PORTFOLIO MANAGEMENT OF INNOVATION FIELDS :

APPLYING CK DESIGN THEORY

IN CROSS INDUSTRY EXPLORATORY PARTNERSHIP

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Keywords: CK design theory, management of innovation fields, cross-industry exploratory partnerships, innovation partnerships, OPERA

ABSTRACT

Our paper refers to an industrial practice based on an integrated theoretical framework of design, CK design theory (Hatchuel and Weil, 2002, Hatchuel and Weil, 2003, Hatchuel and Weil, 2008), to support people in management of innovation fields. This study is based on an empirical case in a new form of R&D partnerships, the Cross Industry Exploratory Partnerships. MINATEC IDEAs Laboratory® is composed of a broad scope of partners 2 which aims to co-explore opportunities of micro-nanotechnologies. The paper deals with a strategic design tool, OPERA (French acronym for "tool for exploration, representation and action"), which has been experimented since 2007 and involved participation of design team work and power-holders. During two years, creative insights and projects of the two laboratory's major innovation fields have been collected and structured within CK theory. This tool permits power-holders to drive innovation projects by giving an overview of explored concepts (and still not explored), activation and production of competencies and knowledge.

Our paper is original in four main directions :

1. Compared to numerous theoretical papers (Hatchuel, 2001, Hatchuel, Le Masson, et al., 2008, Howard, Culley, et al., 2008, Kazakçi and Tsoukias, 2005, Le Masson, Hatchuel, et al., 2007), only few articles relate explicitly to the appliance of CK design theory principles into management of innovative projects (Le Masson and Magnusson, 2003, Lenfle, 2008). Our paper refers to a specific tool empirically tested.

2. Moreover, we argue that putting into practice the CK theory does not limit to design innovative project but can be used like a boundary object (Star and Griesemer, 1989) by a large variety of power-holders. We show that OPERA permit to handle carefully a double uncertainties : cohesiveness and coordination (Segrestin, 2003, Segrestin, 2005).
3. We show that, in order to keep coherence between diversities of innovation projects, OPERA permits to be used as a portfolio of management project. We point out the specific challenge to construct projects behind what we call *generic concepts*. Those are built by association of "collective partitions", some examples are provided.
4. Our tool integrates both recommendations given by innovation management project literature, especially Fuzzy Front End (Khurana and Rosenthal, 1998) and theoretical issues of collaborative design in innovation partnerships (Ring and Van de Ven, 1994).

INTRODUCTION

After mainly focusing on topics such as motivations for cooperation formation, evaluation of inter firm performances or description of partners selection process, literature on R&D partnerships has been moving into a deeper understanding of the "black-box" inter-firm collaborative process dynamics. This paper investigates the collective management of innovation fields in a new form of R&D partnerships that we named : Cross Industry Exploratory Partnership. The empirical study of that research has been run in MINATEC IDEAs Laboratory, a French exploratory partnership that gather a broad scope of partners (sport industry, telecommunication, energy, building…) all interested in exploring the new space of values provided by micro-nanotechnologies. Diversity of competences, resources, knowledge, design strategies exhibited at MINATEC IDEAs Laboratory get serious trouble to the classical rule of management of projects. How to manage collectively a so fuzzy and huge field ? How to keep collective interests and postpone the moment when partners split into their own preference ?

In this paper, we based our findings on a recent theoretical framework : CK design theory. According to (Hatchuel and Weil, 2002, Hatchuel and Weil, 2003, Hatchuel and Weil, 2008), design presents a fruitful duality and can be modeled by co evolution of two interdependent spaces : the space of concepts {C} and the space of knowledge {K}. The plan of the paper is organized as follows : in section 2, we first define what are Cross-Industry Exploratory Partnerships and mainly insist on related implications of such organizations in the innovation design process. We point out two main fences of Cross Industry Exploratory Partnership : difficulties due to social and cognitive crises of members involved; capacity to manage a huge quantity and heterogeneity of knowledge and concepts across projects. In section 3, we present the theoretical frameworks upon which this paper is structured, CK design theory. Furthermore, we propose an extension of CK theory as a collective design theory to model collaborative patterns. In that perspective, we illustrate two main co-exploration mechanisms ("*matching and building*"). In section 4, we present two empirical studies of innovations fields (Visual Interface; Energy & Mobility) and the implementation of OPERA, an intermediary tool based on CK design theory that enables to map exploration areas (concept, knowledge missing) and to procure landmarks for power-holders. Finally, in section 5, we give key managerial findings to manage innovation fields in Cross Industry Exploratory Partnership. We stress a particular artifact ("*generic concept*") and propose to organize exploration around it.

LITERATURE REVIEW AND RESEARCH METHODOLOGY

Theoretical background

Innovation partnerships : introduction of Cross-Industry Exploratory Partnerships

Fostering innovation capacities and launching innovative products or services are crucial issues for firms which want to struggle against cost-competitions. Inter-firm collaborations have since long been studied as key activities for innovation, even qualified as a *locus of innovation* ((Powell, Koput, et al., 1996), (Gomes-Casseres, 1996)…). Various purposes have been mentioned to explain motivations for R&D cooperation as granting quality, accessing to strategic knowledge, reducing costs or development times. Numbers of R&D collaborations have been continuously increased since 1960 (Hagedoorn, 2002) and nowadays reach all industries. At the same time, several different typology have been mentioned in literature to contrast R&D collaboration : for instance, level of relationships formalization (informal/formal arrangement), type of organizational structure (e.g. alliance, joint-venture, communities of practices and social networks, R&D agreements), positions of partners in industry architecture (e.g. vertical/horizontal cooperation, public-private partnerships, triple helix,…) or for instance participation degree.

