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MANAGING THE EMERGENCE OF CONCEPTS IN FUZZY FRONT END: A FRAMEWORK OF STRATEGIC PERFORMANCE AND EMERGING PROCESS OF INNOVATION BRIEFS

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Abstract

Despite the importance of *new concept development* (NCD) literature, the variety and evolution of concepts generated in the fuzzy front end and that lead to the concepts that will be design briefs for new product, technology and radical innovation projects is still misunderstood. In this paper, we propose to address this issue of multiplicity and coherence of emerging concept descriptions in the fuzzy front end at three levels of analysis — cognitive, managerial and strategic — in order to describe the dynamics of conceptual works. We rely on a longitudinal study (8 years) of the innovation capability management in a large established firm, SNCF, the French railroad company. Our main results are i) to give a typology of emerging concept formulations; ii) to elicit a structured process of building a “desirable unknown” for both the firm and involved individuals, that gather three dimensions: cognitive generative power, collaborative attractiveness for new organizations experimentation, and strategic positioning renewal of the firm in quickly evolving environments; and iii) to explicit specific patterns of emerging concept that can improve the performance of design briefs. We thereby contribute to guide practitioners involved in NCD work to reach their innovation goals.

Keywords: Fuzzy front end, Radical innovation, emerging concepts, design briefs

1. Introduction

In this paper, we propose to address the issue of the emergence of concepts in the upstream phase of innovation projects, as known as *fuzzy front end* (FFE) of innovation (Reinertsen and Smith, 1991). As stated by Koen et al (2006), the front end's goal is to propose inputs for projects portfolios of new product development (NPD), new technologies, or for radical innovation activities. These inputs are often referred to as *innovation concepts*, that could take in practice different names from *product ideas* to *design briefs*, that all refer to the specific step of ideation maturity that supports resources allocation for further developments within innovation projects (Reid and de Brentani, 2004). Nevertheless, they have in common to refer to an extended and formalized formulation of the innovation concept: "*Has a well-defined form, including both a written and visual description, that includes its primary features and customer benefits combined with a broad understanding of the technology needed*". (Koen et al, 2002, p6). Due to the impact of concept briefs on innovation process, the FFE has clearly been demonstrated as having a high potential for improving the innovation performance, since many failures of the NPD can be traced back to the concept or initial idea (Florén et al., 2017). However, literature on the management of the emergence of concept within the FFE is still scarce even the link to innovation performance has been early identified since a long time (Koen et al, 2002; 2006). Thus, the front end of innovation is often described as an unpredictable and unmanageable phase, due to both specificities of creativity processes and the great degree of unknown on future product and market patterns associated to innovation, This is the case because, as pointed out by Markham (2013), the FFE cannot be managed using the same tools and best practices as new product development (NPD) or the stage gate process. Through this research, we wish to contribute to the research on the FFE's management and performance evaluation.

As underlined previously, new concept development in FFE comes before very different kind of innovation project processes : NPD portfolios, technology portfolios or radical innovation projects. Koen et al. (2006) stated that expectations and goals differ a lot between radical innovation projects and more continuous innovations, so we could assume that the expected output of the FFE depends on the type of project that will be launched afterwards. Even though radical innovation projects also target new product development, these activities differ from exploitation projects in the nature of their outputs on the firm performance (Levinthal and March, 1993) and the knowledge process they are managing within a firm (Floyd & Lane, 2000). Radical innovation projects explore original areas for the firm, aiming to create new business units or pioneering offers through original combination of knowledge that could open new technology or market approaches, while the latter will aim to improve the knowledge of the firm in order to propose the best answer to the actual competitive environment, mostly through technologies adaptation and more relevant features to meet the needs of actual customers (Lenfle, 2016; Nonaka, 1994). Consequently, radical innovation projects have long been seen as activities that generate intensive sociopolitical interactions between managers as they disturb the organization established for exploitation performance (Weick, 1995) and need to demonstrate the strategic benefits so much novelty brings to the firm (Burgelman, 1991). We will therefore focus on how the FFE for radical innovation supports an elicitation of formulation patterns during the new concept development works.

Concept formulations for radical innovation projects should simultaneously address a triple goal to ensure innovation project success (Reid and de Brentani, 2004; O'Connor & de Martino, 2006; Backman, Börjesson & Setterberg, 2007; Le Masson, Hatchuel & Weil, 2009): firstly, a cognitive goal to support the unusual knowledge process of exploration, secondly, a collaborative purpose to overcome the organizational rigidities of the exploitation structure and thirdly, an explicit value proposition built on a recognized opportunity that

explains the strategic vision. Indeed, cognition theorists have for years underlined the crucial role of concept formulation in the achievement of creative thinking (Koestler, 1964; Fauconnier and Turner, 1998) and in particular, how concepts play the role of stimuli that could sustain or decrease the ability of individual to propose original and elaborated ideas (Smith et al., 1993; Ward et al., 2004). These works led to researches on the design field about the different cognitive processes of learning that allow formulating concept or contributing to its elaboration (Hatchuel and Weil, 2003; 2009; Taura and Nagai, 2012). On the other hand, idea generation and selection process has been largely studied in new product development process to address managerial and strategic goals, and help managers to distinguish what makes effective idea for collective action and innovation performance (Björk and Magnusson, 2009; Boeddrich, 2004; Girotra et al., 2010). Nevertheless, those works are mostly concentrated on final formulation generated for NPD investment decision than in its evolution during ideation phase. Thus, the variety and evolution of concepts generated to describe the innovative purpose *for the firm* beyond individual's cognitive efforts to think the novelty across the whole innovation process is still misunderstood. Our research addresses this gap of new concept development process.

Building on a longitudinal research, we investigate the concept development process of a large established firm — SNCF, the French railroad company — having radical innovation as a goal and that involved more than one thousand collaborators in systematic fuzzy front end works facilitated through thematic workshops since 2011. We built a database of all formulations of emerging concepts used in 52 different workshops for radical innovation projects from June 2011 to 2018. More than 520 different concepts have been identified, divided in 162 “stand-alone” innovation concept descriptions and 123 formalized sets of interrelated concepts (conceptual formulation that contains at least a set of 3 dependent innovation concepts). First of all, we led a systematic analysis on the three performance axis

— cognitive, collaborativeness and strategic —of all concept formulations and then, we trace and compare evolution paths of concepts within thematic workshops in order to understand the similarities of conceptual work dynamics operated within the fuzzy front end.

Three main results emerged from our analyses from the database and their uses in the 52 industrial projects.

First, the exhaustive census of concepts highlights the existence of seven types of concept formulations that combine cognitive, collaborative and strategic goals but address it differently. The first three are **stand-alone concepts** — workshops' name, initial concept for exploration, creativity stimulus — that are designed to be **self-supportive and attractive ambassadors of the exploratory project purpose and firm's ambition of disruption**, whereas the four others types are interrelated concepts — exploratory control map, detailed conceptual map, conceptual argument and pre-exploration trees — where the **contingent presentation of stepped levels of conceptual disruption structures different levels of novelty for the firm in order to support a more comprehensive and effective division of the exploratory work**.

Second, these different types of concepts do not appear randomly in the field: they form a **structured and coherent set of specific facets of the emerging concepts**. Each types **appears within clear sequences of concept maturation** we identified across the panel of radical innovation projects, that support the coordination and coherence on the different management goals across the process. In particular, the research underlined a **step-by-step dynamics to name the “desirable unknown” of the innovation concept brief** to reach in the three dimensions: **cognitive generative power, collaborative attractiveness for new**

organizations experimentation, and strategic positioning renewal of the firm in high velocity environments.

