INNOVATION AND THE LIMITS OF THE SELECTION LOGIC: INTRODUCING GENERATIVE CAPACITY AS A COMPLEMENT TO ABSORPTIVE CAPACITY

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ABSTRACT

The relation between competitiveness and innovation has become indisputable in large firms. However, innovative concepts often have difficulties surviving in the efficient NPD processes. This paper argues that there are two basic assumptions in the selection logic that they are based on, availability of sufficient knowledge and availability of opportunities to select from. It is further argued that this is not true in innovative situations and therefore a dual model for innovative capabilities is suggested where absorptive capacity is complemented with a generative capacity. This paper is based on exploratory studies of managerial practices in the automotive the pharmaceutical industries.

Key words: *innovation, NPD, innovative capabilities, absorptive capacity, knowledge generation*

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1. INTRODUCTION

Intense technology development has made products such as cars and telecom systems more complex and knowledge-intensive (e.g. Mikaelsson, 2004). The competitive situation is described as fiercer than ever before (Kummerle, 1997), and firms must succeed in launching new products on new markets at an increasing pace while satisfying local differences in market demand and implementing best-practice engineering and manufacturing practices – all in parallel. In this era of constant change, the increasing cost pressure has led to an increasing consolidation in many industries that are trying to reach economies of scale and lower costs for New Product Development (NPD) as well as for manufacturing. In this context, globalization of Research and Development (R&D) is considered the overarching mega-trend (Anderson, 2001). The increasingly informed customers are also getting used to the arrival of new product versions at an increasing pace, and they seem to favour products that offer individual choices. To systematically launch innovative products has become inevitable to survive. But often, these demands for cost efficiency and risk reduction have resulted in highly structured development processes with very little room for creative activities and experimentation with new knowledge.

In the academic field it is also well established that developing innovative products is an essential success factor for firms that have been profitable over long periods of time (e.g. Tushman and Nadler, 1986; Cooper and Kleinschmdt, 1987; Drucker, 1988; Utterback, 1994; Christensen 1997; Thomke, 2001). Nevertheless, NPD research has mostly focused on how to make development processes more efficient (i.e. Cooper 1988; Wheelwright and Clark, 1992; Gupta and Wilemon, 1990). However, research has also shown that as the NPD processes get more efficient, the ability to absorb new and innovative technology concepts diminishes (Christensen, 1997; Sharma, 1999).

Research on how to enable innovation within the structured processes has focused either on how to enable late changes within planned product structures, (Baldwin and Clark, 1997; Verganti, 1999, Bhattacharya *et al.*, 1998) or on the early phases of NPD, the Front End (FE) of innovation (Reinertsen and Smith, 1991; Khurana and Rosentahl, 1997; Khurana and Rosentahl, 1998; Reid and de Brentani, 2004; Nobelius and Trygg, 2002). In those early phases, the costs of introducing innovative concepts and product changes are still relatively low (Reinertson and Smith, 1991) which makes it an important phase for companies that aspire to develop innovative products. Others have proposed the need for a context that fosters innovation, focusing on the roles of individuals (e.g. gatekeepers) or various organizational mechanisms (Van de Ven, 1986; Iansiti and West, 1997; Sharma, 1999; Colarelli O'Connor and Rice, 2001). Research results show that successful companies often fail to recognize innovative concepts that are disruptive to the technology base of their previous business (Christensen, 1997) and there is a clear call for an increased understanding of innovation processes in large firms (e.g. Cheng and Van de Ven, 1986; Dodgson, 1993; Sharma, 1999).

This paper is based on two research studies from the automotive and the pharmaceutical industries respectively, both industries under strong pressure for both efficiency and innovation. This paper aims at contributing to an increasing understanding of how large established firms develop innovative products through exploring the prerequisites for innovative concepts in large firm's R&D structures. It also aims at contributing to the literature on innovative capabilities though proposing that it is dual in nature, consisting not only of a firm's absorptive capacity, but also of its generative capacity. This paper is structured as follows: first, the theoretical framework of NPD, innovation and

absorptive capacity is presented. Then the two studies are presented and the results are put forward and discussed. Finally the dual model of innovative capabilities is presented including the introduction of "generative capacity" notion. This paper is based on a dissertation presented at Chalmers University of Technology (Elmquist, 2007a).

2. Theoretical Framework

2.1 R&D processes and Innovation

New product development (NPD) processes in large firms are often complex structures with many interdependencies, implying that even small changes may have an important impact on other parts of the process. Research on R&D has mostly focused on how to make these processes more efficient. During the eighties and nineties, focus lay on efficient manufacturing and lean production (Womack, 1991), while the turn of the century brought with it an increased focus on the preceding development work through stage-gate systems (Cooper, 1988) along with lean product development (Karlsson and Åhlström, 1996) and modularization (Baldwin and Clark, 1997). In this work, efficient product development is defined as the acceleration of execution and the shortening of lead times, reducing uncertainties as early as possible to minimize costs (e.g. Cooper, 1997; Wheelwright and Clark, 1992; Gupta and Wilemon, 1990). However, research has also shown that as the NPD processes get more efficient, the ability to absorb new and innovative technology concepts diminishes (Christensen, 1997; Sharma, 1999).