Among existing categorizations, nature and specificity of design activity have been highly noticed as a fruitful distinction of R&D cooperation patterns. **We assume that to understand interfirm collaboration dynamics, co-design process should be deeply investigated. We propose in this paper to adopt this perspective and delimit R&D cooperation towards design process feature. We propose to focus in this paper on a specific class of innovation partnerships : exploratory partnerships.**

In his seminal article entitled "exploration and exploitation in organizational learning", (March, 1991) states that firms develops theirs strategies through two different ways : exploration and exploitation. Contrary to exploitation situations, exploration one are defined as risky activities because they involve new alternatives, the returns are more longer than in exploitation case and require relevant organizational learning capabilities (March, 1991). Exploration projects tend to explore new possibilities and are often assimilated as radical innovation whereas exploitation one are seen as refinement of existing solutions, extensions of competences and technologies and thus, they are more generally qualified as incremental innovation.

Exploratory partnerships have been thus primarily defined as inter firm cooperation under conditions of uncertainties. Recently, (Segrestin, 2005) based on (Hatchuel and Weil, 2002) proposes extension of exploration's definition, and define it as formulations of concepts which do not yet exist and are supported by a lack of available knowledge. The author highlights a specific characteristic of such cooperation : **when the contract is signed, functional or technical specifications do not exist yet, the common purpose need to be built**. That main feature extremely differentiate co-exploration relationships from more traditional co-development or sub-contracts cooperation. The fact that the "object to design" is not stabilized casts doubt on the way to organize collective works : boundaries of competences between partners are fuzzy, division of labors and prescription rules to coordinate actions are unclear.

Furthermore, (Segrestin, 2004, Segrestin, 2005) stresses that **a dual exploration process emerged in co-exploration partnerships : an exploration of the concept and exploration of interests between partnerships.** In fact, during design process, partners are confronted to a double uncertainty, they are not sure that the project would be a success (*coordination uncertainties*) and they can not be certain, at the beginning, that they will agree each other on the way to manage that project (*cohesiveness uncertainty*). The author shows that managing exploratory partnership requires to manage the both aspects, it means to build common purpose and to create conditions for collective actions.

Surprisingly, literature on management of exploratory partnership or innovation partnerships focus frequently on cooperation between few partners (3max.) and most of time, R&D cooperation are established into a unique industry : cooperation in automobile, in bio technology, in IT and so on. Case study of the paper refers to a Cross-Industry Exploratory Partnerships involving simultaneously a large number of partners (>5) and a broad scope of industry areas (automobile, sport, energy, …). Emergence of such partnerships are in line with the increasing literature regarding open innovation (Chesbrough, 2003) and highlights a specific paradox (Parkhe, 1991) : **combination of heterogeneous knowledge seems to have a positive effect on innovation success, however, literature recommend to firms to establish collaboration with partners not too different of them (regarding assets, cultures, objectives, sizes) to limit risks of conflicts.**

The ability of the firm to manage cooperation with heterogeneous actors is still challenged. The management of cohesiveness and coordination is thus even more meaningful in Cross Industry Exploratory Partnership : How partners will agree and co-explore together a same innovation field ? How to maintain the collective interests and organize the working process despite divergent goals ?

We use term **"cross-industry exploratory partnerships"** to refer to commitment of at least two partners from separate industry which jointly explore new space of value and new knowledge or competences.

Likewise exploratory partnerships, Cross-Industry Exploratory Partnerships are means to open boundary of firms and acquire external ideas and competences. However, researchers still face three main challenges regarding management of such collaborative processes: First, a major difficulty is to cope between partners with sometimes different strategies, needs and competences in order to maintain joining objectives and avoid conflicts of interests (1). Second, exploratory partnerships are characterized by several innovative projects which include high quantity and heterogeneity of knowledge and concepts to manage (2).

<u>(1) Ensuring collective process between partners</u>

Despite of several advantages procured by interfirm collaboration, authors insist on the fact that such organizations run into serious trouble, frequent crisis of instability and low rate of success (Bleeke and Ernst, 1991, Das and Teng, 2000). Most of scholars states that main reason of failures alliances lies in relational aspects and thereby interpartners conflicts and resolutions conflicts techniques are broadly tackled. (Das and Teng, 1998, Doz, 1996, Ring and Van de Ven, 1994) claim that trust and confidence in the relationships can be reinforced by considering cooperation as learning cycles which require to question initial conditions and making arrangements of it while designing. (Das and Teng, 1998) suggest taking care of contracts elaboration and recommend to write recurrent contracts and to clearly delineate property rights. Authors argue that partners could have different goals and timeframes; to overpass such difficulties partners need to enhance communication by using appropriate information systems, to develop common language or to hire project leader with knowledge-brokers skills. Regarding partners' selection, scholars proposes to examine carefully prospects profile and reduce risks by assessing cultural identity, strategic ambitions…

Although the use of various modalities is possible to struggle potential conflicts between partners, the literature is still challenging and particularly stressed in Cross-Industry Exploratory Partnerships case :

First, quantity and diversity of actors question the ability to unite participants on collective objectives. One major issue faced is to mobilize actors in consensual-vision building. How to align divergent interest in a same way of exploration and avoid opportunistic behaviors ?

