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Learnings from the front end of radical product innovation in mature firms

A descriptive analysis of how BillerudKorsnäs can manage the front end of radical product innovation

Master of Science Thesis
in the Management and Economics of Innovation Programme

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CHALMERS UNIVERSITY OF TECHNOLOGY
Göteborg, Sverige 2016
Report No. E 2016:062

MASTER'S THESIS E 2016:062

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Chalmers Reproservice
Göteborg, Sweden 2016

ACKNOWLEDGEMENTS

The authors of this master's thesis would like to thank the main supervisor Sofia Börjesson for her guidance and encouragement. We would also like to express our gratitude to our second supervisor at BillerudKorsnäs, Magnus Wikström, who made this thesis possible and always showed a great interest. Lastly, we would also like to thank all of the interviewees at ABB Corporate Research, Bombardier RCS, and Sandvik Coromant. Without your knowledge and experience, this thesis would not have been possible. Thank you.

ABSTRACT

The activities prior to the formal New Product Development (NPD) constitute the front end of product innovation. There is significant value in mastering the front end of product innovation, but difficult due to a high degree of uncertainty. BillerudKorsnäs is a mature firm with an ambition to find radical innovation. However, due to their history of incremental and process innovation, they need to adapt their front end of product innovation in order to facilitate more radical products. Hence, they need to learn from how other mature firms manage the front end of radical innovation, as well as what previous research emphasize.

This master's thesis provides brief examples and methods of how a mature firm with a focus on pulp and board material for packaging can work with the activities in the front end of radical product innovation. Eight interviews were conducted that provide insights and brief examples from BillerudKorsnäs, ABB Corporate Research, Bombardier Transportation Rail Control Solution, and Sandvik Coromant.

This thesis comes to the conclusion that there are several activities, methods, and facilitating factors regarding the front end of radical product innovation. The observed companies do not rely on one single activity, method, or facilitating factor to enable radical innovation. Instead, they rely on a combination of individuals, informal networks, external collaborations and foremost experience in order to identify opportunities, generate ideas, and select ideas. In addition, they actively manage the facilitating factors by organizing to enable idea surfacing and sharing, utilizing various external collaborations, as well as making innovation a strategic priority.

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1 INTRODUCTION

The activities prior to the formal New Product Development (NPD) constitutes the front end of product innovation (Koen et al., 2001). Many scholars and firms agree that there is a significant value in mastering the front end of innovation (Khurana & Rosenthal, 1998; Koen et al., 2001; Reid & de Brentani, 2004). Some scholars even claim that improving the front end of product innovation is one of the utmost opportunities to advance the whole innovation process (Koen et al., 2001). Similarly, managers indicate that the greatest weakness in product innovation lies in the front end of innovation (Khurana et al., 1998). Due to the substantial degree of uncertainty within the front end of product innovation makes it highly difficult to manage, especially for new-to-the-world products (Reid & de Brentani, 2004).

The front end of product innovation has been diligently discussed among scholars without an agreement on what it entails or how to master it. Some scholars claim that these activities can be seen as a 'holistic' process (Khurana & Rosenthal, 2001) while other explicitly argue that companies should stop chasing a common process for the front end due to the uniqueness of each project (Nobelius & Trygg, 2002). In addition, each theory contains both similar and distinct activities, and factors which facilitate these activities, resulting in a fuzzy definition. This study combines several theories and divide the front end of product innovation into two areas; facilitating factors and activities of the front end; containing opportunity identification, idea generation, and idea selection.

Innovation at BillerudKorsnäs has long been portrayed by incremental product innovation. Finding opportunities, generating ideas, and selecting ideas has been characterized by finding and customizing existing customer needs for prevailing processes, which have mainly resulted in incremental improvements. However, due to recent developments in related industries, increased rivalry, and the advancement of technology, BillerudKorsnäs has developed an increased sense urgency to find radical product innovation. Consequently, uncertainties has emerged and the front end activities at BillerudKorsnäs need to change in order to effectively enable radical product innovation.

Changing the innovation agenda for the front end of product innovation requires learning. In order to achieve radical innovation, BillerudKorsnäs needs to gain knowledge about how to widen the search for opportunities (Cooper, 2011), generate and select more radical ideas (Cooper, 20011; Nagji & Tuff, 2012), as well as overcoming knowledge gaps (Vanhaverbeke et al., 2003). This can include working with specific methods or facilitating the process through other factors, such as organizational structures (Leifer, 2000; O'Reilly & Tushman, 2004), external collaborations (Chesbrough et al., 2006), and communicating a clear innovation strategy (O'Connor & Veryzer, 2001). Hence, BillerudKorsnäs wants to understand how other successful mature firms in Business-to-Business (B2B) industries are currently facing the same challenges. This study provide an external outlook for BillerudKorsnäs complemented by a theoretical view of the front end of innovation to satisfy an ambition for radical innovation.