Research on how to enable innovation within the structured processes has focused either on how to enable late changes within planned product structures, such as working with modules within a product architecture (Baldwin and Clark, 1997) or keeping a "planned flexibilty" in the process (Verganti, 1999, Bhattacharya *et al*., 1998), or on the early phases of NPD, the Front End (FE) of innovation (Reinertsen and Smith, 1991; Khurana and Rosentahl, 1997; Khurana and Rosentahl, 1998; Reid and de Brentani, 2004; Nobelius and Trygg, 2002). In those early phases, the costs of introducing innovative concepts and product changes are still relatively low (Reinertson and Smith, 1991) which makes it an important phase for companies that aspire to develop innovative products. Despite intensive research activity, most of the effort has been put into how to structure these early phases as well and make them more efficient (e.g. Khurana and Rosenthal, 1997; Koen *et al*., 2001; Burchill and Fine, 1997). Others have proposed the need for a context that fosters innovation, focusing on the roles of individuals (e.g. gatekeepers) or various organizational mechanisms (Van de Ven, 1986; Iansiti and West, 1997; Sharma, 1999; Colarelli O'Connor and Rice, 2001).

The model of an innovation funnel is often used to describe the complete R&D process consisting of four activities: input, feasibility, implementation and launch (Clark and Wheelwright, 1992). The authors claim that an efficient funnel has a wide opening and then rapidly narrows down as the viable solutions are selected. The search and selection of new ideas is often described as a central part of an innovation process (e.g. Laursen & Salter, 2006; Fetterhoff & Voelkel, 2006). Some authors claim that NPD is centered on knowledge creation (e.g. Nonaka, 1991; Nonaka and Takeuchi, 1995; Madhavan and Grover, 1998). Still, empirical studies have shown that experimenting and learning are challenging in industries where product cycles are long and costly and NPD projects are very complex (Bartezzaghi *et al*., 1997; Aggeri and Segrestin, 2007).

Unlike the NPD process, innovation is recognized to be a nonlinear process (Cheng and Van de Ven, 1996). Many researchers agree that innovation is an incontestable source of competitive advantage (e.g. Tushman and Nadler, 1986; Cooper and Kleinschmdt, 1987; Utterback, 1994) but to manage an innovation process is described as problematic since it is inherently linked to risk and uncertainty (Birchall and Tovstiga, 2005). Some researchers have even argued that too much formalization can be detrimental for innovation (Benner and Tushman, 2002; Murray and Blackman, 2006). Instead, the management of innovation is sometimes described as a balancing act between planning and chaos (Quinn 1985).

Several authors stress that while the NPD process is appropriate for incremental innovation projects, it is inadequate for developing innovative products that are radically different from previous products (Veryzer, 1998; Eisenhart and Tabrizi, 1995; McDermott and Colarelli O'Connor, 2002; Rice *et al*., 1998) and that large, established firms have difficulties managing a more radical innovation process" (Henderson and Clark, 1990; Dougherty and Heller, 1994; Christensen, 1997; Tushman and O' Reilley, 1997; Leifer *et al*., 2001).

Le Masson, Weil and Hatchuel (2006) argue that it is not possible to work according to the logics of traditional research and development processes when the aim is to develop innovative products (Le Masson *et al*., 2006). The authors define Research as "a controlled process for producing knowledge, answering previously formulated questions" and Development as "a controlled process that activates existing competencies and knowledge in order to specify a system (product, process, or organization...) that reaches well clarified criteria (quality, delay, cost) and for which the value for the company has been clearly conceptualized and more or less evaluated" (Hatchuel *et al*., 2001:9). The authors further argue that in an innovation process, the value of future offers is not given: performances criteria and evaluation criteria are not known but needs to be designed and the competencies needed to develop new technologies or new solutions are even not identified (Hatchuel et al., 2001; Le Masson *et al*., 2006).

The NPD process is designed to be a rational process that is possible to plan and make more efficient and strive to reduce uncertainties and eliminate risks is often prevalent. However, allowing the development of innovative concepts implies a certain degree of experimentation and risk taking. The underlying rationales of the NPD process thus seem to fit badly with the underlying rationales of innovation that implies working also with innovative concepts. It is also noteworthy that there is an abundance of literature on the barriers to innovation (e.g Assink, 2006; Moss-Kanter, 2006) and the difficulties of previously successful firms to succeed again, but very little research on how to enable innovation and build organizations that support the development of innovative products. This weakness of the research field motivates the need for an increased understanding of how the prerequisites for innovation can be ameliorated in R&D organizations.