Second, even if initializations of projects are succeeded, how to maintain sustainable collective interests during the exploration process ? In fact, the exploration of concepts need progressively to make operational choices and so requires to manage successfully preferences of partners.

<u>(2) Managing innovation fields face to heterogeneous concepts and knowledge</u>

Diversity of memberships are not the only challenge implied in innovation partnerships. There is also a need to manage simultaneously numbers of projects, each of them including various knowledge domain and concepts. So, how to manage the portfolio of innovation projects in Cross Industry Exploratory Partnerships ? How to maintain consistent paths between all the projects ?

Basically, management of projects requires to execute operational tasks and control efficiently that projects respect cost, quality and delay fixed at the beginning (Clark and Wheelwright, 1992). In that perspective, many sophisticated projects management tools are employed like Program Evaluation and Review Technique (PERT) or GANTT diagrams to optimize stage gate process (Cooper, 1976). In general, the actual management project paradigm can be view as a rationale process to reduce risks and to control uncertainties.

In innovation context, such paradigm is challenged : determination of well-specified initial targets is delicate and objectives can shift during the process, the knowledge, human resources and timetable may be difficult to estimate (Beaume, Maniak, et al., 2009, Elmquist and Le Masson, 2009)). Previous researches in Fuzzy Front End (Khurana and Rosenthal, 1998) or Front End of Innovation (Koen, Ajamian, et al., 2001), first phase of New Product Development, point out that the actual paradigm often narrows innovativeness by setting up early definition products, technical specifications and customer preferences that could become obsolete at the time of product launch (Bhattacharya, Krishnan, et al., 1998).

Recently, (Hatchuel, Le Masson, et al., 2001) introduces term of innovation fields, they define innovation fields as exploration of new values without neither customer specifications nor available competences. In such case, people are face to explore a large theme (e.g. Mobility and Energy) not well defined. In order to achieve that goal, several innovation projects are launched, each projects are more or less linked to that theme. The objectives are not only to generate new ideas and prepare heavy recommendations (feasibility studies…) for development phase like in FFE but also to identify knowledge and competences required to explore such problematic. Furthermore, managing innovation fields are argued to be simultaneously iterative and linear, each project contributes to the entire innovation field but each phase of the project are interdependent (mock up, market study…). Regarding temporal aspect, projects are short duration and steps are not known at the beginning of the project, each step is defined thanks to the knowledge acquired previously (Le Masson, Hatchuel, et al., 2007). Nevertheless, except some papers (Holmberg, Le Masson, et al., 2003, Lenfle, 2008, Lenfle and Midler, 2003), very few papers empirically refer to management of innovation fields and a call for new insights is launched.

Theoretical frameworks: CK design theory and matching/building strategy

CK design theory

(Hatchuel and Weil, 1999, Hatchuel and Weil, 2002, Hatchuel and Weil, 2003, Hatchuel and Weil, 2008, Le Masson, Hatchuel, et al., 2007) propose CK theory of design – **a theory of design reasoning based on the interplay between two different spaces – a space C of concepts and a space K of knowledge**; Fig1. Knowledge space models all that is known by a designer (or, a group of designer). This may include knowledge about objects and services, users' preference, competences of the firm, laws, norms and regulations, etc. In terms of the theory, knowledge space contains all the propositions the designer is capable of declaring as true or false. Concept space, on the other hand, contains new ideas (the novelty of an idea is relative to a given knowledge space of a particular designer). According to the theory, such propositions do not have a logical status when a design process starts. The designer cannot say whether such thing may be possible, nor can he say that this would never be the case (e.g. some tables can dance). Concepts are *undecidable* propositions in K (neither true nor false in K) about some partially unknown object x. Formally, *concepts are descriptions of an object of the form "C: there exist an object x with the properties p_1; p_2;…; p_n such that C is undecidable in K*" (Kazakçi, 2008).

Design starts with a disjunction process upon wish a concept is created. It can progressively be built and detailed by partitioning (i.e. by adding new properties) using available knowledge. The structure obtained this way is a tree spanning from the initial concept; the paths of the concept tree are called design paths. Design paths correspond to object definitions. When a new and unprecedented property is introduced into the tree (by partitioning), a new definition is created – which might or might not lead to innovation. Such operations are called (conceptual) expansions or expansive partitioning (e.g. a car without wheels). The new concepts that appear this way should be investigated, built and validated in the knowledge space. Often, this requires acquiring new knowledge - the expansion of the knowledge space. **Design process can then be described by the interaction of two spaces: knowledge is used to further elaborate the product descriptions in concept space, while concepts are used to reorganize and expand the knowledge space**. Design stops when a proposition which was previously "undecidable" become decidable in K.