Third, longitudinal analyses of concepts over 8 years of practice underlined the increasing ability of radical innovation projects stakeholders involved in concept formulation **to jointly elicit the three dimension** needed to gather a sustainable the desirable unknown for subsequent innovation projects. In particular, we observed in this firm that innovation support team progressively stabilized some features of the different types of concepts.

2. How to reach concepts for radical innovation in the FFE – strengthening the innovation concept brief

In their description of the FFE, Koen et al. (2006) state that concepts are developed through the “New Concept Development” (NCD) process, described as a non-linear interaction where ideas circulate and flow between five activity elements of the front end: opportunity identification, opportunity analysis, idea generation, idea selection, and concept definition. The NCD process was developed as a framework to be used by individuals to *strengthen* the innovation concept brief.

Literature on the front end points to organizational attributes (senior management commitment, vision, strategy, resources, and culture) as having the highest impact on the front end’s performance (Koen et al. 2014a) and contributions of team composition, collaboration practices, and specific front-end activities as also being factors influencing this performance (Koen et al., 2014b). Most literature on the FFE however, deals with incremental innovation.

Defining the quality of a concept or design brief in an innovation process is an ambitious research issue that has been studied for a long time by researchers in creativity, new product development (NPD) and design theory. Like in literature on the FFE, the distinction between

radical and continuous innovation projects is not always explicit in all of these fields of research. However, all these researches discuss individual or collective contributions to the progress of the activity.

We present how researchers from Creativity, NPD and Design theory tackle the issue of concept formulation to address managerial goals of originality, collaboration efficiency or internal attractiveness and strategic relevance. In a first part we develop the different results on stand-alone concept (2.1) before presenting works on the set of interrelated concepts (2.2).

2.1. Creativity approaches of concepts for cognitive performance

In creativity theory, researches on concept formulation aims for the understanding of different managerial goals.

The most studied approach is how to give the ability to managers to compare different ideas produced by individuals during creativity sessions. Following the seminal hypotheses of brainstorming formulated by Osborn that “*quantity breeds quality*” and that assessment of ideas could be postpone after the generation of ideas (Osborn, 1953), quality of ideas is based on ex ante assessment of conceptual formulation per comparison *relatively* to a set of ideas (the other participants of the same session or a previous set). A lot of works studied efficiency criteria, mainly to discriminate novelty of ideas (fluency, flexibility, originality, elaboration) that highlights a cognitive performance of some participants (Torrance, 1965; Diehl and Stroebe, 1991; Runco and Charles, 1993), and the relevancy (feasibility, applicability, implementability, acceptability) that underlines the adequacy of the concept to the problem context (Gallupe et al, 1992; MacCrimmon and Wagner, 1994; Plucker et al., 2004).

Even Osborn’s hypotheses and team’s creativity has been largely disputed (e.g., Girotra, et al, 2010; Kazakci et al, 2014), the large amount of research works on creativity criteria and the

profusion of practices based on brainstorming since the 60's, promote largely concepts as stand-alone objects that could intrinsically bring more or less novelty and feasibility to an innovation project. Concept formulations in this approach are more or less detailed expression of an idea that could vary from some keywords on a post-it to idea cards that could integer idea name, drawings or illustrations.

Moreover, the managerial importance to take care of the content of concept formulation is, for us, further to link to a second approach of these objects in creativity theory, which focused on the cognitive steps before idea formulation. Based on cognitive studies, researchers stressed long ago the impact of concept formulation in the achievement of creative thinking. Thus, Koestler (1964) described the origin of concept formulation as the result of new junctions between former knowledge or assumptions. Fauconnier and Turner (1998) explained *blending*, a specific cognitive process where individuals modify the initial inputs of a problem and change their view of the corresponding situations, resulting in an increased capacity to formulate original concepts. Still in creativity, researchers studied how stand-alone concepts play the role of stimuli that could sustain or decrease the ability of individual to propose original and elaborated ideas (Smith et al., 1993; Ward et al., 2004). These works led to researches on the design field about the different cognitive processes to formulate a concept (Hatchuel and Weil, 2003; 2009; Taura and Nagai, 2012) and the nature of examples that sustain originality and “generativity” in creativity tasks (Agogu   et al, 2013). In those approaches, efficient concept formulations for innovation are phrases that help individuals to inhibit *mental fixation*, due to a spontaneous memory of previous ideas that impeded the generation of new and appropriate ideas (Smith, 2003). Consequently, creativity criteria of variety and fluency used to discriminate a contingent production of ideas are powerful tools to highlight fixation effects, both at individual and collective levels. If we consider all the ideas

of a creative workshop as an interrelated set of conceptual formulation, a density of proposals in the same category obviously points out the shared mental fixations (Le Masson et al., 2011).

2.2 New product development approaches of concept formulation for collaborative and strategic fitness performance

Creativity works had a large impact in the field of new product development. Less focused on the cognitive processes, researchers in new product development (NPD) management concentrate their research on the facilitation of idea generation and the selection processes that could support the realization of a disruptive market strategy. In this literature, ideation is largely considered as the starting point of the innovation journey (Van de Ven, 1986; Cooper, 1990) and many authors stressed the importance of ideation management to feed the funnel of new product development (Boeddrich, 2004). Consequently, these researches are motivated by the theoretical and empirical challenge to distinguish what makes effective idea for collective action and innovation performance.

In the lineage of Koestler's work, idea quality is clearly associated to new connections between knowledge. Many studies have been conducted to compare ideation techniques performance for innovation (e.g., Cooper and Edgett, 2008) and they focused on the management of new resources for ideation (customers' observation or collaborative workshops, open innovation with the industrial and scientific ecosystem's stakeholder, technological watch, etc.). Thus, Björk and Magnusson (2009) underlined the interrelationship between innovation idea quality and network connectivity of ideas providers (internally and outside organizational boundaries). In particular, they stressed knowledge patterns — newness and collaborativeness — of idea formulation to be an innovation idea:

“To turn new knowledge in the form of an idea into an innovation, the idea in question also has to be made explicit so that the knowledge can be shared with other organizational members and realized through action” (p663). Such approach is focused on the levers to fasten the further elaboration of an innovative offer.

In addition to the literature on knowledge elicitation for collaboration, Girotra et al. (2010) insists on the importance of generating ‘best’ ideas, *i.e.* with very high potential for firm’s business, and the ability to recognize them since the first steps of creativity. Building on creative theory criticisms about team inefficiency, they confirmed that groups that worked firstly independently then collectively produced best quality of ideas according creativity criteria of performance, but they were also more capable to *identify* the best. Theirs conclusions are for interest to our research as they conclude that this increased ability was due to a specific set-up of the creative process: as individuals engaged themselves independently in the same problem-solving issue they became more accurate to evaluate others proposals and less victims of the path by which the idea was generated. Nevertheless, coalitions of employees are numerous during innovation a process, creating dissociated sub-groups within firms (Akrich, Callon and Latour, 1988) and it has been demonstrated that in the setting of internal selection, creative teams systematically under-evaluate ideas associated to actors outside their subunit (Reitzig and Sorenson, 2013). Such an in-group bias is a micro-level symptom of the well known “not invented here” syndrome largely studied in ambidextrous organizations (Katz and Allen, 1982). Pursuing the theoretical effort of digging the steps of ideation in order to improve high-quality idea generation and facilitating its implementation, Zhu et al. (2018) recently observed in internal idea contests new kinds of interactions during the generation phase that could help to overcome such an in-group bias. They underlined specific characteristics of colleagues’ or facilitators’ feedbacks that positively affect idea

quality: *diversity* resulting from a heterogeneity of commentator's skills and competencies, *constructiveness* that provides in-depth knowledge to the idea authors on potential feasibility path or strategic fitness elaboration, and *integration* that results from facilitators' efforts to connect the idea to other ideas. If we return the rationale, an efficient stand-alone concept formulation in exploratory project should be designed to induce constructive feedbacks from the largest diversity of internal stakeholders and stimulate managers to propose integration with others activities.