2.2 Absorptive capacity and innovative capabilities

The sources of innovation can be both internal and external (Drucker, 1985). Ideas for innovative products often stem from external actors, (von Hippel, 1988; Von Hippel 2005), which is also accentuated in more recent research on open innovation and the management of activities outside the boundaries of the firm (e.g. Chesbrough, 2003;

Dahlander 2006). But to be able to exploit any new idea, firms first need to identify and assimilate it. The term *absorptive capacity* (AC) of the firm (Cohen and Levinthal, 1990; Van den Bosch *et al*., 1999; Lane *et al*., 2006), was first coined by Cohen and Levinthal (1990) who define it as "the ability of the firm to recognize the value of new external information and apply it to commercial ends" (Cohen and Levinthal, 1990:128). They argue that a firm's absorptive capacity 1) build on prior investments in the absorptive capacity of individuals in the organization, 2) is path dependent and cumulative and 3) depend on the ability of the organization to share knowledge internally. Therefore they suggest that investments in R&D not only expand the knowledge of the firm, but also enhance the absorptive capacity of the firm. The authors further argue that the greater the absorptive capacity of a firm, the greater the ability to recognize emerging technological opportunities (Coen and Levinthal, 1990). Van den Bosch *et al*. (1999) argue that the level of absorptive capacity of the firm depend on the organizational structure of the firm and the combinative capabilities of the firm.

In a review of the literature on the absorptive capacity construct, Zahra and George (2002) develop a generic model based on four organizational capabilities that they claim contribute to an enhanced absorptive capacity: acquisition, assimilation, transformation and exploitation of knowledge. Based on this framework they introduce the notions of *potential absorptive capacity*, (for the first two capabilities) and *realized absorptive capacity* (for the last two). The authors underline that developing the potential absorptive capacity is not enough to enhance performance - that necessitates also the realization of the absorptive capacity (Zahra and George, 2002), however this model has been criticised for omitting some of the fundamentals of the original concept, such as the differences between individual and organizational learning (Todorova and Durisin, 2007). Lane, Koka and Pathak (2006) build on Coen and Levinthal and propose a process model based on an extended definition for AC, with antecedents and outcomes: "Absorptive capacity is a firm's ability to utilize externally held knowledge through three sequential processes: (1) recognizing and understanding potentially valuable new knowledge outside the firm through exploratory learning, (2) assimilating valuable new knowledge through transformative learning and (3) using the assimilated knowledge to create new knowledge and commercial outputs through exploitative learning." (Lane *et al*., 2006:856). They define transformative learning as linking explorative and exploitative learning, allowing existing knowledge to be used in new ways (through the combination of existing and new knowledge).The model is presented in Figure 1 below.