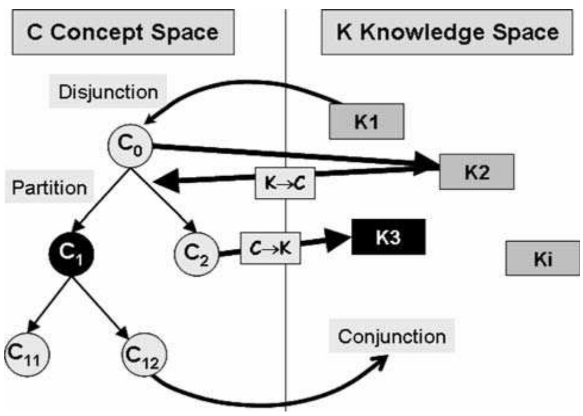

Fig1. CK design formalism (Hatchuel and Weil, 2002)

Understanding collective action towards building and matching strategy

In (Kazakçi, Gillier, et al., 2008) we previously propose a new way to use CK design theory. According to us, CK design theory not only permit to model design reasoning but also to understand collective design reasoning, it means to model co-design reasoning; Fig2. In literature, aspects like "negotiation", "mediation" are frequently discussed but it does not permit to understand the effect of such complex process on the design strategies. **According to us, CK theory permit us to model impact of collaboration on design reasoning**. We propose to model different partners as design oriented organizations (Hatchuel, Le Masson, et al., 2002, Hatchuel and Weil, 1999)). Each partner has its own K-space and C-space. K-space is all competences, technologies, information (market, socio-technique studies…) or internal strategies which could be used by partners during exploration. Similarly, C-space is the edge of new project, there are concepts of new product, new service or new design methodologies.

In order to co-innovate, each partner needs to explore other partners' C and K spaces to discover synergies. (Kazakçi, Gillier, et al., 2008) show previously that co-exploration process consist on reducing distance between their respective spaces. Furthermore, the process of co-exploration corresponds to a process of finding or creating intersections or complementarities between the respective concepts and knowledge of the partners. By matching or building existing C spaces and K-spaces, partners aim to discover interesting concepts (or simply, sub-properties) on which it is promising to work together. We called such properties : **collective partitions**.

This can be characterized with :
- a **process of matching**; a process aiming at detecting existing intersections of partners' C spaces or K spaces.
- **a process of building**; a process of creating intersections either in C spaces or in K spaces.

In our view, management of Cross Industry Exploratory Partnership implies to make visible and operational strategies of matching and building, for instance, memberships need to know :

- preoccupation with same concept, same ideas and projects (*matching Concept*)
- opportunity to create new partition in their C-space (*building Concept*)
- partners need to see if they have similar interest on specific knowledge (*matching Knowledge*)
- partner need to see what they have been learning during the projects (*building Knowledge*)

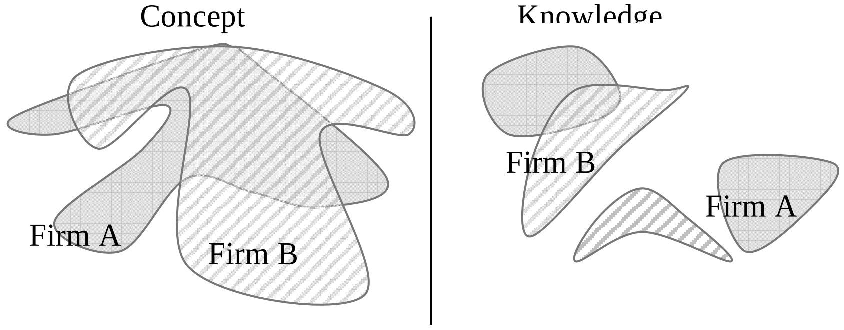

Fig2. Matching or building collective strategy (Kazakçi, Gillier, et al., 2008)

CASE STUDY AND RESEARCH METHODOLOGY

MINATEC IDEAs Laboratory® : a platform for exploring innovation opportunities

MINATEC IDEAs Laboratory® , H is an innovation platform located in Grenoble, France, next to French Center of Research in Micro-nanotechnology, MINATEC CEA. The platform was created in 2001 by France Télécom (a telecommunication operator), ST Microelectronics (semiconductor company) and) Hewlett Packard and CEA Commissariat à l'Energie Atomique (the French atomic commission - technological research organization). It has been progressively opened to new partners from 2003. Today, MIL is composed of industrial partners - EDF, CEA, Renault, Bouygues SA (Bouygues Telecom, Bouygues Immobilier, Colas, Alsthom, …), Rossignol, CEA and Grenoble – Universities: Pierre Mendès France and Stendhal.

The participants of MIL aims at discovering and mastering new competencies (in new technologies in general and in particular, in the domain of micro-nanotechnologies) through the attempts of creating innovative applications (products or services) for their base field of activity.