This master's thesis complements previous literature by providing insight into how mature firms are currently stimulating and working with activities in the front end of radical product innovation, as well as how they can work with the activities. The thesis does not attempt to prove the superiority of one method or approach over another, or show the exact impact of a facilitating factor on the front end activities. However, as the theory and examples of mature firms aids to understand how, rather than what to do, the applicability is to some extent generalizable to mature firms. This

master's thesis was written at Chalmers University of Technology by Eric Schillström and Victor Sellman, and was undertaken at BillerudKorsnäs in the spring of 2016.

1.1 PURPOSE & RESEARCH QUESTIONS

Based upon the discussion in the previous chapter, this thesis aims to fulfill the following purpose;

The purpose of this master's thesis is to provide examples of methods from theory and empirical observations and discuss possible lessons for how BillerudKorsnäs can work with the front end of radical product innovation.

The purpose is further divided into three research questions.

1. How do some mature firms identify opportunities and generate ideas in the front end of radical product innovation?
2. On what basis do mature firms select ideas, to further pursue in research and/or product development, in the front end of radical product innovation?
3. How do mature firms gain initial knowledge and overcome knowledge gaps in novel technological areas?

2 LITERATURE REVIEW / THEORETICAL FRAMEWORK

This chapter aims to present prior studies within the front end activities of product innovation, and primarily radical product innovation. Initially, radical innovation is defined and difficulties mature companies experience in these areas are described. Subsequently, an analytical model is presented, containing two main areas of description; activities in the front end of innovation and the factors that facilitate them. The model build a comprehensive understanding of how mature companies approach activities regarding radical product innovation in the front end.

2.1 TOWARDS A DEFINITION OF RADICAL PRODUCT INNOVATION

The term radical innovation has been diligently discussed by scholars without reaching a unanimous definition. Ahuja et al. (2001) described that radical innovations can be radical both in terms of the technology in a new product, or radical from the perspective of users and the market. An innovation can also be radical for a specific firm if it relies on knowledge in which the company is inexperienced, even if the "knowledge is available in the general scientific community" (Green et al., 1995). The application of radical product innovations, as opposed to incremental innovations, can create new markets or bring about dramatic changes of behavior to existing markets (McDermott & O'Connor, 2002; Galbraith, 2004; Leifer, 2000). Incremental innovations, instead, address cost or performance improvements of existing products (Leifer, 2000). It is further important to differ between product innovation - changes in product or service - and process innovation - changes in how something is made (Tushman & Nadler, 1986).

Leifer et al. (2001) defines radical innovation as an innovation where technological and market uncertainties are high. Technical uncertainties include questions about the technological feasibility, the validity of the scientific knowledge, and technical specifications of the product (Leifer et al., 2001, Vanhaverbeke et al., 2003). Developing radical innovation requires the exploration of novel technology areas and the development of new technology bases (Vanhaverbeke et al., 2003). Leifer et al. (2001) also describe market uncertainties related to radical innovation such as what the customers' needs and wants are. Vanhaverbeke et al. (2003) adds that projecting sales of a radical innovation is only a reasonable guess.

This thesis will define radical product innovation as an original product which incorporates new technology from the company's perspective, with the potential to create new, or drastically change existing, markets.

2.2 WHY IS IT DIFFICULT FOR LARGE AND MATURE COMPANIES TO ACHIEVE RADICAL INNOVATION?

Mature companies often experience difficulties in creating radical innovations. The older and larger companies are, the more likely they are to develop incremental innovations (Koberg et al., 2003; Tushman & Nadler, 1986). Older and larger organizations often have routines in place to extract process innovations but structural rigidity and inertia make them less able to quickly change and develop more radical innovations (Koberg et al., 2003). Stringer (2000) further argues that the conservatism and inability to learn hinder large companies to develop radical innovations. He lists four reasons for this; limited incentives for leaders and managers to pursue radical innovations, a culture and structure which discourage the development of radical innovations, an over reliance on the internal R&D, and the inability of companies to attract and retain innovators.

Firstly, there are stronger incentives for managers to develop incremental innovations rather than radical innovations. New and radical innovations are often less optimal in addressing the needs and problems of current customers (Christensen & Bower, 1996). Cooper and Edgett (2009) similarly note that responding to customer's request for new products often result in only slight modifications to an existing product - incremental innovation. These types of projects do not individually consume a lot of resources, but can collectively divert a large proportion of resources away from genuine product development (Cooper and Edgett, 2009). Even if a manager can see the potential of a future technology, the obligation of delivering sustainable results and avoiding risk can steer a manager or industry leader away from more radical innovations (Cooper 2013; Stringer, 2000).