To summarize NPD approaches, a 'good' "stand-alone" concept formulation for an exploratory project is a high-quality idea proposal (original, elaborated, feasible, strategic fit) that guides collaborative exploration in a radical innovation NPD project by obviously pointing out knowledge to explore and eliciting a specific potential of business consistent with strategic goals. It is a crucial step of the collective process of starting an exploratory project that result of an idea generation phase and become the input of a business-oriented selection phase that could be improved by an individualization of the generation phase. The formulation must not explicitly designate internal actors or team as providers of the idea in order to reduce in-group bias of under-evaluation in selection and to provide a more heterogeneous knowledge base to later elaboration and constructive feedbacks.

Inter-relations between ideas are less studied in NPD literature but we identified two significant recent researches that bring interesting insights for our research issue. First, dealing with issue of the scarcity of resources of idea screening, Magnusson et al. (2016) highlighted that both technically-skilled users and technically-naïve users are able to rank ideas in the same order than professional experts (even there is no conformance between users and experts when comparing their absolute score) and consequently, select the same top ideas. Second, studying how to reduce shortcomings associated to web-enabled ideation systems,

Beretta et al. (2018) isolate specific roles of moderators to *build* interrelations between stand-alone ideas proposals that are directly linked to the management of originality (*formalizing the ideation process*), collaboration efficiency (*combining means for community building*) and strategic relevance (*formulating an ideation strategy*).

2.3 Innovative design approach of concepts for generativity performance

Design is a common reasoning resulting in new and original proposals based on knowledge re-combination, acquisition and creation that is shared by numerous stakeholders of industrial exploratory projects whose most known representatives are engineers and industrial designers. They all shared the use of concepts in their reasoning to nurture their knowledge process (Hatchuel and Weil, 2009). For example, a classic concept promoted by industrial designers in innovation activities is the “Design brief”. Researchers in design theory underlined that this conceptual object can’t be considered as the elicitation of a problem-solving task, but should be seen instead as “*only propositions on artefacts that are desirable but partially unknown. They are highly underdetermined both from a framing and solution seeking perspectives.*” (Hatchuel et al, 2017, p7). This illustrates the main difference for our purpose between design theory approach and the previously presented of creativity (and NPD which is largely rooted in ideation): the ability to identify the “generativeness” of a concept.

This notion of generativity, i.e. “*the ability to produce design proposals that are different from existing solutions and design standards*”, is at the heart of the different successive or co-existing theories of design (Hatchuel et al., 2011). To explain it briefly, throughout an innovative design process, actors manipulate different generative concepts that engineering design theorists named as ‘set of functional requirement /design parameters’, ‘function-

attribute couple’, ‘infused function-attribute model’, ‘concepts-knowledge expansion’, etc. (Suh, 1990; Braha and Reich, 2003; Shai and Reich, 2004; Hatchuel and Weil, 2009). Generativity designates the power of a concept to support and guide the creation of *new* knowledge during exploration, whereas creativity is focused on ideation within existing bodies of knowledge (Le Masson et al., 2011). Thus, in C-K theory, a concept is the unknown object to design, described through a list of desirable properties extracted from knowledge bases of the designers, whereas concept-knowledge expansions are successive interactions between concept space and knowledge bases that induce the *creation* of new knowledge and new conceptual paths to address the problem at the origin of the will to innovation (also called dual expansion mechanism, Hatchuel and Weil, 2003; 2009).

Then, in exploratory project, an efficient concept formulation is generative: it induced surprising way to address the problem (original design paths) and the generation of new knowledge. Interrelations between concepts formulation are very studied in design science. The relationship between conceptual formulations is even at the heart of the works that deals with the design process of major innovations as Infused Design or C-K Theory. As the aim is to create really new design paths, they can’t appear without a deep modeling of existing paths and their novelty can’t be assessed without a reference to the dominant design (i.e. main products and business model) (Gillier et al.2015).

3. Method: Analyzing a longitudinal production of concepts in a systematic FFE based on workshops for radical innovation

The paper is a first qualitative research of the issue that investigates the practices of concept definition in a large established firm — SNCF, the French railroad company — that used to manage radical innovation projects in a systematic way across a dedicated process of structured innovative design workshops which involved more than one thousand collaborators

since 2011. Those workshops are based on KCP workshop method (Elmqvist and Segrestin, 2009; Le Masson et al, 2009; Hooge et al.,2016), that have been created to generate simultaneously a radical innovation strategy and the networks of stakeholders to make it happens. Thus, the aim of KCP workshop is not to produce design briefs for innovation projects managed through NPD or stage-gate processes but moreover to structure a consistent roadmap of innovative and research activities to explore disruptive areas. It's unusual that these workshops are used as a routine for innovation and our research on concept formulation dynamics takes place in a long-term collaborative partnership between researchers and practitioners (Adler et al., 2004; Shani et al., 2008) on the impacts of systematic fuzzy front end management on the innovation capability of the firm.

To manage its radical innovation FFE with design theory inspired methods since 2011, the firm created an innovation and foresight team inside the research and innovation department. One of this team's goals was to develop methods that would allow radical innovations to emerge, and to lead applications of these methods under deep cooperation with the different R&D departments and business unit inside the firm. We will refer to the *ad hoc* small teams that managed thematic workshops as "exploratory project managers": these always include at least one person from the innovation team and one to five people from the departments (Research or Business unit). The innovation team organized over 80 structured innovative design workshops over the 2011-2018 period to achieve this goal that contribute to 52 different thematic exploratory workshops. Each workshop involved large groups of collaborators (up to 100 collaborators) that still followed the same main steps of collaboration to collectively investigate the issues raised by the exploratory project managers: a first phase of intensive knowledge sharing and acquisition, a second phase of creativity and conceptual exploration and a third phase to structure innovation strategy, i.e. the proposal for business

elaboration, specific research programs and validation strategy.

Both PhD in innovation management, two authors of this paper are reflexive practitioners (Schön, 1983), part of this innovation cell since respectively 2011 and 2015; one created the innovation and foresight team in 2011. Another author, researcher in innovation management, is involved in the longitudinal partnership with SNCF since 2010. Thus, our case study is particularly interesting due to the fact that we were able together to collect a very large amount of internal data on 8 years of innovative design workshops. Data was collected from different internal sources, from field notes of participants of the workshop, official communications on each one of the workshops, as well as through non-structured interviews with participants of the innovation workshops.

Due to the fact that the innovative design workshops were structured, concept formulations with different cognitive and managerial goals were formalized, and collecting this data over time allows us not only to better understand the emergence and evolution of each concept, but also their interactions. We will describe these in the next paragraphs and also give some examples. Nevertheless, to give a preview on the amount of concept formulations collected, Table 1 shows the data collected on the 52 exploratory workshops conducted from June 2011 to 2018. We divided the database of concepts into stand-alone concept descriptions (162 extended formulations) and structured sets of concepts (123 sets of interrelated formulations of at least three distinct conceptual paths). The different concepts will be discussed in our case study.

Autonomous concepts (Stand-alone)			Structured sets of concepts (interrelated)			
Workshop name	Initial concept for exploration	Creativity stimulus	Exploratory control map	Pre-exploration tree	Detailed concept map	Conceptual argument tree

52	43	67	52	11	40	20
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Table 1. Data collected (number of concept formulations per category)

4. Case study: The experience of SNCF on concepts

4.1 Concept emergence and evolution

In the sample of 8 years we studied, we identified seven different kinds of concepts that were employed to foster creative thinking and exploratory project management. These concepts emerged at different points of the front end of radical innovation projects, structured through the collaborative innovative design workshops. The concepts also had different formats. We will start by describing their emergence and evolution, by separating between stand-alone concepts and structured sets of interrelated concepts.