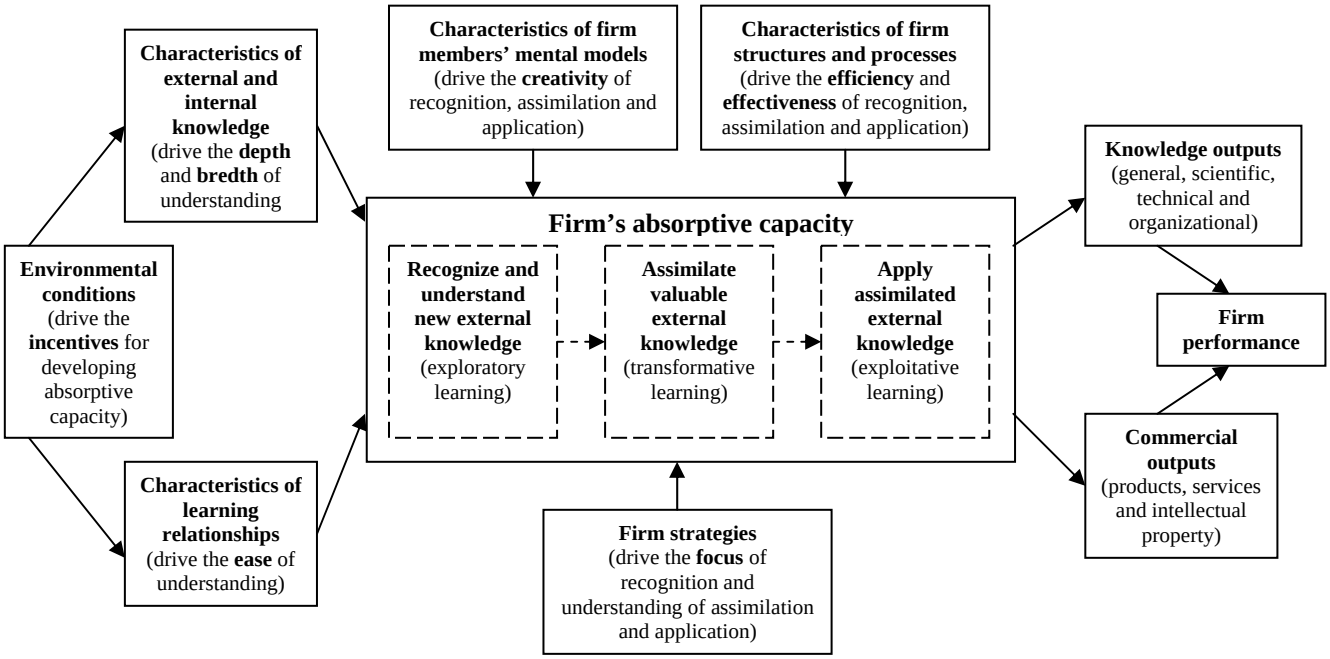

Figure 1. A process model of Absorptive Capacity, its antecedents and outcomes. (Source: Lane *et al.*, 2006)

Szulanski has also shown that a weak absorption capacity in an organization is one of the main barriers to knowledge transfer and he stresses the need to develop learning capacities in the organizational units, to foster closer relationships and a systematic understanding of different practices (Szulanski, 1996). Also other authors have stressed the link between absorptive capacity and the firm's capability to learn (Todorova and Durisin, 2007) and to enable innovation (e.g. Assink, 2006; Williander, 2006).

3. Method

3.1 Research approach

This paper is based on two collaborative research studies. Collaborative research is defined as "an emergent and systematic inquiry process, embedded in a true partnership between researchers and members of a living system for the purpose of generating actionable scientific knowledge" (Shani *et al.*, 2004:84). The problems addressed are emergent and developed in collaboration with the industrial partner as the mutual understanding of the knowledge area increases. A combination of academic problem definitions and an industrial perspective on relevant challenges, leads to intermediary theories that can be tested and further developed in an iterative manner (Adler and Shani, 2001). Using an abductive approach, revisiting relevant literature as knowledge on the subject grows, enables a multi-perspective knowledge generation process, where both academics and practicing managers are part of the knowledge creation process. A key notion of collaborative research is the generation of *actionable scientific knowledge* that underlines the production of knowledge that is relevant for the research community as well as for managers (Starkey and Madan, 2001) and that this knowledge should be actionable (Argyris, 1995).

Since the aim of this paper is to understand actual practices, the companies have always been studied in real time, and the results of those studies have not been known on beforehand the approach has been exploratory. It has also been confirmed in literature that studying product development in experimental settings is a challenge in itself as the organization often does not know what the outcome will be (Thomke, 2001). The included studies are both qualitative and build on the creation of in depth knowledge of a limited number of case companies, enabled by the collaborative research approach. The concept of a case in itself is not easily defined (Ragin and Becker, 1992), but it has been argued that there is no need for numerous cases to justify the knowledge generated (Easton, 1995). Eisenhart (1989) suggests that a number of research methodologies should be used for case studies, in order to "triangulate" the results. In these two studies, several methods have been used such as ethnographic data collection, interviews, documentation studies and discussion seminars. Both studies are described in more detail in previous publications (Backman et al., 2007 and Elmquist, 2007b for study I and Elmquist and Segrestin, 2007 for study II).

3.2 Study I: Concept work and concept cars at Volvo Cars

A collaborative partnership with Volvo Cars focusing on the practices of innovation and early phases of R&D dating back to 1997 enabled a broad interview study of concept work as well as an in-depth study of a concept car project. The interview study was based on 16 semi-structured interviews designed to capture how different players viewed and worked with concepts and integration of concepts with the NPD. Interlocutors were selected on the basis of their key roles in the interplay between Product Planning, Design and R&D. The interviews were made in pairs, with a varying constellation. Notes from the interviews were made by one of the interviewees and then completed by the second. An abductive approach for interpretation of the data was applied, where the empirical data was viewed against an intermediate conceptual models and understanding was continuously developed, referred to as systematic combining (Dubois and Gadde, 2002). Interview results were combined with contextual knowledge from a number of other studies of conceptual work at Volvo Cars as well as with the pre-understanding and continuous data collection of insider researchers in the team (Bartunek and Louis, 1996).

Also, a longitudinal study of a concept car project was conducted (Backman, 2005), following both the development phase (2003-2004) and the absorption of innovative concepts into the NPD process. Here, data was mostly collected through the observation of project management meetings. After each encounter, detailed field notes (van Maanen, 1988) were written where the activities of each meeting were systematically reflected upon. A total of 130 formal meetings, mounting to a total of 170 hours, and numerous informal meetings and lunches were attended to. In addition to this, 18 interviews were made during the project with project members and key stakeholders and internal documentation was studied. Two discussion seminars were also organized with the project members. Two years after the project, another 24 interviews were conducted, adding up to a total of 42 interviews that have been recorded and transcribed and the data was analyzed and interpreted based on sub themes. The analysis followed a systematic combining model (Dubois and Gadde, 2002), working with the creation of intermediate models and the iterative collection of data. The results have also been discussed with managers at Volvo Cars to strengthen the validity of the analysis.