Moreover, the platform allows partners to share risks and costs generated by technological innovation attempts. Each year, partners accept to invest a same amount of money and allocate same human resources. However, this last aspect induces the necessity to reach consensus on the innovation fields to be explored so that a maximum number of partners can benefit from the result. Due to the large scope of partners' businesses, a variety of project ideas covering a large domain like telecommunications, home automation, sport and leisure or even electronic interfaces are proposed and reaching the consensus on which project to pursue is not straightforward

MINATEC IDEAs Laboratory can be qualified as an exploratory partnership and more precisely as a Cross Industry Exploratory Partnership : at the beginning of projects, they do not know exactly what they desire to design and common interests between partners can merge at any moment. The only common purpose is to explore innovation fields (e.g. Visual Interface) procured by micro-nanotechnology. As a result of large heterogeneity of industries, very few products are jointly commercialized, the return of invest of such partnership are measured to the amount of new knowledge created. Consequently, making a durable process of collaboration is challenged, partners need to take advantage much possible of wealth provided by multi-cultural context.

Research methodology

The present research follows an active participatory research approach. The findings reported here are the result of an in-depth empirical case-study investigation (Yin, 1994) and participation coupled by an abstraction and theoretical modeling effort. During 15 months, two of the authors continuously participated to operational projects (new technology-based projects and user centered design studies) and to managerial meetings (one meeting per month) taking place at MINATEC IDEAs Laboratory.

Several research paradigms similar to our approach are proposed in the literature for collective action and management research (see e.g. clinical field research (Schein, 1987), grounded theory (Glaser and Strauss, 1967), intervention research (David, 2001)). Among these approaches, ours would be closest to Intervention Research since, beside constant observation and interaction with the field, our team played active roles in organizational processes by participating to projects. This methodology allows understanding on-going organizational processes and problems from an insider point of view which in turn allows adapting the way the researcher interact with the field and adjust its investigation when trying to make sense of the field (David, 2001, Hatchuel, 2001).

That paper is illustrated by two empirical cases, "Visual Interface" and "Energy and Mobility". Both of them can be defined as innovation fields : it doesn't exist precise customers' needs, competences required are fuzzy or unknown. A steering committee, composed of the representatives of all the partners, meets regularly to address these innovation fields, to supervise advancement of different projects and discuss courses of actions for newly emerging project ideas. During each steering committee, OPERA, the tool proposed in that paper, has been used to drive innovation fields and enhance decision making process.

USING CK THEORY TO MAP INNOVATION FIELDS: OPERA

Experimental # 1 : collected prior innovation projects and ideas

<u>Visual Interfaces Projects</u>

The beginning of OPERA (French acronym for "tool for exploration, representation and action") experimentations was in October 2007 on " Visual Interfaces". At first, members of MINATEC IDEAs Laboratory had difficulties to gather the constellation of ideas produced by brainstorming sessions in a coherent approach. Ideas were various, some of them more or less feasible, more or less original. The first objective of OPERA was to collect that different ideas and structure them into a CK tree arborescence to give an overview of exploration. In order to reach that goal, we collect ideas and making reverse-engineering of them. We mainly support our action according to recent research studies which propose a new technique for mastering existing ideas by a bottom up process (see the following example of reverse-engineering process of a mobile service idea; Fig3 (Le Masson and Magnusson, 2003)). Thus, each idea was traduced as concepts and declined into relevant partitions. Regarding K-space, each idea were confronted to the following questions : How to make that idea real ? What is the knowledge needed ? What I know and what we have to learn ?

Thus, we obtain a CK tree with all concepts spread over the partitions, the knowledge existing, the missing knowledge. Steering committee was very interested in that first approach. It enables to visualize all ideas in a synthetic way, similarities and distance between them, and the knowledge involved. However, a main criticism was that this initiative came too late in the exploration process, it did not enlighten the decision making process. That first experimentation appears as a post-rational operation that for instance, doesn't permit clearly to understand interaction strength between C-space and K-space. A second experiment, more pro-active, had thus been ordered.