Secondly, the culture in a mature firm works to stabilize and get rid of any new and potentially dangerous changes to the established hierarchy (Stringer, 2000). Radical innovations often require shifts in production capabilities and customer relationships and can potentially cannibalize on existing products which threaten the status quo, and so the culture pushes against such changes (Stringer, 2000). Furthermore, some business unit managers rather stick to incremental zones, where targets are clearly defined, and feel uncomfortable when things diverge too far from current structures (Witzeman et al., 2006). This mind-set inhibits revolutionary ideas and locks in evolutionary thinking, and thus discourages radical innovation (Witzeman et al., 2006). Witzeman et al. (2006) explain this behavior by new employees being schooled to think internally and to learn concepts such as six sigma, core competence, stage-gate, etc., which results in incrementalism.

Thirdly, the R&D function in a mature company is required to simultaneously improve existing products and produce radical innovations. A short financial focus and risk aversion in combination with an inherent uncertainty related to the development of radical innovations naturally minimize the radical innovation effort (Cooper, 2013; Stringer, 2000). Lastly, Stringer (2000) argues that smaller companies better provide the environment that an innovator desire. Smaller companies better nurture the innovators and motivate them to take risks in comparison to the more rigid larger companies where they are more subject to a hierarchical environment (Stringer, 2000).

A more recent study by Chandy and Tellis (2000) however suggest that the so called incumbent's curse may be over. Although it is shown that smaller firms have historically introduced more radical innovations, in more recent times, Chandy and Tellis (2000) found that large incumbent firms introduce as many. Regardless whether the distribution has changed, the difficulties many mature companies experience still remains.

2.3 UNDERSTANDING THE FACTORS FACILITATING THE EMERGENCE OF INNOVATION IN THE FRONT END

Regarding the front end of innovation, Reid & De Brentani (2004) discuss three interlinked perspectives to fundamentally understand the emergence of innovation; the environment, the individual, and the organization. Firstly, radical innovation is an environmental-level phenomenon, meaning that internal and external random events and changes foster new paths for evolution which in turn destabilizes organizations (Ahmed, 1998; Reid & De Brentani, 2004). As a result, firms are challenged by new product life cycles and new opportunities, which in turn initiate the development of radical innovation (Klepper, 1996; Reid & De Brentani, 2004). Utterback (1994) argues in the same pattern stating that radical innovations often are rooted in the external environment.

Secondly, Reid & De Brentani (2004) discuss that the individual perspective explains how individuals on all levels of an organization act as catalysts and enablers for innovation. Hence, it is the individuals that supports and forward ideas (Reid & De Brentani, 2004). Lastly, Reid and De Brentani (2004) argue that the nature of discontinuity and what is new can be interpreted differently among customers and organizations. As new phenomena often are identified at the environmental and individual level, it can be difficult for organizations to fully comprehend and know how to proceed (Reid & De Brentani, 2004). Thus, organizations need to be seen as whole understanding entities where culture, joint competencies, and values plays a major role (Ahmed, 1998; Cohen & Levinthal 1990; Reid & De Brentani, 2004).

2.4 DEVELOPING AN ANALYTICAL FRAMEWORK FOR THE FRONT END ACTIVITIES OF RADICAL PRODUCT INNOVATION

In this section, an analytical framework is discussed and presented. The analytical framework serve as a tool to understand the earliest activities of radical product innovation in the observed firms. The framework include the front end activities of radical product innovation as well as the factors which facilitate them. As many of the facilitating factors have an effect on several of the front end activities, they are presented separately in the theoretical framework, so as to avoid repetition. How the observed companies work to facilitate the front end activities are however examined together in the analysis and discussion under the specific activities. The included factors and activities described in the analytical model is derived from what previous research have identified as areas of importance. These will be described in greater detail in the following sections.

2.4.1 Facilitating factors to the front end activities

There are many factors described by scholars which directly and indirectly facilitates the front end activities of product innovation and one can argue for many more. To find, generate, and select ideas is a process that encompass many entities, structures, systems, practices and values, both inside and outside a company's borders. Griffiths-Hemans and Grover (2006) describe factors which affect the informal generation and harnessing of new product ideas such as individual characteristics, the corporate culture, access to resources, and organizational roles. Formed from a basis of the most common reasons of failure in innovation efforts, Cormican and Sullivan (2004) identify five key success factors which facilitate product innovation and needs to be managed: strategy and leadership, culture and climate, planning and selection, structure and performance and communication and collaboration. Koen et al. (2001) highlights leadership and culture as something that drives front-end activities. They also discuss influencing factors to the entire process of innovation such as the environment of the company, including organizational capabilities, business strategy, and the outside world of customers and competitors. Ahmed (1998) suggests that possession of certain positive cultural characteristics will provide the firm with necessary ingredients to innovate. Other scholars emphasize the effect of organization, external collaborations and the ability to absorb knowledge (Cohen & Levinthal, 1990; Galbraith, 2004; O'Reilly and Tushman, 2004; Van de Vrande, 2013; Zhao et al., 2005).