3.3 Study II: Drug design in PharmaCorp

A collaborative research project was launched with PharmaCorp in 2003 with the objective of increasing the understanding of how to organize early phases of discovery work. A joint interest in understanding the managerial processes used by the discovery department of PharmaCorp at that time led to the design of an exploratory study investigating different approaches to managing discovery processes. It had an explicit action orientation where our results would serve as input for them in their creation of a new Biopharma Asset Team in the discovery organization. Data was collected through a combination of interviews, discussion seminars and analysis of documents[2]. The first part of the study focused on a process for identifying and evaluating drug candidates outside the traditional therapeutic areas, known as the scouting process. It was also decided that the study would investigate two internal but exploratory projects (subsequently called "the resting project", and the "unmasking project") outside the established areas of expertise. A total of 39 interviews were conducted at PharmaCorp, and to discussion seminars were organized to validate the results. The interviews were all open-ended, semi-structured, and always undertaken in pairs. All interviews were summarized and reflected upon in a structured way by both interviewers. In addition to and in parallel with the interviews, internal documentation was studied.

The data analysis was made on an ad hoc basis. First, the material was studied and then comparisons were made between the projects, their phases, initiation, knowledge acquisition etc. We searched for patterns and links and created intermediary models that we tried to test and develop. The analysis was thus abductive (Alvesson and Sköldberg, 1994) and an example of systematic combining (Dubois & Gadde, 2002). Also, we extensively used our colleagues and project champions to test and question our evolving results and the results were tested in the discussion seminars.

4. The prerequisites for innovative concepts – some findings

4.1 Findings from VolvoCars

The study of concept work at Volvo Cars (Backman et al., 2007) revealed that different types of concepts seem to have different inherent driving forces which influence their ability to impact the NPD processes. Two main categories of concepts could be distinguished: on the one hand, technology driven concepts (including design and some service and value driven concepts), and on the other hand, customer and market driven concepts (including some service and value driven concepts). It was shown that technology driven concepts are the most familiar ones to the NPD process, and since they are the natural input to the NPD process, they can be processed, calculated and evaluated with familiar metrics. Looking at the formal processes, such as the business evaluation process, the advanced engineering process and the stage gate process, they were all designed to accommodate technology driven concepts and thus used its inherent language and norms. The design driven concepts were related to those processes in a natural way and fit well with evaluation models. Some value driven concepts are combined with technology driven concepts, thus gaining from their inherent advantage. However, customer and market based concepts experienced certain difficulties since they had a lower status in the organization and several examples showed that they had to find alternative ways to actually make their way into the processes. These concepts succeeded based on extraordinary support, for example from

[2] This study was supposed to lead to a third study based on the results, but unfortunately the study was terminated in 2004, due to a lack of further funding.

strong individuals with high credentials in the organization, or from external attention created through concept cars that created external pressure on R&D to prioritize those ideas.

The study of the concept car (Elmquist, 2007b) confirmed the difficulty of the organization to exploit the knowledge created in the project. Based on the framework developed by Szulanski (1996) some barriers to learning could be identified. First, the *knowledge created was of a different character*, not necessarily directly linked to the product itself – much of it was related to norms and values. The project was also dependant on a strong support from the CEO, by-passing the regular processes for launching a concept car project. This was necessary to keep the project alive, but it also created barriers to learning through the *NIH effects of building a strong group on the side*. To learn from the project, resulting knowledge needs to be integrated into the established processes, and the fact that the group was constituted by an all-female team made the distance to the organization dominated by men even greater. The *lack of integration* resulted in communication problems. Finally, a strong barrier to learning lies in *the organizational context*. Since there were no processes, no support and no evaluation in the routines of organizing concept car projects; it was based on ad hoc activities and individual capabilities. On an organizational level, there was no clear strategy, no responsibility nor even a clear role for this type of project. The study showed that despite abundant knowledge production in the project that was no guarantee for organizational learning.

Even though many strong ideas continuously emerge at Volvo Cars, they often fail to enter the NPD process or fail in early evaluations. It is easier to evaluate a technology driven concept that fits with the formal evaluation tools and methods, but this leaves little room for untested, resource-consuming complex concepts with revenues that are future-based and therefore difficult to pinpoint – whish is often characteristic for market and customer based concepts. The structured process thus easily suffocates concepts that deviate from the more easily recognizable concepts, instead of investigating their potential opportunities.