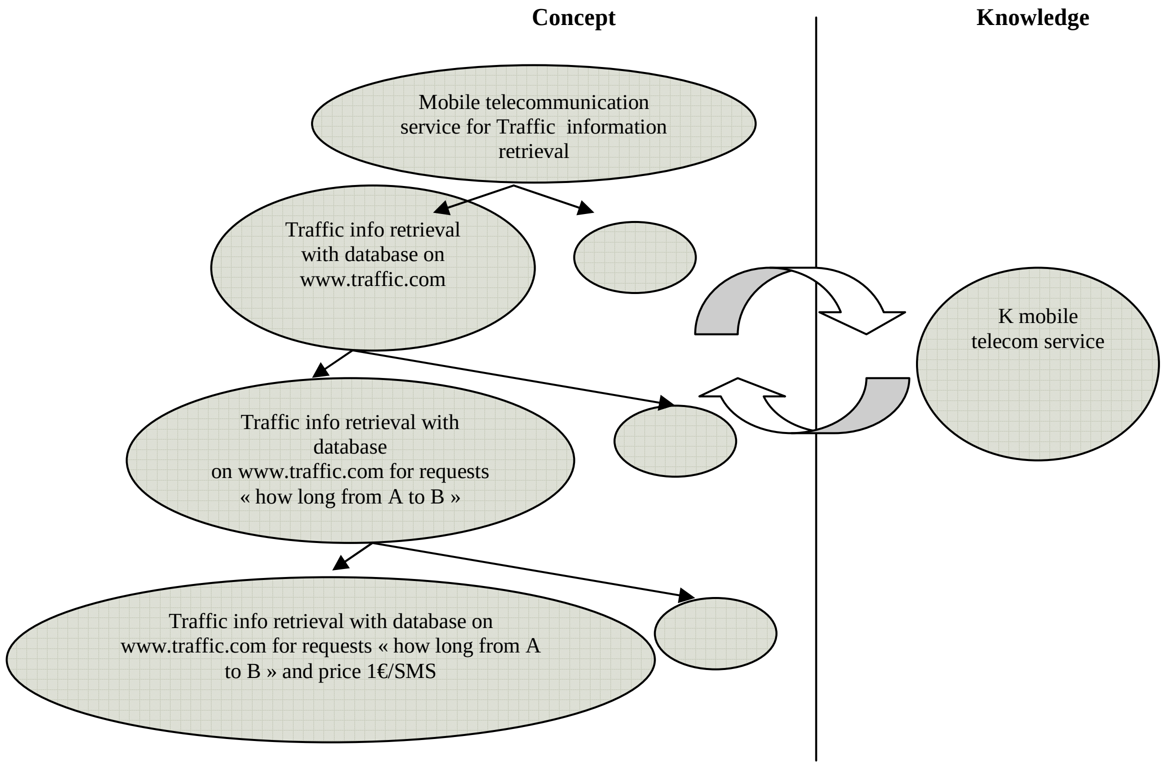

Fig3. Reverse-engineering of "a mobile service idea", adapted from (Le Masson and Magnusson, 2003)

Experimental # 2 : driving innovation fields in progress

<u>Energy & Mobility Projects</u>

Consequently, the second experimentation was conducted at the beginning of 2008 on a second innovation field : "Energy & Mobility " (see snapshot Fig4). It aims to co-design valuable concepts related to new systems of power management and power supplies. It lasted one year and lead to various original concepts, some of them were proved by mocks-up and user-studies.

At the beginning "Energy & Mobility" was only a thematic which was interesting for all partners, not any projects were detailed, any mock-up specified. First of all, we decide to divide our innovation-fields in three broad parts :

1. new energy production systems
2. new energy suppliers
3. and, smartly energy consumption

That first effort was a large debate with power-holders and design-team. We immediately admitted that these 3 parts were not totally independent but the objective was nevertheless to separate contrasted sub-innovation fields. In (1), we consider all projects and ideas where the nomad users not have any energy and need to produce it. Sub-innovation field (2) included that energy exists somewhere but the way to acquire it is unknown. And finally, we assume that our mobile-devices were loaded and we question our energy consumption (3).

Second step of the experimentation was to propose those first partitions for all sub-innovation fields. That step enables to lead exploration process and monitor the partners' preferences. It reveals clearly that (1) was the most interesting topics for partners. In accordance with (Hatchuel, Le Masson, et al., 2009), these first partitions have been reached by examination and exchange of existing knowledge and detection of missing knowledge on each sub-innovation field (relevant partners' K and C-spaces, state of art …).

Then, from this first mapping of exploration, steering committee decided to launch few projects to enhance deeper exploration : brainstorming, technical studies or prototyping were launched. All ideas, knowledge production were continuously implemented in OPERA, it permitted to see synergies between projects. Remark that robustness of OPERA had been challenged during all the exploration process. For instance, if a new idea emerges, we try to position it in OPERA and we modify the CK tree arborescence (extension of partitions by adding new attributes or modification of entire partitions).

Finally, steering-committee had a representation of "Energy &Mobility" innovation field, they knew exactly contributions of each project on the innovation field. Each project can be itself managed with CK theory. Thereby, the concepts and knowledge produced were transferred in OPERA that gives a more macro-view of innovation fields. Progressively, memberships proposed new partitions and could redirect projects (back to step 2). Indeed, participants can see all projects, concepts and ideas linked, the production of knowledge and the missing knowledge (that missing knowledge could be a way to select new partners for entering into MINATEC IDEAs Laboratory or to hire new skills…)

Four main steps for OPERA implementation :

- **Step 1 :** Formulation of innovation-fields (or sub-innovation fields),
- **Step 2 :** Knowledge gathering and first partitions to lead exploration process
- **Step 3 :** Positioning projects into the innovation-field - execution of standard R&D activities (prototyping, brainstorming sessions, technical studies…) and integration of concepts and knowledge into OPERA.
- **Step 4 :** Reporting and examination of sub-innovation fields and projects (detection of the value, knowledge gaps…) (back to step 2)