4.1.1 Stand-alone concepts

There are a series of concepts used inside the firm for innovation that can be used and understood by themselves. This does not mean that these concepts are independent from the others. As we will describe further down, they are still part of a global reflexion in the innovation field the radical innovation project is addressing. However, they can be employed alone, without the need to mobilize other concepts for them to be understandable. There are three types of stand-alone concepts we identified in SNCF's longitudinal experience: workshops' name, initial concept for exploration, creativity stimulus (also named "disruptive searchlight" by Elmquist and Segrestin (2009), "C-Projectors" in (Hatchuel et al., 2009), "conceptual exploratory axis" in (Hooge et al., 2016).

The *workshop name* is the first stand-alone concept defined for each workshop. It is created

every time there is a subject identified as being relevant for exploration: its source is consequently sometimes hard to define as it often crystalizes before the official launch of the radical innovation project. Its emergence allows starting exploration and creating a project team, considered legitimate inside the firm. The workshop name makes it easier to communicate inside the firm, invite participants for the workshops and do preliminary explorations on a subject. Workshop names are not completely static, but since they identify a workshop and its associated team, they usually do not evolve once the first invitations for a workshop have been launched. If evolutions happen, they are managed by adapting or adding a sub-title to the initial workshops' name. The exploratory project managers could make such modifications to better match with participants' mindsets, to open on unexpected conceptual dimension or to detail some aspects of original concept.

The *initial concept* for exploration is defined by the exploratory project managers once they have done preliminary exploration both inside and outside the firm and are able to better identify the perimeter they want to work on. The initial concept is formulated to highlight an unknown to explore that is 'desirable' for the many stakeholders that could impact or be impacted by the achievement of the project (in the sense of Freeman, 1983): it has value for the firm, is fitting with the strategy and is not a question that can easily be answered. It demands to go beyond the dominant design, and despite consistency with strategy can demand to redefine certain of its aspects. The formulation of the initial concept is done by exploratory project managers before collective workshops start, but in three of the workshops in our database it was the outcome of the collective workshop, and one of the identified workshops never defined one. For those cases, the radical innovation project is still on-going or had been postponed to gather a more adapted team of "exploratory project managers". In all the other projects, the initial concept was communicated to all workshop participants in the

first workshop session. It is the backbone around which the exploration will be structured, and the starting point for all the structured sets of concepts done linked to a workshop. It's a living object for the group: the initial concept for exploration is often reformulated, even during the workshop, but its initial formulation is often recalled by participants or project manager to discuss the new paths a reformulation opens.

Creativity stimuli are used to guide exploration during collective workshops. They are built by the exploratory project managers and based on their first structuration of the innovation field to explore ('exploratory control map', presented in 4.1.2). The goal of creativity stimuli is to make sure explorations by the workshop group go in a valuable direction, both in term of disruption and strategic fitness. Depending on the size of the group involved in the workshop, there can be from two to six different creativity stimuli proposed, and they are worked on in smaller groups, of around 10 to 15 participants. Each creativity stimulus has a verbal formulation as title, but since it is used to stimulate the group to innovate, it contains a subtitle and a series of images and words, creating expansive examples and tensions that stimulate discussions inside the group. One example of creativity stimulus (without the images for copyright reasons) can be found in Figure 2.



Figure 1. Example of a creativity stimulus without the images for the “cabin futures” workshop. Images were removed for copyright reasons

As we highlighted in the presentation of the different stand-alone concept formulations, the moments in which these concept are employed are different, and they are interlinked. Concepts furthermore differ in their form. To better understand the diversity inside the database we collected, we will give some examples of the concepts used in eight exploratory projects in table 2.

Year	Workshops' name	Initial concept for exploration	Creativity stimulus title
2012/2013	Mass Transit	SNCF Transilien Railway operator of the current and future network, multimodal and high capacity, for a resilient traveller service	1. Transilien = Hardened operator 2. Mass transit comfortable in degraded operations 3. Chameleon transilien 4. From the station to the interface 5. Mass transit as a universal platform 6. Positive Mass Transit
2013/2014	Rolling Stock High Performances Mainten@nce	Enlarging vision of rolling stock maintenance to regenerate it and to reduce cost by 30%	1. Flexible, quick and robust maintenance 2. Just maintenance 3. Operations-maintenance symbiosis 4. Open maintenance 5. 0 maintenance, the maintenance that disappears 6. Positive impact maintenance
2016	Immo Futures	Immo Futures - The future of real estate by the same actors doing different projects	1. Urb@n Dynamic Lifestyles 2. Bionic Real estate 3. Future net value
2016	Voyage Analytics	New ways for transport optimization	1. Stealthy production 2. Collaborative and collective services
2016	Mobilities & societ@l tempos	Regenerating vision of mobility and transport organization to face mutations of everyday life with local end-users and authorities	1. Augmented Mobility Traveller 2. Societ@l station: triple Hub 3. Flexible mobilities
2016	Adaptive st@tion	The station viewed as a flexible bubble of mobility for users	1. Emancipated traveller 2. High/Low tech Station 3. St@tion for diversity
2017/2018	Cabin Futures	Hypercockpit for hyper operations as a conceptual exploration to design innovative pre-competitive R&D roadmap for major European industrial and operational actors	1. Manager of any cabin(s) 2. Polymorphism applied to driving locus/place/cabin of operations 3. Personalized cabin through on-demand standards 4. Hypercockpit for Innovative low cost train operations
2018	Convers@tions	Building a transversal community on conversational agents based on collective exploration projects	1. Chatbots as socio-technical objects 2. From the collective and individual to chatbots

Table 2. Stand-alone concepts gathered for eight workshops

4.1.2 Structured set of interrelated concepts

Besides the stand-alone concepts, we also identified structured sets of concepts, where at least three different conceptual paths are linked, and the concept set has to be seen as a whole. There were four identified types of concept sets: exploratory control map, pre-exploration trees, detailed conceptual map and conceptual argument.

The *exploratory control map* is a tool manipulated only by the exploratory project managers. It helps them structuring the different workshop phases: before workshop's collective phases, it allows the managers to identify where fixation effects could occur and where new knowledge could help the group in the exploration. The project team often makes several different exploratory control maps, since these evolve with the workshop preparation and during workshop. Although an exploratory control map is done for every workshop, these are rarely formalized in reports or presented to other internal stakeholders of the radical innovation project, since they are preparation and coordination tools for the managers and are therefore mostly done on paperboards or are in the field notes from the workshop preparation meetings. Concretely, the exploratory control map is a conceptual tree that starts from the initial concept for exploration, that tries to map the new conceptual paths linked to this initial concept, thinkable from knowledge available in the firm or mobilizing new knowledge to extend exploration. Creativity stimuli result from these properties of the exploratory control maps.

Pre-exploration trees are a second type of structured set of interrelated concepts. Like creativity stimulus, they are a way to guide explorations during the workshops. Pre-exploration trees are generally considered more effective by the workshop organizers when the group has some experience reading and using exploration trees. They are composed of a

series of concepts linked to the initial concept for exploration, and participants of the workshop are encouraged to continue expanding the tree. One example can be found below, in Figure 3.