4.2 Findings from PharmaCorp

In the pharmaceutical industry decreasing productivity is an important concern (e.g. DiMase et al, 2003). As drug development becomes more risky and more costly, discovery departments of pharmaceutical companies are increasingly compelled to provide strong drug candidates for efficient development processes and quick market launch. The study at PharmaCorp (Elmquist and Segrestin, 2007) explored the actual practices of a discovery department. Through modelling both a scouting (screening) process initiative and two exploratory projects from a design reasoning perspective, very contrasted FE activities were highlighted. The analysis suggested that the screening logic is insufficient when entering new fields where the knowledge base is weak. When PharmaCorp actively tried to develop a new therapeutical area through screening the market for sustainable ideas to internalise and develop further, they failed completely despite an important investment. Actually, they did not have enough knowledge internally to evaluate what ideas were the viable ones. The analysis of the two exploratory projects suggested that instead a more successful way of entering the therapeutical area turned out to be to begin in a small area where they already had some knowledge and then actively work on developing it further. The discovery process in this case was actually more of *a design process* where the iterative generation of new concepts and new knowledge led the work; the product concept was not selected and

narrowed down to one optimal candidate, but concept generation was rather about the expansion of the attributes into a range of concepts.

4.3 Innovation and the limits of the selection logic

The studies show that innovative concepts, especially if based on customer and market knowledge, have difficulties impacting the NPD processes. The results also indicate that screening activities is not a successful way of entering new areas since knowledge is missing to evaluate innovative ideas. Instead, a more successful approach turned out to be to begin where some knowledge existed and then actively work on developing it further, developing new concepts in a generative process. It seems that the traditionally used selection logic is not efficient when aiming at innovation.

Innovation processes are often described generically as consisting of four steps: to search, select, implement and learn (e.g Tidd et al.., 2005). But this approach is built on two important assumptions:

- That the knowledge exist, i.e. that the company has enough knowledge internally to recognize good opportunities (knows what to look for)
- That the opportunities exist, i.e. that there are a number of "available opportunities" to chose from (there is something to find)

But when companies want to develop innovative products, companies do not always have the relevant knowledge to recognize a good idea. There is also a risk that opportunities that are difficult to evaluate in traditional decision models are not chosen. The studies show that in the development of more innovative products and services, these assumptions are not necessarily true (Backman et al., 2007; Elmquist and Segrestin, 2007). Therefore, to develop more innovative products, the prevailing selection logic is not enough – the assumptions need to be revisited.

If assuming that in an innovative situation a company does not have all the necessary knowledge, nor can rely on the availability of opportunities, an alternative approach to developing innovative capabilities is needed. It is thus proposed that the notion of absorptive capacity should be complemented with a notion of *generative capacity* signifying the firm's ability to develop new knowledge, internalise valuable knowledge and apply it internally. To enable an efficient R&D process and the development of more innovative products, both these capacities seem equally important.

5. Innovative capabilities as a dual capacity – introducing generative capacity

5.1 Revisiting absorptive capacity from an innovation perspective

The literature on learning and capabilities seemingly offers a more dynamic view of the firm than NPD literature in general, as it describes how an organization can change through expanding its knowledge base. Yet, when looking at the model of the firm as an interpretative system proposed by Daft and Weick (1984), it is based on the same prevailing assumptions. Although the authors discuss the environment in terms of analyzability they do not question how the strategy is influenced by the existing knowledge base of the firm that interprets the signals (the ability of the firm to identify

what to scan), nor does it worry that the opportunities/knowledge may not be there to find. This reactive approach is linked to the prevailing selection logic of NPD.

Absorptive capacity is also defined as a quite passive construct– to *recognize knowledge and to apply it* (Cohen and Levinthal, 1990). In more recent literature the dimension of internalizing the knowledge (combining old and new knowledge to se how it is valuable to the organization) has been added to the notion. Absorptive capacity is then described as a capability based on three activities, to *recognize, assimilate and apply new knowledge* (Lane *et al*., 2006). However, it still builds on the same assumptions – that there is enough knowledge available to identify signals in the environment and that the signals are there to be identified. Further, Cohen and Levinthal (1990) describe absorptive capacity as the identification and assimilation of knowledge *external to the firm* which is rather limiting – knowledge may just as well stem from the internal organization, not only from the R&D department but also from other functional areas. Further, in Cohen and Levinthal's (1990) discussion on enhancing absorptive capacity, the result is defined as recognition of *technological* opportunities, ignoring that not all opportunities may be of a technological character. In this paper it is argued that since innovative concepts have different driving forces and subsequently different prerequisites to survive in NPD processes, firms need reflect on how to deal with such concepts within the processes.

The absorptive capacity is also described as connected to three learning processes: *exploratory learning, transformative learning and exploitative learning* (Lane *et al*., 2006). Transformative learning is described as the combination of new and existing knowledge, enabling existing knowledge to be used in new ways. This resembles the combinative capabilities described by Kogut and Zander (1992). The outcome of absorptive capacity is described as both knowledge and commercial output, as shown in Figure 2 below (partial figure from Lane *et al*., 2006:856).

