come to find "the solution" but because of the good collaborative conditions to *invent* solutions. SAFER shows a striking case where the intermediaries do not raise expectation on the solution (so-called anticipative expectations) but raise expectation on the capacity to generate multiple solutions (so-called generative expectations) (Le Masson et al., 2012). The legitimacy is not based on the output but on the working conditions. Note that this was already the logic of the machine shop culture at the root of Edison Invention Factory (Israel, 1998; Millard, 1990): Just as in Edison's factory, working at SAFER is just more innovative, more fruitful in terms of innovation output, than working inside one's own parent company.
- ***Conflicts as a resource for collective exploration***: Contrary to the "intermediation in the known", where conflict avoidance or trade-offs are often the rule, the management principle illustrated by CEA-CEBC is to deal with conflict in a creative way and even, to deal with conflict to be creative. Indeed, conflicts reveal a need for an innovation that would solve contradictory interests, and hence it might be a source of radical innovation. It is well known that innovation is also marked by power relationships (Santos & Eisenhardt, 2009); still the works on these topics have shown that this power relationship

is precisely based on the definition of boundaries. Conversely the intermediation in the unknown consists in blurring existing boundaries by reinventing their definitions (new markets, new technological variants and combinations, new constraints understanding, questioning the identity of the object of conflict…), this creates opportunities for "new boundaries" that correspond to possible common interests. In the case of CEA and CEBC the actors in the beginning had very distinct understandings of the key use of grassland: grassland is "for production" (boundary 1) vs. grassland is "for Little Bustard preservation" (boundary 2). The intermediation work consisted in creating new designs of "grasslands" that could combine several values (productive farming as well as the preservation of fauna and water resources). The intermediary redesigned the identity (functions and design parameters) of grasslands and hence created the conditions to overcome conflicts and power relations.

- ***Sharing an agenda of open issues instead of sharing knowledge***. The I-Care case shows a management principle to deal with ill-defined problems. The absence of well-identified problems might block knowledge sharing. However, knowledge is not necessarily the key resource in radical innovation. It is commonly accepted that creativity and the capacity to imagine can also produce innovations. It helps people to think out of the box, to avoid so called fixations (Agogué et al., 2011; Hatchuel et al., 2011; Jansson & Smith, 1991), so that it is today a critical capacity for radical innovation, a new form of absorptive capacity (Le Masson et al., 2012a, 2012b). Moreover, sharing knowledge is often critically linked to confidentiality or IP issue; sharing questions and unsolved problems is paradoxically easier.

Table 7. Management principles for intermediation in the unknown

Main Functions	**Can intermediaries be active in the unknown?**	**Management principles**
Connect	Can they connect parties when relevant stakeholders are not identified?	Develop a capacity to unfold an ad-hoc network where the right people commit to collective innovation (not incentives)
Involve / commit / mobilize	Can they mobilize joint innovation while being in conflict and competition?	Create a legitimate place for collective innovation (not a shared vision)
Avoid / solve conflicts	Can they overcome conflict without pre-existing common interest?	Deal with conflict in a creative way in order to leverage collective exploration
Stimulate innovation	Can they stimulate innovation without pre-defined problem or research questions?	Share an agenda of open issues and questions (before sharing knowledge and answers)

We have a set of four management principles for an intermediation in the unknown. Our cases suggest that these principles are compatible between each other. They are also compatible with the management principles used in situations of low unknown.

One of the consequences of this work is to uncover the paradoxical complexity of this so-called intermediation. In early studies of open innovation, intermediation was almost absent. In recent years, many authors have shown the importance of intermediaries for open innovation. Progressively it appeared that an intermediary was a quite complex actor, with sophisticated management principles (with its specific processes, competences, performance criteria, …). Studying the intermediation in situation of high degrees of unknown, the complexity of the intermediation management principles is even further increased. We are talking about the introduction of new actors into the ecosystem, about stimulating innovation to overcome collective fixation, about organizing a legitimized collaborative working place, and about dealing with conflicts in a creative way. The intermediary becomes the architect of

the ecosystem, in charge of renewing the language of forms and values, of inviting the "entrepreneurs", of dividing and coordinating the exploration work between them, and of dealing with conflicts between them. Hence this new intermediation of the unknown is coherent with what Agogué et al. (2012) propose as "the architect of the unknown" .

While firms are increasingly relying on outside input and collaboration to revitalize their innovation process, there is a dilemma inherent in collective radical innovation: Radical innovation seems to require even more learning, well-managed collective exploration processes, long-term commitment and complex coordination – but open innovation teams can neither rely on classical internal coordination capacities of the firm (learning, core competencies, collective ownership, common purpose, etc.), nor rely on market mechanisms that fundamentally change existing entities. Hence there seems to be more coordination needed and less coordination capacity available. The "architect of the unknown" seems to solve this dilemma in situations of high degrees of unknown. The existence of the "architect of the unknown" explains why open innovation also can be radical. Our article has described the properties of intermediation of the unknown and principles for how to manage it. We call for further research to look for more examples of this kind of actors and to better understand their management tools and doctrines.

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