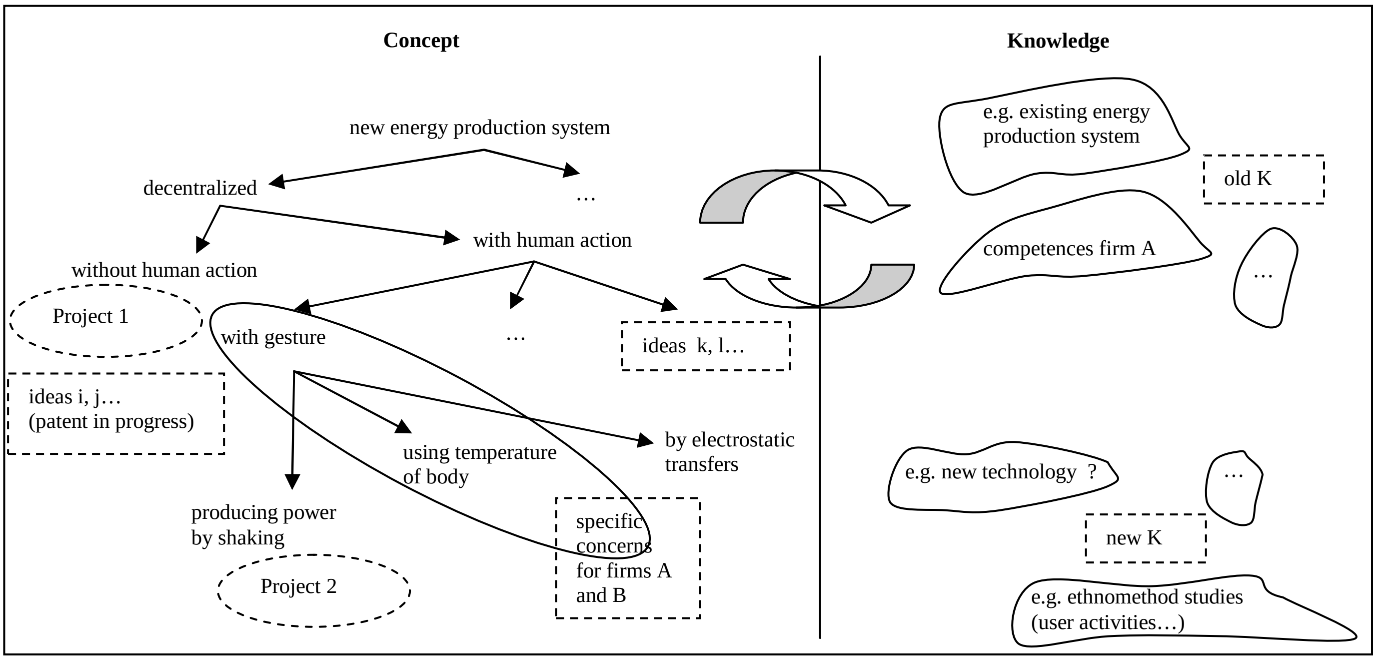

Fig4. Driving innovation fields by OPERA

DISCUSSIONS AND CONCLUSION

Theoretical and managerial implications

Ensuring collective process between partners by sharing understandable representation of exploration

In Cross Industry Exploratory Partnership, divergent interests can be sources of major conflicts. We show in this paper that CK theory enables to design suitable tools to manage innovation fields. OPERA can be interpreted as a boundary object, it means objects which are both plastic enough to adapt to local needs and the constraints of the several practices employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use. These objects may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation. The creation and management of boundary objects is a key process in developing and maintaining coherence across intersecting social worlds ((Star and Griesemer, 1989), p 393).

OPERA balances long-term vision with current activity, it keeps both "big picture" and "detailed picture" of innovation fields. Additionally, OPERA represents a part of partners' identity, which permits partners to see "what they are" (e.g. its strategy, products commercialized, its patents...) and what they "could be" (new opportunities of learning or commercial outcomes…).

Because coordination and cohesiveness have been identified as necessary conditions for maintaining the efficiency of exploratory partnerships (Segrestin, 2003), we have designed OPERA by identifying which operational components should be implemented on MINATEC IDEAs Laboratory projects management tool. Regarding cohesiveness dimension, partners can visualize the areas where they collectively explore, concepts and knowledge into which they have common interests ("some branch of OPERA tree are more heavy", i.e. with much more collective interests). Furthermore, they can see what are the preferred personal areas and the preferred areas of the other partners. Regarding coordination, power-holders can more easily estimate the knowledge required by projects and competences of different partners. We proposed to operationally translate dimensions of cohesiveness and coordination into the following items :

Few operational components of cohesiveness :

- giving to partners a global view on explored innovation fields
- taking into account partners specificities concerning business, skill, technologies
- identifying common and opposite interest areas (e.g. partner can encircle areas in C and K-space)
- managing patents rights on concepts into account

Few operational components of coordination :

- facilitating addition into C-Space of existing and new concepts issued from different creativity works
- identifying and showing the old and new generative rules which have been used to design existing and new concepts into K-Space as well as 3 types of K (existing K, K to acquire, K forecasting)

(see (Le Masson and Magnusson, 2003) for further details on generative rules.)
- specifying objectives of each study or project
- specifying knowledge issued from one project which could add value to another
- acting on the link between functions and technologies
- specifying human resources

Proposition 1 : In Cross Industry Exploratory Partnership, we propose to support collective representation by using specific boundary object, a CK theory based tree (OPERA or similar). According to us, such shareable externalizations permit to see exploration areas and to maintain cohesiveness and coordination.