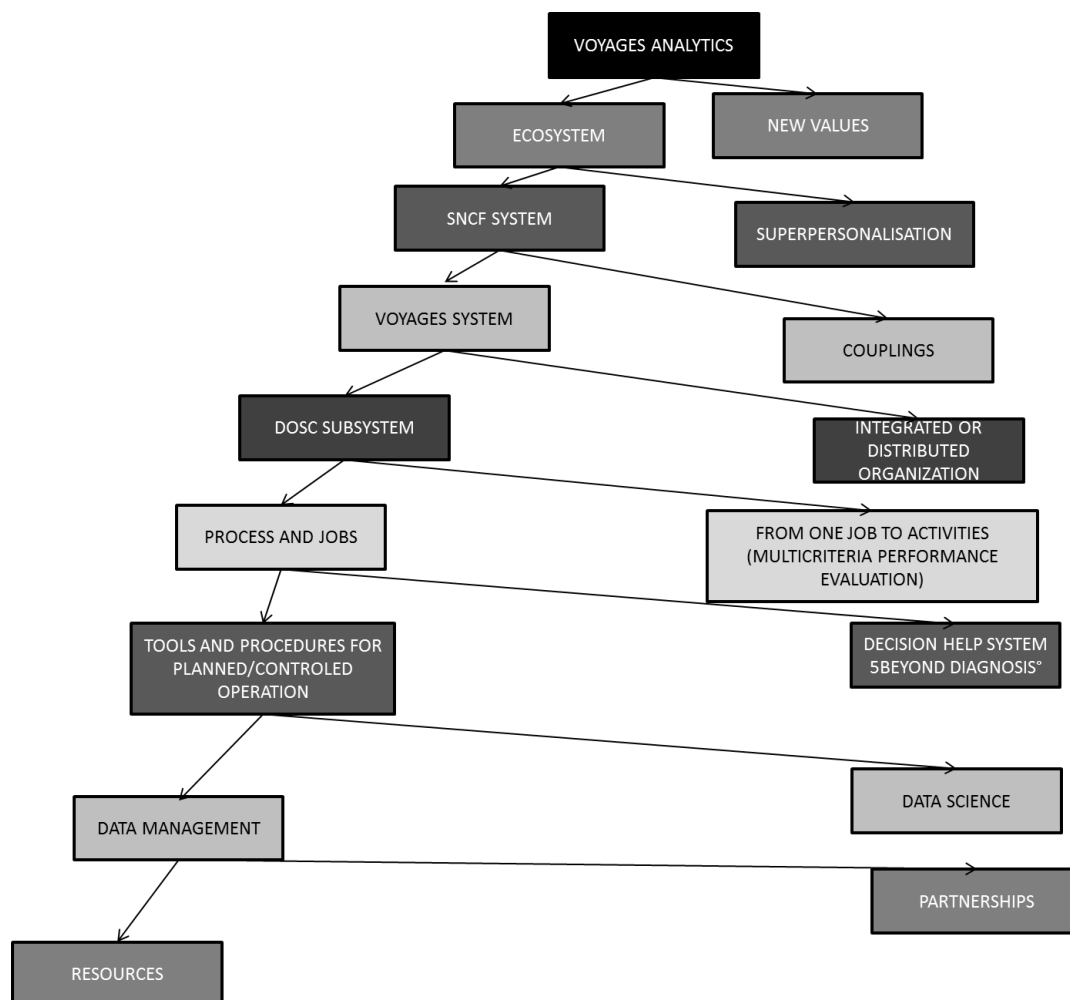


Figure 2. Pre-exploration tree used for the “voyage analytics” workshop. Translated by the authors.

The *detailed conceptual maps* describe the entire exploration done during the workshop on the given innovation field to explore identified in the project. They also start from the initial concept for exploration, and by adding attributes allow expanding it to a series of new concepts. Since they give a complete overview of the exploration done in an innovation field, the detailed conceptual maps are used to build the roadmap inside an innovation field.

Innovation field project managers also use them to build their strategy and sometimes to build an argument to justify specific learning project launches. Due to their close link to the innovation strategy and to confidentiality issues, we will not present any detailed conceptual maps in this paper.

The *conceptual argument tree* is a synthesis of the detailed conceptual map, which highlights the main paths opened during the exploration that has been done. It is formulated based on the detailed conceptual map and allows participants to explain the exploratory project to outsiders. It is also used to present the exploration to stakeholders inside the firm. By giving a simple visual overview, it helps justifying why an exploratory project was interesting. One example of conceptual argument tree can be found in Figure 4.

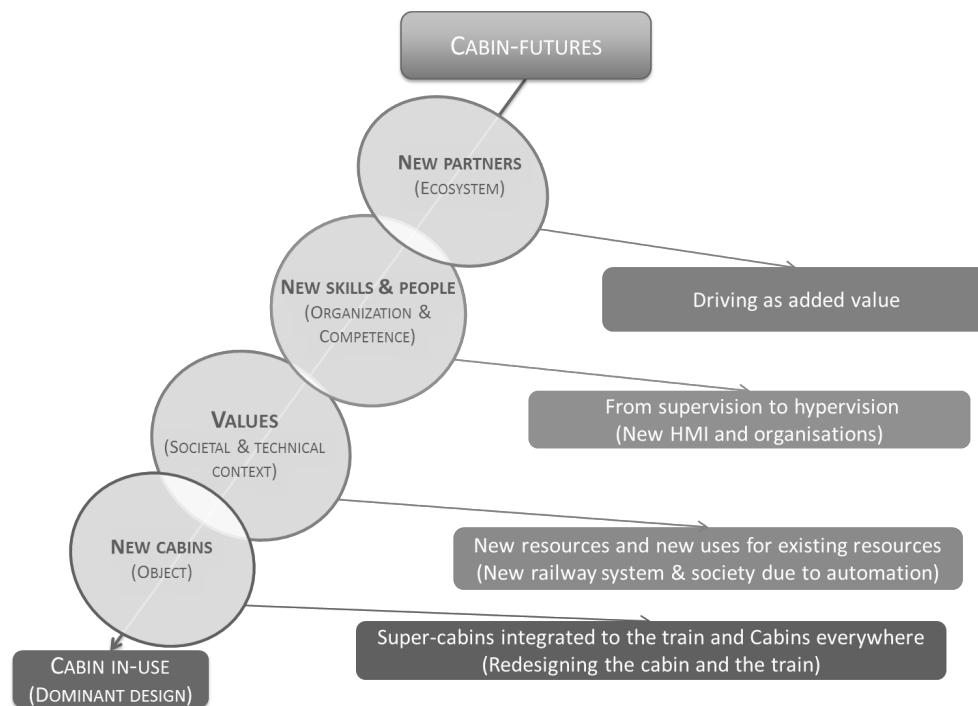


Figure 3. A conceptual argument tree example from the cabin futures workshop

4.2 Concepts inside an innovative design process: their interactions

As can be seen in the emergence of the different concepts, there is an interaction between them. These links can be seen in Figure 5. In general, the first conceptual formulation defined for every workshop is the workshop's name. After the workshop name has been defined and exploratory project managers for the workshop have been defined, first explorations will lead to defining the initial concept for exploration. Starting from the initial concept for exploration, the exploratory project managers draft an exploratory control map. As cited before, the exploratory project managers from the departments are accompanied by managers from the internal design methods team to insure method coherence.

Exploratory control maps are tools that help the project managers guide the exploration. They are used to identify where there might be value in an exploration and where the exploration has higher interest for the firm. It is based on this map, which is in continuous evolution, that the creativity stimulus or pre-exploration trees are built. These are then used in the workshop to help participants to make propositions. Based on the participant's propositions and on the exploratory control map, a detailed concept map is built. The main exploration directions from the detailed concept map are then summarized into the conceptual argument.