Naturally, a trade-off exists between including a large quantity of facilitating factors and securing a sufficient depth and relevance of each factor to the firms in the study. In order to cover a significant amount of factors and avoid a brief description of many factors and activities, a selection has been made to create a comprehensive model. The selection was mainly based on perceived relevance for the observed companies. The influencing factors that are used in the model are *organizational structure*, *external collaborations*, and *strategy and leadership*.

2.4.2 Activities in the front end of radical product innovation

There are multiple approaches to describe which activities take place in the front end of product innovation. Many scholars describe the activities in the front end of innovation similarly, but use different terminology. Reid & De Brentani (2004) suggested that the front end of innovation is where ideas are identified and pre-developed before entering the initial group meeting to discuss them, i.e. it is the area leading up to organizational-level absorption of the innovation process, also known as New Product Development (NPD). Koen et al. (2001) similarly claim that front end of product innovation can be seen as the activities prior to a formal stage gate process and contains five activities: opportunity identification, opportunity assessment, idea genesis, idea evaluation, and concept and technology development. The activities do not necessarily follow each other in a concurrent process but is rather iterative. Griffiths-Hemans and Grover (2006) describe the front end activities as an 'idea fruition process' composing of an informal idea generation and idea development. Khurana and Rosenthal (1998) see the front end activities as a 'holistic' process, which include product strategy formulation and communication, opportunity identification and assessment, idea generation, product definition, project planning, and executive reviews. Björk et al. (2010) instead present ideation as the starting point of any innovative endeavor, which consists of the stimulation, identification, selection and implementation of ideas. The alternative descriptions of the front end activities are in the analytical model condensed into three activities: opportunity identification, idea generation and idea selection.

The final model is presented in figure 1.

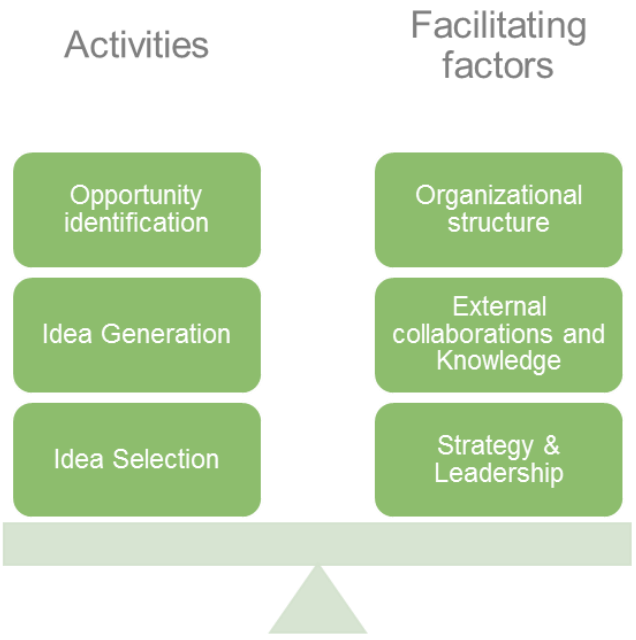

Figure 1. Activities and facilitating factors in the front end of product innovation

2.5 FACILITATING FACTORS

This section expands on the three factors discussed in the analytical framework: *organizational structure*, *external collaborations and knowledge,* and *strategy and leadership*. In order to understand how these factors facilitate front end activities, existing theories and relevant examples are illustrated.

2.5.1 Organizing for radical innovation

A factor which naturally affects the front end activities of radical product innovation is how the firm is organized and structured. Senior managers can affect and promote innovation by structural mechanisms to effectively capture ideas - both increase number of surfaced ideas as well as promoting the transfer of ideas (O'Connor & Veryzer, 2001). There are many different views regarding how to best organize to achieve radical product innovation. Due to the potential conflicts over resources and power between radical innovations and existing systems, Galbraith (2004) argues that a company must separate its organization in an innovating and operating organization. O'Reilly and Tushman (2004) similarly describe the ambidextrous organization as the optimal way of organizing to achieve synergies while avoiding conflict. Other researchers find alternative ways of organizing to facilitate radical innovation in mature firms, such as the formations of systems or groups to catch radical ideas and subsequently develop them (Björk et al., 2010; Leifer et al., 2001; Stringer, 2000).