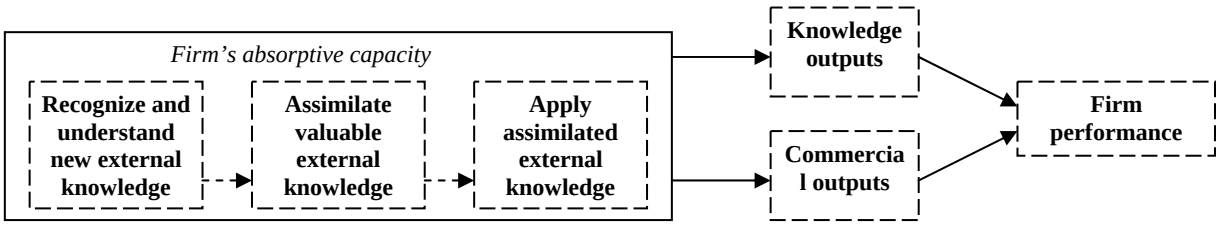

Figure 2. Absorptive capacity and its outcomes (Lane et al, 2006)

Despite this elaborated wording, the absorptive capacity notion is also reactive, and based on the same assumptions - that the opportunities exist and can be recognized with the available knowledge. This is mirrored in the potential and realized absorptive capacity notions introduced by Zahra and George (2002). They claim that acquisition and assimilation is activated by a trigger and that social integration mechanisms govern whether the absorptive capacity is realized (Zahra and George, 2002). Despite describing absorptive capacity as a dynamic capability, this model does not encourage firms to more actively generate new concepts and search for new knowledge (initiate the signals). Other authors have suggested the addition of feedback loops to enable learning (Todorova and Durisin, 2007) but without addressing the assumptions linked to the selection logic.

5.2 Towards a dual model for developing innovative capabilities

Assink defines innovative capabilities as "the internal driving energy to generate and explore radical, new ideas and concepts, to experiment with solutions for potential opportunity patterns detected in the market's whitespace and to develop them into marketable and effective innovations, leveraging internal and external resources and competencies" (Assink, 2006:219). Stressing more on the collective aspect, Le Masson, Hatchuel and Weil define innovative capabilities as "a collective capacity to permanently and simultaneously recreate new sources of value (products, concepts, patents, environmental values etc.) and competences (knowledge, know-how, professions etc.)"(Le Masson *et al*., 2006:21). In contrast to the absorptive capacity construct, both Assink (2006) and Le Masson *et al*. (2006) thus define innovative capabilities as the capacity to actively and iteratively both explore and generate knowledge. In line with these definitions, the notion of a firm's *generative capacity* or the ability to actively generate opportunities is proposed. Although literature on innovative capabilities underlines the need to explore and recreate, NPD models seem to theoretically build on the selection logic which is not in line with the ability to be innovative as described above. The empirical results also show that this logic is insufficient when aiming at developing more innovative products.

Combining the well known notion of absorptive capacity with a generative capacity is thus a way of re-conceptualizing the innovative capabilities of a firm towards a creation logic that can complement the hitherto prevailing selection logic. Decision and evaluation processes then need to value not only the knowledge and commercial output, but also the identification of knowledge gaps and the set of new ideas and concepts generated in the design process (c.f. LeMasson et al., 2006). To enable managers to work with the strengthening of the innovative capabilities of the firm, a new conceptual model for innovative capabilities is introduced, based not only on a firm's ability to absorb new knowledge, but also on its ability to work with the generation of new concepts and knowledge. Innovative capabilities are thus considered as: a dual capacity of both a firm's ability to *absorb new knowledge* through recognizing and understanding potentially valuable new knowledge and ability to *generate new knowledge* through actively experimenting and creating potentially valuable new knowledge. This new knowledge is then assimilated and applied to create commercial outputs and to develop new knowledge and new concepts as well as to identify relevant competence gaps. In **Error! Reference source not found.** below, this tentative model for describing a firm's innovative capability, entailing both absorptive and generative capacities, is proposed.