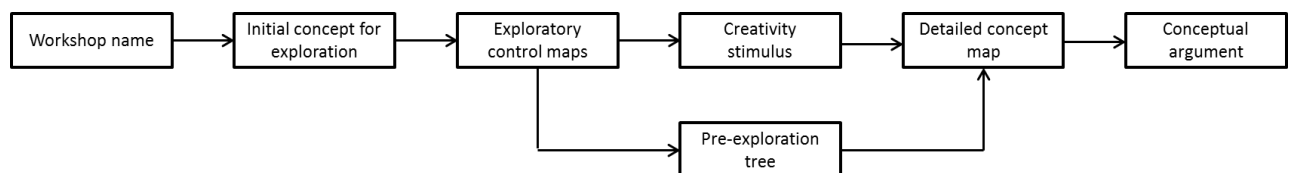


Figure 4. The links between different conceptual formulations during a structured innovative design workshop

Even though this is not modelled in Figure 5, there can be a retro-action from concepts proposed later on the first concepts. As has been said before, all concepts are not static; many

of them will evolve in time. For example, after doing a detailed concept map, in some cases, it became evident that the initial concept for exploration only encompassed one of the paths explored by the map. In this case, a new initial concept for exploration was formulated. In yet other cases, after drafting a detailed concept map, the project team realized there were interesting paths to be explored that had not been discussed. This led to two different approaches: proposing new creativity stimulus and working on them; or formulating an initial concept for exploration for another workshop.

5. Results and discussion

The 52 radical innovation workshops we analysed in our database show a great diversity of concepts usage. Not all of the workshops will mobilize all types of concepts. This can be justified by the diversity of exploration situations and goals. We will now discuss the different goals and impacts of concepts in the next session.

5.1 Managing the FFE through a concept development process

Our case study sheds light on the question of how the FFE for radical innovation projects can be managed. We were able to identify that concept development can be described as a process, where the final brief for a radical innovation project is reached through different concepts. These concepts are interlinked, and of different types, and our next result will describe them and their interactions. In SNCF's case the FFE's management was done thanks to oriented creativity workshops, using the KCP method.

5.2 A typology of stand-alone and interrelated concepts

As previously mentioned, stand-alone concepts and sets of interrelated concepts are all contributing to the exploratory project progress thus they are definitely not independent. Nevertheless, they are not eliciting the cognitive, collaborative and strategic goals of an exploratory project in the same way. In table 3, we describe how each of them specifically addresses these different challenges of the management of such disruptive activity. To be coherent with the literature state of the art, we distinguish the two dimensions of cognitive involvement generated by the introduction of original properties in concepts formulation: overcoming fixation effects and inducing new knowledge recombination or acquisition.

Innovation brief performance axis	Cognitive goal		Managerial goal	Strategy
	<i>Originality for Creativity (de-fixation)</i>	<i>Originality that induce knowledge process</i>	<i>Collaboration and team building</i>	<i>Firm competitiveness and sustainability</i>
Workshops' name	Name conceptual frontier to be reached – first occurrence of the area to explore	Indicate the exploratory nature of the activity	Allows participants to candidate to the collaborative workshops	Proposes a shift in company strategy under agreement of top managers
Initial concept for exploration	Detail of the desirable unknown dimension with explicit properties of cognitive, collaborative and strategic challenges to explore	Points to missing knowledge	Basis to choose participants on every dimensions of the desirable unknown; Stimulus for workshop participants	Specify the exploration axes opening new strategic potential outside of the dominant design
Exploratory control map	Formalize new potential conceptual paths (compared to dominant design path)	Identify the knowledge recombination and acquisition strategy to reach the new conceptual paths	Identify major fixations shared within the firm that could block the exploration of the new conceptual paths	Allows to identify strategic fitness of the new conceptual paths to explore
Creativity stimulus	Guide new explorations through a set of various approaches of the desirable unknown (based on original Co evolution after the phase of knowledge sharing and acquisition)	Support collective identification of ideas and tracks of action to acquire new knowledge Identification and collective recognition of fixation effects	Creates a design community focused on deepening futures tracks of action	Naming of creative stimuli details the strategic fitness of a new conceptual approach of the issues explored in the project
Pre-exploration	Formalize already done explorations	Elicit links to learning done, on-	Federation of participants around	First identification of new knowledge needs

tree	and work to do to explore	the-go and new knowledge to acquire	first conceptual production	facing original conceptual paths
Detailed concept map	Shows all the conceptual logic formulated during the whole workshop (final exploratory concept map)	Maps the missing and available knowledge to reach the whole set of conceptual paths explored by the group	Positioning the overall exploration work beyond future projects	Allows to prepare future strategy of proposals with executive sponsor of the exploratory project and to relate work done to existing innovation field strategy Propose new innovation field beyond the exploratory project
Conceptual argument tree	Reduced detailed concept map to the core conceptual argument sharable by all internal stakeholders of the exploratory project	Identifying the core learning for participants	Allows the participants to communicate within the firm, and helps the project managers to commit project leaders for next validation steps	Clarifying strategic intent with top-managers and the exploratory project executive sponsor.

Table 3. Analysis of concept type contributions to innovation brief performance

In particular, stand-alone concepts — workshops' name, initial concept for exploration, creativity stimulus — are designed to be self-supportive in order that they could easily diffuse in the organization among the various internal stakeholders of exploratory projects. Thus, they play an important role to federate the community of active members of the project (project managers, participants to the collective innovative design workshops, executive sponsor). Proposing short and attractive naming of the exploratory project purpose and ambition of disruption, they are foundational elements of the identity of the epistemic community raised by the exploration (Cowan, David and Foray, 2000; Cohendet and Llerena, 2003). Beyond active members, they play an important role for the socialization of the exploration project.

Interrelated concepts — exploratory control map, detailed conceptual map, conceptual argument and pre-exploration trees — are more complex tools: they allow understanding the level of disruption addressed by the different conceptual paths by the elicitation of their co-

existence. Indeed, contingent presentation of stepped levels of conceptual disruption structures different levels of novelty for the firm in order to support a more comprehensive and effective division of the exploratory work required to address the journey from the dominant design the firm used to manage to new innovative design paths.

5.3 A process to elicit the “desirable unknown” within the FFE for radical innovation projects

Elicitation of a “desirable unknown” is, in itself, a cognitive and a social process. As a cognitive process, elicitation means understanding future participant’s socio-technical imaginary, to identify possible conceptual frontiers as inputs for the definition of “unknown”. As a social process, elicitation means fine tuning the workshop’s name and the initial concept formulation to be sure that it will be “desirable” by participants. To make this possible, an exploratory project needs both managers who are experts from the innovation team and socio-technical experts, to make sure that “desirable unknown” is both challenging (a conceptual frontier) and contingent (fine tuning).

As cited before, there are different goals across the exploratory project process, on cognitive, managerial and strategic levels. Our research shows that the cognitive aspect of the “desirable unknown” interesting in an exploratory project is both that it allows defixation and that it allows identifying missing knowledge: it allows a greater *cognitive generative power*. From a management perspective, the “desirable unknown” should allow new collaborations and new partnerships, through *collaborative attractiveness for new organizations experimentation*. Finally, we identify that from a strategic point of view, the “desirable unknown” should not be in line with the company’s strategy, but rather render the current strategy more robust to

changes, add new activities or make the firm's strategy evolve, it should allow the *strategic positioning renewal of the firm in quickly changing environments*.

The different types of concept formulation we observed appear in a clear sequenced way and form a structured set of concept formulations. We will discuss the step-by-step dynamics to reach in the three above cited dimensions: cognitive generative power, collaborative attractiveness for new organizations experimentation, and strategic positioning renewal of the firm in quickly changing environments. Although the workshop name already carries elements that contribute to the three aspects, as can be seen in table 3, the subsequent concepts contribute to at least one of the aspects and allow improving the exploration's performance.

The dynamic on increasing the cognitive generative power is launched with the workshop name, by giving a first frontier. The generativity is then expanded through the initial concept formulation. This expansion allows formulating new unknowns that have potential value and that increase the cognitive generative power, the creativity stimulus or the pre-exploration tree. The exploratory control map and the detailed concept map are both tools thanks to which the cognitive generative power is made explicit and they can therefore be used as guidance to increase it.