Separation of innovating and operating functions - Ambidextrous organizations

As described earlier, many issues and difficulties related to radical innovation in mature firms have been identified. O'Reilly and Tushman (2004) describe how companies struggle to exploit their current capabilities at the same time as they explore new radical opportunities. Benner and Tushman (2003) describe exploitative innovation as incremental innovation for the current customers, and explorative innovation as radical innovation for emergent customers. Galbraith (2004) argues that companies need to separate their organizations into an operating and an innovating organization. It is necessary to achieve some sort of separation as the two organizations work according to conflicting principles, where the operating organization attempts to prevent errors, while the innovating organization works with trial and error (Galbraith, 2004).

A study by O'Reilly and Tushman (2004) found that so called ambidextrous organizations was the most successful alternative. In ambidextrous organizations, the explorative efforts was executed by a structurally independent unit with their own processes, structures and cultures but integrated in the larger company through a senior manager. In comparing the results of launching radical innovation as well as the impact on the performance of the traditional business, the ambidextrous organization performed better than cross functional teams, unsupported teams and functional designs (O'Reilly & Tushman, 2004). Due to the separate nature, the traditional operations were not affected by the explorative efforts in a negative way, and the exploring unit were able to share resources through the coordination at a managerial level without being "overwhelmed by the forces of business as usual" (O'Reilly & Tushman, 2004).

Organizing for capture of ideas in mature firms

Björk et al. (2010) argue that many firms simply rely on ideas to spontaneously appear in the organization. The authors criticize the passiveness of such an approach and question whether the best ideas for the organization necessarily are those that become developed (Björk et al., 2010). Without a system which can capture and handle ideas, they are often lost or people with ideas remain silent (Cooper & Edgett, 2009).

Many authors suggest measures that large and mature companies can take in order to achieve a larger stream of radical innovations. Leifer et al. (2001) claim that people who generate ideas often do not recognize its potential. It is therefore useful for initial ideas to quickly be assessed by some function in order to provide guidance, or articulate potential (Leifer et al., 2001). Furthermore, Leifer et al. (2001) argues that if a new idea or innovation threatens to cannibalize or disrupt the existing business, the idea can meet opposition which could make the process even more difficult. Similarly, Galbraith (2004) claims that ideas usually come from people at lower levels of an organization, who can see problems and attempt to solve them differently than executives, managers, or people who has worked at the organization for a longer time. Lower levels of an organization are often synonymous with lower status which can hinder the ability for a person to develop the idea. Leifer et al. (2001) propose implementing so called radical innovation hubs in mature firms which can work to reduce market and technological uncertainties related to the development of radical technologies, and separate the distribution of resources from the ordinary business areas. The hub would serve as a base for people with extensive experience of working in high uncertainty environments. Leifer et al. (2001) describe how the proposed hubs can perform several functions such as capturing radical-innovation ideas, establishing early-evaluation boards, serve as mentors during the incubation period, advising project teams about resource acquisition, and managing interfaces with existing business units and senior management.

Stringer (2000) suggests creating a similar structure of autonomous teams to identify and commercialize radical innovations. Stringer (2000) means that these autonomous teams, or knowledge markets, would be responsible for collecting ideas throughout the organization and independently develop the best ideas. Stringer (2000) emphasizes that the most effective autonomous teams would have the authority to hire their own staff, freely use the organization's resources, and report directly to the CEO. The teams would only be responsible for developing the earlier steps of an innovation, and leave the commercialization of the innovation to the established business units (Stinger, 2000).

Facilitating idea generation and sharing with informal networks

Informal networks and contacts between people can stimulate the generation of ideas (Koen et al., 2002). Björk and Magnusson (2009) found a positive relationship between the centrality degree in a network of an idea provider and the quality of generated innovation ideas. Centrality degree is described as the amount of different sources of information and knowledge that the idea generator has access to (Björk & Magnusson, 2009). Hence, it becomes important for management to facilitate the possibility of interaction between its employees. Examples given by Björk and Magnusson (2009) include increasing the formal collaboration between employees of different departments, creating and supporting communities, and facilitating the sharing of knowledge in knowledge management systems. In addition, access to relevant and diverse knowledge, both internally and externally, is important in developing an idea with varied knowledge needs, as the expertise of the idea-generator is not necessarily sufficient (Griffiths-Hemans & Grover, 2006). Griffiths-Hemans and Grover (2006) claim that since idea-generators are interested in keeping the work fun in combination with a need for cooperation with other individuals to successfully develop innovations suggests that informal relationships in the organization are important. Griffiths-Hemans and Grover (2006) recognize the difficulties in structuring informal relationships, but suggest that an organization can take steps in facilitating social interaction across departments.