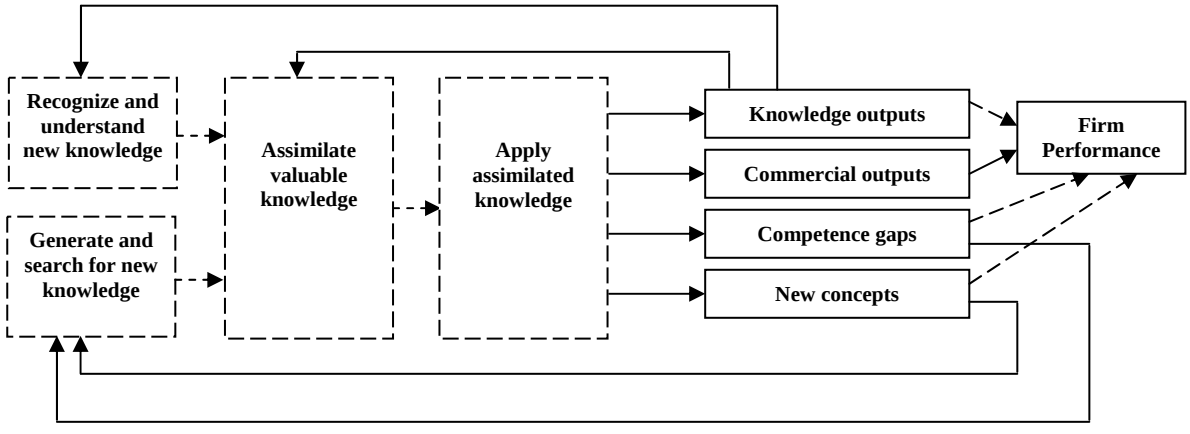

Figure 3. A conceptual model for a firm's innovative capability.

Adding to previous research on absorptive capacity this model is based on the assumption that the processes for absorbing internally produced knowledge (internal to the firm or even from within R&D) present as much of a challenge as absorbing external knowledge, which is why knowledge in this model refers to both internal and external knowledge. In their work, Lane *et al*. (2006) also describe the outcome of the process of absorptive capacity as being both knowledge and commercial output there may also be other outcomes. New concepts can be developed that can lead further explorations and gaps in knowledge and/or in competence can be identified. These outputs may not lead to short term firm performance but they do contribute to the future competitiveness of the firm, and the long term firm performance.

The model describes an iterative process where both the absorptive capacity and the generative capacity induce knowledge that lead to four types of output. The commercial output is the revenue coming from the products and services that result from the application of knowledge. The knowledge outcome is looped back into the process, but also used in the assimilation of new knowledge. The identification of competence gaps is used to develop new knowledge and skills and the new concepts are used to launch new exploratory projects. This model can be used on multiple layers; it is applicable on individuals as well as on a process level or a company level, as suggested by Cohen and Levintal (1990). This model also has some links to the hypertext organization proposed by Nonaka and Takeuchi (1995) in that it considers knowledge creation a key to innovative capabilities, and that it argues that the knowledge created in the NPD process must be looped back into the wider organization to find its application. It is also related to the RID structure and the design-oriented organization (Hatchuel *et al*., 2001; Hatchuel et al., 2003; le Masson *et al*., 2006) where Innovation is seen as a set of structures and processes that generate relevant knowledge.

The suggested model also underlines that the NPD process also play an important role as a generative process where multiple types of value is created. The product-centered image of R&D as a sequential process that needs to be optimized and efficient (e.g. Wheelwright and Clark, 1992) has led to the image of a trade-off between efficiency and innovation. In the model proposed here, the integration between generative and absorptive processes is a fundamental dimension to enable both an efficient NPD process and the development of more innovative products. This integration is achieved through the explicit management of the interface between knowledge generation activities and the NPD processes (absorption) - sometimes referred to as a duality perspective (Janssens and Steyaert, 1999). The tentative model presented here provides a starting point for a better understanding of a firm's innovative capabilities but further research is needed to validate its actionability.

Conclusion

In the academic field, it is indisputable that innovation contributes to the long term competitiveness of the firm (e.g. Tushman and Nadler, 1986; Cooper and Kleinschmdt, 1987; Drucker, 1988; Utterback, 1994; Thomke, 2001). Although the urgency to innovate is often present in management discourse, managerial actions tend to focus on short term development efficiency. However, innovation is not a rational process that can be optimized as such. What needs to be managed is rather the development of capabilities to develop products that will be perceived as innovative once they reach the market. In NPD theory, innovation is based on a firm's ability to recognize and exploit external opportunities, or the absorptive capacity of the firm.

In line with previous research (Veryzer, 1998; Eisenhart and Tabrizi, 1995; McDermott and Colarelli O'Connor, 2002; Rice *et al*., 1998), this paper argued that NPD processes are designed mainly for developing well-defined products in an efficient way and that innovative concepts have difficulties impacting these processes. It was argued that the processes are insufficient when aiming at developing innovative products since they are based on two basic assumptions, that the existing knowledge is sufficient (that the actors in the process possess enough knowledge to respond to the right signals) and that the opportunities already exist (that there are a number of existing potential opportunities to select among). A modification of these assumptions was suggested in innovative situations. As a consequence, it was argued that the innovative capabilities of a firm can be described and managed as a dual capability of both a firm's ability to absorb new knowledge through recognizing and understanding potentially valuable new knowledge and ability to generate new knowledge through actively experimenting and creating potentially valuable new knowledge, then assimilating the new knowledge and using it to create new knowledge, new concepts and commercial outputs as well as to identify relevant competence gaps. To develop their innovative capabilities, managers were encouraged to work with both absorptive and generative capacities.

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