The collaborative attractiveness for new organizations experimentations also begins with the workshop name. It is a first means to interest different actors that don't necessarily work together to start new collaborations and to participate in an exploratory project. The initial concept for exploration further details on what the organization experimentations could be, and attract new actors thanks to this detail. The exploratory control map allows identifying possible barriers to collaborations by identifying fixation effects inside the firm. The

creativity stimulus and the pre-exploration tree allow federating the workshop participants around new propositions, a further step in collaboration. Finally, the conceptual argument tree allows to communicate about the exploratory project and to attract new actors.

The strategic positioning renewal also starts with the workshop's name. It is used to get the top management's agreement to explore a direction that might renew the strategy. Once there is an agreement for working on strategic path renewal, the initial concept formulation, the creativity stimulus and the pre-exploration trees are used to stimulate the workshop participants to propose alternatives. The detailed conceptual map retraces all the different exploration paths, and allows positioning the different possible strategies. It is a tool to propose new activities and new strategy shifts. Finally the conceptual argument tree allows clarifying the strategic intent and discussing the strategic positioning renewal with top management.

5.4 Specific concept patterns

The longitudinal analyses of concepts formulation over 8 years of practice underlined the increasing ability of exploratory projects stakeholders involved in concept formulation to elicit jointly the three dimensions of the desirable unknown. In particular, we observed in this firm that innovation support team progressively stabilized some features of the different types of concept formulation. As can be seen in the sample of eight projects in table 2, the use of the symbol “@” in the stand alone concepts is recurring. It was a way for the project managers to integrate the challenges brought about by digitalization. By doing so, they improved the cognitive generative power of the concept formulations.

The creativity stimulus' format also evolved over time, starting from a title and a list of images and words, they became more structured over time, with the addition of a subtitle and the introduction of tensions between different possible positions in the images and formulations. This was justified by the practitioners by saying it facilitated interactions during the creativity sessions and produced richer explorations. It was a way to improve both the cognitive and managerial impact of the creativity stimulus.

Another stabilization observed concerns the detailed concept map and the conceptual argument tree. Both evolved to always contain exploration paths on four aspects: the object; the societal and technical context; organization and skills; and the ecosystem, as can be seen in Figure 3. The reason why these aspects are always included is because they insure a better coverage of the three dimensions we cited before. Cognitive generative power is increased by having at least four different paths. Collaborative attractiveness for new organizations experimentation is improved by systematically asking questions about the ecosystem and the organization, which mean identifying new partnerships and new ways to collaborate. And finally these four aspects improve strategy renewal: it would be easy to work only on technical objects when on an exploratory project, but that would not allow the organization to make its strategy evolve.

6. Conclusion

Through the study of the systematic development of concepts done inside a firm, we were able to gather insights on the FFE for radical innovation projects. The study of SNCF's concept development process allows us to conclude that the FFE can be managed – despite dealing with the unknown – and to give examples of the tools that can be used for this management. Despite the fact that concepts are developed through interactions and that their

development cannot easily be forced into a linear process, the use of KCP workshops and different kinds of concepts as done in our case study allows to create a process that seems to be linear to participants (interactions and non-linearity are only seen and guided by the exploratory project managers).

Our research clarifies benefits for innovation capability and managerial goals achievement of seven types of conceptual formulation. Eliciting their interactions, we propose a new theoretical model for cognitive involvement of individuals and commitment of collaborators on disruptive innovation activities. Our research furthermore allows better understanding the enlarged impact of exploration projects: the “desirable unknown” explored has implications for innovation management far beyond the intent of a single workshop. That is a major difference with exploitation project management, where early goal definition restricts impact of workshop to what was planned.

Our research gives more indications on how to build a concept to reach innovation goals. It's not only about choice between different concepts but developing a process of concept development based on cognitive and social goals management. We therefore propose a new framework to evaluate concepts' performance. It allows us explaining how the succession of conceptual tools before, during and after creativity sessions is a design process that embeds the strategic purpose of disruptive innovation activities. In addition, seeing concepts as a tool to manage as a set helps managers to use the best formulation to interact with stakeholders of innovation activities.

References

Adler, N., R. Shani and A. Styhre (Eds.). 2004. Collaborative Research in Organizations: Foundations for Learning, Change and Theoretical Development. Sage Publications, Thousand Oaks, CA.

- Agogu , M., A. Kazak i, A.Hatchuel, P. Le Masson, B. Weil, N. Poirel and M. Cassotti. 2013. "The impacts of examples on creative design: explaining fixation and stimulation effects". *Journal of Creative Behavior*.
- Akrich, M., M. Callon and B. Latour. 1988. "A Quoi Tient Le Succ s des Innovations? 1. L'Art de l'Int ressement". *Annales des Mines, G rer et Comprendre*, 11, 4–17. (Translation, Akrich, M., Callon, M., Latour, B., & Monaghan, A. (2002). The key to success in innovation part I: the art of interessement. *International journal of innovation management*, 6(02), 187-206.)
- Backman, M., B rjesson, S., & Setterberg, S. (2007). Working with concepts in the fuzzy front end: exploring the context for innovation for different types of concepts at Volvo Cars. *R&d Management*, 37(1), 17-28.
- Beretta, M., J. Bj rk and M. Magnusson. 2018. "Moderating Ideation in Web-Enabled Ideation Systems". *Journal of Product Innovation Management*, 35(3), 389-409.
- Bj rk, J. and M. Magnusson. 2009. "Where do good innovation ideas come from? Exploring the influence of network connectivity on innovation idea quality". *Journal of Product Innovation Management*, 26 , 662-670.
- Braha, D. and Y. Reich. 2003. "Topological structures for modelling engineering design processes". *Research in Engineering Design*, 14(4), pp185-199.
- Boeddrich, H. J. 2004. "Ideas in the workplace: a new approach towards organizing the fuzzy front end of the innovation process". *Creativity and Innovation Management*, 13 , 274-285.
- Burgelman, R. A. 1991. "Intraorganizational ecology of strategy making and organizational adaptation: Theory and field research". *Organizational Science*, 2: 239-262.
- Cohendet, P. and P. Llerena. 2003. "Routines and Incentives: The Role of Communities in the Firm". *Industrial and Corporate Change*, 12, 271–97.
- Cooper, R. G. 1990. "Stage-gate systems: a new tool for managing new products". *Business horizons*, 33(3), 44-54.
- Cooper, R. G., and S. Edgett. 2008. "Ideation for product innovation: What are the best methods". *PDMA visions magazine*, 1(1), 12-17.
- Cowan, R., P. A. David and D. Foray. 2000. "The explicit economics of knowledge codification and tacitness". *Industrial and corporate change*, 9(2), 211-253.