Organization characteristics and its influence on creativity

Furthermore, in terms of organizing and structuring for innovation, Ahmed (1998) argues that an organic organizational structure is to prefer rather than a mechanic. Typical traits of each structure is presented in figure 2.

Organic structures (promotes)	Mechanic structures (hinders)
• freedom from rules; • participative and informal; • many views aired and considered; • face to face communication; little red tape; • inter-disciplinary teams; breaking down • departmental barriers; • emphasis on creative interaction & aims; • outward looking; willingness to take on external ideas; • flexibility with respect to changing needs; • non-hierarchical; • information flow downwards as well as upwards.	• rigid departmental separation and functional • specialisation; • hierarchical; • bureaucratic; • many rules and set procedures; • formal reporting; • long decision chains & slow decision making; • little individual freedom of action; • communication via the written word; • much information flow upwards; directives flow downwards.

Figure 2. List of organizational characteristics for innovation. Adapted from "Culture and Climate for Innovation," by P.K. Ahmed, 1998, European Journal of Innovation Management, 1(1), 30-43.

Martins & Terblanche (2003) follows the same pattern by suggesting that an open systems approach is to prefer in attempt to create an organizational culture supportive to creativity and innovation. They conclude similar to Ahmed (1998) that it is hard to identify an optimal structure for creativity and innovation as it influenced by organizational context and that culture can both inhibit and enhance. Cormican and Sullivan (2004) continue by stressing the importance of openness and sharing. They further suggest that this is achieved by motivating people and embedding knowledge management activities, such as knowledge creation, knowledge transfer, etc., into the organization's daily business processes and internal systems.

Furthermore, Griffiths-Hemans and Grover (2006) tested several individual characteristics which affect the creativity of an idea generator. People driven by intrinsic motivation, or internal rewards, were discovered to be a key for creativity (Griffiths-Hemans & Grover, 2006). They suggest that companies should hire individuals based on their motivations, and focus on individuals who simply love doing what they are doing. Conversely, offering extrinsic rewards, e.g. money, praise, etc., could actually affect innovators negatively and lead to abandonment of experimentation in favor of following rules (Griffiths-Hemans & Grover, 2006; Ahmed, 1998). Griffiths-Hemans and Grover (2006) also found that expertise is a significant factor in creativity and encourage companies to nurture their specialists. This can include sending specialists to seminars and conferences as a reward for their creativity in addition to keeping the specialists up-to-date on the most recent research (Griffiths-Hemans & Grover, 2006). Ahmed (1998) however stresses the paradox of specialization, where it both can enable creativity as prior knowledge enhance the creation of new understanding, as well as inhibit creativity as specialist work in narrow fields which in turn result in narrow search heuristics.

2.5.2 External relationships and knowledge

The effect of collaborations with external entities in innovation is emphasized by many scholars (Zhao et al., 2005; Van de Vrande, 2013; Witzeman et al., 2006). A company cannot rely on internal

competencies and resources alone to create innovations which maximize customer value (Witzeman et al., 2006). However, transforming external information into innovation requires absorptive capacity (Cohen & Levinthal, 1990) and management of external relationships.

Absorptive capacity - Transforming external information into innovation

Marrying new information with old knowledge is something that has been problematic for a long time (Reid & De Brentani, 2004). In order to fully utilize external knowledge, companies must possess specific absorptive skills (Rothaermel and Alexandre, 2009). Cohen and Levinthal (1990) suggest that firms possess something called absorptive capacity, which they define as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends". Absorptive capacity can be seen as a cognitive basis at an individual and organizational level (Cohen & Levinthal, 1990).

On an individual cognitive basis, research on memory development shows that accumulated prior knowledge eases the ability to acquire, recall and use new related knowledge (Cohen & Levinthal, 1990). Cohen and Levinthal (1990) also claim that prior psychology studies show that new knowledge is easier obtained with prior knowledge as associative learning plays an important role, i.e. pre-existing concepts being interlinked with new related events. Thus, they come to the conclusion that it is preferable to have a wide range of prior knowledge categories, a differentiation of those categories, and linkages between them in order to facilitate individual sense-making and acquisition of new knowledge. Hence, Cohen & Levinthal (1990) stress the importance of individuals having prior related knowledge in order to achieve a higher absorptive capacity.

Furthermore, Cohen and Levinthal (1990) argue that an organization's absorptive capacity is dependent on the individual members' absorptive capacity. They argue however that an organization's absorptive capacity is not the sum of all the members' absorptive capacity, as it also refers to the ability to exploit acquired and assimilated information. Thus, the organizational absorptive capacity is dependent on how the organization transfers knowledge within and across sub-units and not only its interaction with the external environment (Cohen & Levinthal, 1990). However, individuals at the interface between the firm and its environment, and between subunits play an important role (Cohen & Levinthal, 1990).