Managing Innovation fields by portfolio management projects in Cross Industry Exploratory Partnership

Driving innovation fields in Cross Industry Exploratory Partnership requires to manage simultaneously multiple innovation projects, those can be more or less heterogeneous as regard as variety of partners, with different maturation degree and stakes. **The dynamics of classical project management is essentially based on updating the data concerning scheduling; the dynamics of innovation project are essentially based on building knowledge allowing the design team to schedule the following steps. Consequently, building tools for innovation projects management consists in giving framework for representation of knowledge and actions depending on this knowledge. According to us, CK theory enable to adopt such perspectives.**

Furthermore, we want to introduce a novel theoretical notion, we named it : generic concept. Generic concept are concepts which enable to crystallize a valuable area of exploration. Thereby, the determination of relevant generic concept allows to deal with numerous sub concepts, to activate and acquire new knowledge. Such notion can be highly connected to *lineage* (Hatchuel and Weil, 1999), it means a sequence of products that help firms both to drive exploration and organize value-creating reuse of acquired knowledge (Silberzahn and Midler, 2008). However, from our special collaborative context, benefits of generic concepts can be perceived quite differently. Beyond making exploration process easier, generic concepts are key elements to assure cohesiveness : they are made of partitions that embedded all individual interests and can be determined by matching or building strategy (see Fig5).

We define **generic concept** as concept that embedded collective partitions :

Let's imagine that firm A wants to design object Y with properties A_1, A_2, A_3, A_4, A_5 and firm B who wants to design Z with properties A_1, A_4, A_5, A_6, A_7; a concept generic C_g is thus of the form : *"there exists some objects Cg, for which a group of properties A_1, A_4, A_5 hold in K".*

In such example A_1, A_4, A_5 are **collective partitions**.

According to us, driving innovative fields requests first exploring broad areas of potential valuable ideas and knowledge. Then, determination of generic concepts enable to procure certain fixations points to gain "depth" and guide the exploration. In line with (Seidel, 2007), associations of projects with some generic concepts help to maintain common conceptual references and increase cohesion.

Proposition 2 : We propose to manage innovation fields by structuring portfolio of innovation projects around of generic concepts.

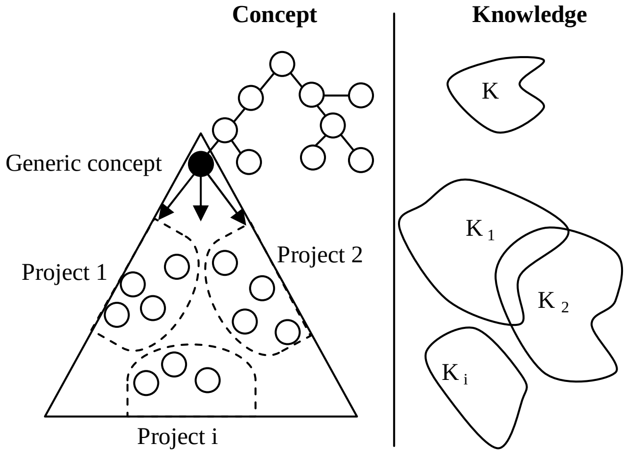

Fig5. Organizing co-exploration process around generic concept

Conclusion and perspectives

This paper presents new form of innovation partnerships : Cross Industry Exploratory Partnerships. In such case, memberships are numerous and various, the common purposes of the collaboration do not exist *ex ante* and need to be designed. This research study has been empirically grounded in MINATEC IDEAs Laboratory, a Cross Industry Exploratory Partnership that involves a French government-funded technological research organization specialized in new technologies Research and developments and specially in micro-nano nanotechnology (CEA) and embrace diverse partners from a large broad scope of fields (automotive, energy, sport, building…).

According to us, Cross Industry Exploratory Partnerships face two main theoretical and managerial fences :

first, heterogeneity of interests questions the faculty to align divergent interests and assure conditions of cohesiveness and coordination between memberships;

then, because of many various projects, Cross Industry Exploratory Partnership presents high risks of resources and competences disseminations;

In this paper we present an original tool for supporting people in collective exploration, OPERA. The latter has been based on advanced results of a recent design theory, named, CK design theory. CK theory interprets design as interactions process between dual process, C-space and K-space. OPERA gives key answers to the two previous issues and had been experimented in MINATEC IDEAs Laboratory upon two innovation fields. It plays a role of boundary object, which permits to give consensual-vision building of the exploration between partners. Furthermore, OPERA enables to manage innovation fields after detecting special artifact, the generic concept, which embedded the collective interest and crystallize exploration operations.

The findings put forward in this article are based on a single case study and thus, more empirically research is needed to generalize and refine OPERA. From this study, few perspectives can be addressed. Experimentations show that OPERA could be improved by automation, some research have been already run in this way (Kazakçi and Tsoukias, 2005). Indeed, it may be possible to make automatic links between "CK tree" of single projects (micro-view) with the "CK tree" of innovation field (macro-view). Moreover some functionalities could be subject for further works like the intellectual property management or the estimation of time and cost to acquire new knowledge or to exploit existing knowledge. Finally, OPERA will be extended to include explicit criteria to assess performance of innovation fields, such issues have already been proposed by (Le Masson, Hatchuel, et al., 2007) (see *variety, robustness, originality, value*).

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