- Diehl, M. and W. Stroebe. 1991. "Productivity Loss in Idea-Generating Groups: Tracking Down the Blocking Effect," *Journal of Personality and Social Psychology*, (61) 3, pp. 392-403.
- Elmqvist, M. and B. Segrestin. 2009. "Sustainable development through innovative design: lessons from the KCP method experimented with an automotive firm". *International Journal of Automotive technology and management*, 9(2), 229-244.
- Fauconnier, G. and M. Turner. 1998. "Conceptual integration networks". *Cognitive science*, 22, 133-187.
- Florén, H., Frishammar, J., Parida, V., and Wincent, J. 2017. Critical success factors in early new product development: a review and a conceptual model. *International Entrepreneurship and Management Journal*. doi: 10.1007/s11365-017-0458-3.
- Floyd, S. and P. Lane. 2000. "Strategizing throughout the organization: Managing role conflict in strategic renewal". *Academy of Management Review*, 25: 154-177.
- Freeman, R.E. 1983. "Strategic Management a Stakeholder Approach", *Advances in Strategic Mgt* pp 31-60.
- Gallupe, R. B., A. R. Dennis, W. H. Cooper, J. S. Valacich et al. 1992. "Electronic Brainstorming and Group Size," *Academy of Management Journal* (35) 2, pp. 350-369.
- Gillier, T., S. Hooe and G. Piat. 2015. "Framing value management for creative projects: An expansive perspective". *International Journal of Project Management*, 33(4), 947-960.
- Girotra, K., C. Terwiesch and K. T. Ulrich. 2010. "Idea generation and the quality of the best idea". *Management Science*, 56 , 591-605.
- Hatchuel, A., P. Le Masson, Y. Reich and E. Subrahmanian. 2017. "Design theory: a foundation of a new paradigm for design science and engineering". *Research in Engineering Design*, 1-17.
- Hatchuel, A. and B. Weil. 2003. "A new approach of innovative Design: an introduction to CK theory". In *DS 31: Proceedings of ICED 03, the 14th International Conference on Engineering Design*, Stockholm.
- Hatchuel, A., and B. Weil. 2009. "CK design theory: an advanced formulation". *Research in engineering design*, 19(4), 181.
- Hooe, S., M. Béjean and F. Arnoux. 2016. "Organising for radical innovation: The benefits of the interplay between cognitive and organisational processes in KCP workshops". *International Journal of Innovation Management*, 20(4), 33.

- Katz, R. and T. J. Allen. 1982. "Investigating the Not Invented Here (NIH) syndrome: A look at the performance, tenure, and communication patterns of 50 R & D Project Groups". *R&D Management*, 12(1), 7-20.
- Koen, P. A., G. Ajamian, R. Burkart, A. Clamen, J. Davidson, R. D'Amoe, C. Elkins, K. Herald, M. Incorvia, A. Johnson, R. Karol, R. Seibert, A. Slavejkov, and K. Wagner. 2001. "New Concept Development Model: Providing Clarity and a Common Language to the 'Fuzzy Front End' of Innovation." *Research Technology Management* 44, 2, March-April, 46–55.
- Koen, P. A., Ajamian, G. M., Boyce, S., Clamen, A., Fisher, E., Fountoulakis, S., ... & Seibert, R. (2002). *Fuzzy front end: effective methods, tools, and techniques*. The PDMA handbook of new product development. Wiley, New York, NY.
- Koen, P. A., Bertels, H.M.J. and Kleinschmidt, E. 2006. "Effective Practices in the Front End of Innovation" in *The PDMA handbook of new product development*, Kenneth B. Kahn, editor, Wiley, New York, NY.
- Koen, P. A., Bertels, H. M., & Kleinschmidt, E. 2014. Managing the front end of innovation—Part I: Results from a three-year study. *Research-Technology Management*, 57(2), 34-43.
- Koen, P. A., Bertels, H. M., & Kleinschmidt, E. J. (2014). Managing the Front End of Innovation—Part II: Results from a Three-Year Study. *Research-Technology Management*, 57(3), 25-35.
- Kazakçı, A., T. Gillier, G. Piat and A. Hatchuel. 2014. "Brainstorming versus creative designreasoning: A theory-driven experimental investigation of novelty, feasibility and value of ideas". *Designcomputing and cognition 2014*, Jun 2014, London, United Kingdom. pp.1-20, 2014.
- Koestler, A. 1964. *The act of creation*, Penguin Books, New York, 751p.
- Le Masson P., A. Hatchuel and B. Weil. 2011. "The Interplay Between creativity issues and design theories: a new perspective for design management studies?" *Creat Innov Manag* 20(4):217–237
- Le Masson P., A. Hatchuel and B. Weil. 2009. "Design theory and collective creativity: a theoretical framework to evaluate KCP process". In *DS 58-6: Proceedings of ICED 09, the 17th International Conference on Engineering Design*, Vol. 6, Design Methods and Tools (pt. 2), Palo Alto, CA, USA, 24.-27.08. 2009.
- Le Masson, P., B. Weil and A. Hatchuel. 2017. *Design Theory*. Springer International Publishing AG.

- Lenfle, S. 2016. "Floating in space? On the strangeness of exploratory projects". *Project Management Journal*, 47(2), 47-61.
- Levinthal, D. A. and J. G. March. 1993. "The myopia of learning". *Strategic Management Journal*, 14: 95-112.
- MacCrimmon, K. R. and C. Wagner. 1994. "Stimulating Ideas through Creativity Software," *Management Science* (40) 11, pp. 1514-1532.
- Magnusson, P. R., E. Wästlund, and J. Netz. 2016. "Exploring users' appropriateness as a proxy for experts when screening new product/service ideas". *Journal of Product Innovation Management*, 33(1), 4-18.
- Markham, S. K. 2013. "The impact of front-end innovation activities on product performance". *Journal of Product Innovation Management*, 30, 77-92.
- Nonaka, L. 1994. "A dynamic theory of organizational knowledge creation". *Organization Science*, 5: 714-737.
- Osborn, A.F. 1953. *Applied Imagination, principles and procedures of creative thinking*.
- Plucker, J. A., R. A. Beghetto and G. T. Dow. 2004. "Why Isn't Creativity More Important to Educational Psychologists? Potentials, Pitfalls, and Future Directions in Creativity Research," *Educational Psychologist*, (39) 2, pp. 83-96.
- Reid, S.E. and de Brentani, U. (2004) The fuzzy front end of new product development for discontinuous innovations: a theoretical model. *The Journal of Product Innovation Management*, 21, 170–184.
- Reinertsen, D.G. and Smith, P.G. (1991) The strategist's role in shortening product development. *The Journal of Business Strategy*, 12, 4, 18–23.
- Reitzig, M., and O. Sorenson. 2013. "Biases in the selection stage of bottom-up strategy formulation". *Strategic Management Journal*, 34(7), 782-799.
- Runco, M. A. and R. E. Charles. 1993. "Judgments of Originality and Appropriateness as Predictors of Creativity," *Personality and Individual Differences* (15) 5, pp. 537-546.
- Shai, O. and Y. Reich. 2004. "Infused Design: I Theory". *Research in Engineering Design*, 15(2), pp93-107.
- Shani, R., Mohrman, S., Pasmore, W., Stymne, B., Adler, N. 2008. *Handbook of Collaborative Management Research*. Sage Publications, Thousand Oaks, CA.
- Smith, S. M., T. B., Ward and J. S. Schumacher. 1993. "Constraining effects of examples in a creative generation task". *Memory & Cognition*, 21 , 837-845.

- Smith, S. M. 2003. "The constraining effects of initial ideas". Group creativity: Innovation through collaboration, 15-31.
- Suh, N.P. 1990. Principles of Design. Oxford University Press, New York.
- Taura, T. and Y. Nagai. 2012. Concept generation for design creativity: A systematized theory and methodology, London: Springer-Verlag.
- Torrance, E. P. 1965. Rewarding creative behavior. Englewood Cliffs, NJ: PrenticeHall.
- Van de Ven, A. H. 1986. "Central problems in the management of innovation". Management science, 32(5), 590-607.
- Ward, T. B., M. J. Patterson and C. M. Sifonis. 2004. "The role of specificity and abstraction in creative idea generation". Creativity Research Journal, 16 , 1-9.
- Weick, K. E. 1995. Sensemaking in organizations. London: Sage.
- Zhu, H., A. Kock, M. Wentker and J. Leker. 2018. "How Does Online Interaction Affect Idea Quality? The Effect of Feedback in Firm. Internal Idea Competitions". Journal of Product Innovation Management.