Moreover, information reaches organizations in random flows. The directed information needs to be understandable for the recipient, and thus the group as a whole need to possess background knowledge on the subject being passed on (Cohen & Levinthal, 1990). Should the knowledge level of the recipients be insufficient to understand the external information or information from other units, certain individuals play an important role in monitoring, assimilating, understanding, and directing the information (Cohen & Levinthal, 1990). Furthermore, there is a balance in having commonality and diversity of knowledge. Commonality eases the communication among individuals within the organization but could inhibit knowledge diversity (Cohen & Levinthal, 1990). Conclusively, Cohen and Levinthal (1990) suggest that the ideal knowledge structure in the organization and its subunits should be partly overlapping complemented by non-overlapping knowledge diversity.

Cohen & Levinthal (1990) further discuss the possibility of buying absorptive capacity, e.g. via hiring new personnel, company acquisitions, contracting consultancies, etc. They argue that it might be difficult to integrate external absorptive capacity as it needs to fit into the firm's other activities, and thus internal development might be preferable. In order to successfully integrate complex technological knowledge into specific activities, the firm needs to have a staff of technologists and scientist who is highly familiar with the firm, its surroundings, and the new

knowledge (Cohen & Levinthal, 1990). In addition, specialized knowledge may be hard to transfer as it often contains high degree of tacit knowledge (Nonaka & Konno, 1998). Tacit knowledge, as opposed to explicit, is hard to codify and resides in the minds of people, such as hunches and intuitions (Nonaka & Konno, 1998).

Open Innovation - Making use of the external environment

Chesbrough et al. (2006) describe open innovation as the opposite to the more traditional method of developing innovations in an internal vertically integrated R&D effort. In the traditional model, innovations are launched from the science and technology base and passes through closed stages in an organization, where some are selected and eventually launched by the organization (Chesbrough et al., 2006). A definition of open innovation given by Chesbrough et al. (2006) is that "open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively". Faems et al. (2010) support the fact that external innovation together with internal innovation influences product innovation performance. Open innovation recognizes that valuable knowledge can originate from outside the organization, and that ideas can be launched inside or outside the organization (Chesbrough et al., 2006). A core process for innovation in an R&D function is therefore to identify, locate, and utilize external knowledge sources (Chesbrough et al., 2006). Furthermore, Witzeman et al. (2006) discuss the difficulties with resistance to open innovation. From their empirical study, they identified that many companies experienced dynamic tensions between those who defend current models and those who strive for change. These tensions were especially clear when managers allocated limited resources among different high-value opportunities.

As seen in figure 3, Chesbrough et al. (2006) illustrate the open innovation paradigm. Open innovation is concerned with the entire innovation process from the creation to the launching of new ideas. As the main focus of this thesis lies in the front end activities of innovation, only the research phase of the "funnel" will be dealt with. Although technology insourcing is not necessarily part of this phase, it is still presented due to the difficulties in distinguishing what is technology sourcing and insourcing as both incorporates a way of accessing external technology bases.

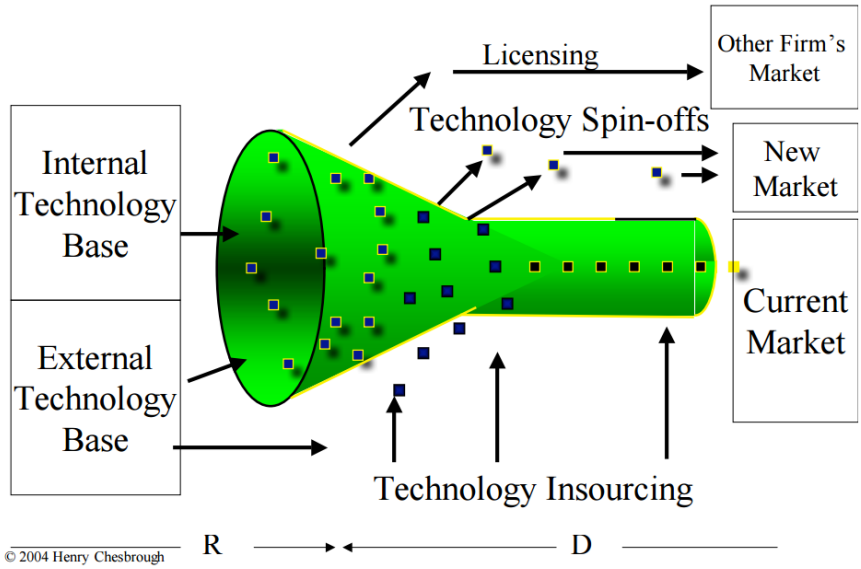

Figure 3. Open Innovation Paradigm. Reprinted from "Open Innovation: Researching a new paradigm," by Chesbrough et al., 2006, OUP Oxford.

Sourcing external technology and accessing external knowledge bases

One contributing factor to the emergent practice of open innovation has been the need to innovate more effectively and quickly (Witzeman et al., 2006; Zhao et al., 2005) and one way to do so is by expanding the search for technical innovation by sourcing external technology (Van de Vrande, 2013). However, when firms use external R&D resources, dependencies occur and they find themselves struggling for a balance between what to own and what to acquire (Witzeman et al., 2006). Nevertheless, the shift from traditional R&D to external sourcing can be difficult as leadership has to change and the new company culture has to antagonize the "not-invented-here-syndrome" (Witzeman et al., 2006).

Choosing between M&A's or Strategic alliances

In terms of technology sourcing, there are several ways how firms can capture and internalize external technologies and knowledge bases, e.g. strategic alliances, M&A's, joint venture, licenses, collaborations, etc. (Lambe & Spekman, 1997; Witzeman et al., 2006; Van de Vrande, 2013). Naturally, each procedure has its advantages and disadvantages and it can be difficult to assess which one to choose; ownership entails control of activities and intellectual property while external sourcing brings speed and risk mitigation to innovation processes (Van de Vrande, 2013).

Vanhaverbeke et al. (2002) studied this subject in terms of M&As versus strategic alliances, which they claim to be the overall choices of external technology sourcing. They discuss that prior research often has turned to Transaction Cost Economics (TCE) frameworks to decide what to develop by the company, jointly with another part, or what to acquire. One perceived difficulty in evaluating possible candidates for acquisition is information asymmetry, meaning that information given by another part may be opportunistic, lack of reliable data, or even false data (Reuer & Koza, 1998; Vanhaverbeke et al., 2002). Another argument against M&As in favor of joint ventures is digestibility, meaning that firms often just want specific parts, i.e. asset-specificity, of another entity, which can be hard to separate from other functions or assets, and thus leading to higher costs (Lambe & Spekman, 1997; Hennart & Reddy, 1997; Vanhaverbeke et al, 2002). A higher price can however be motivated if there exist a desire for greater control (Lambe & Spekman, 1997). Faems et al. (2010) however argue that adopting a wide variety of technology alliances incurs costs which in the short term might influence the financial performance of the firm negatively. The costs mainly come from an increased effort of monitoring and controlling, as well as the need for dedicated functions to support the alliances. As a consequence, Faems et al. (2010) recommend managers to take the potential cost of collaboration in consideration when assessing potential technology alliances and their benefits.

Furthermore, Vanhaverbeke et al. (2002) revealed in their study that there are some circumstances that affect companies to prefer M&As and strategic alliances respectively. First of all, they notice that prior alliances increase the probability of an acquisition. On the other hand, they found that indirect ties in prior networks increase the probability to enter a strategic alliance. This can be explained by that direct ties decreases information asymmetry and mitigate indigestibility while indirect ties do not provide sufficient information desirable for acquisition (Vanhaverbeke et al., 2002). Additionally, when a new potential disruptive technology emerges, the uncertainty of its impact motivates firms to use alliances and joint development rather than acquisitions (Lambe & Spekman, 1997).

Balancing a technology-sourcing portfolio

As technology sourcing is getting more common and becoming a central part of a firm's overall strategy, the issue of organizing and who to source from is of great importance (Van de Vrande,

2013). The relationships and combinations of external sourcing strategies and whom to source from, e.g. supplier, customers, universities, constitutes a technology-sourcing portfolio (Van de Vrande, 2013). Consequently, a technology-sourcing portfolio consist of a wide range of partnerships, which vary depending on the technology per se and to what extent it overlaps with competencies of the focal firm (Mowery et al., 1998).

Van de Vrande (2013) argues that firms need to implement a wider range of governance modes to enhance the effectiveness and efficiency of external technology sourcing, especially in the interaction between sourcing mode diversity and relative technological proximity in the portfolio. Technical proximity can be defined as the closeness in capabilities, regarding a specific technology among partnerships and the focal firm (Van de Vrande, 2013). Hence, if a partner's competence is similar to the focal firm, the variance in relative technological proximity is low. More distant external knowledge base will increase the likelihood of generating creative and novel ideas (Bierly et al., 2009). Fleming (2001) claims that a broader range of technologies and technological diversity, i.e. a variance in technical proximity, will likely enhance a firm's innovative power as it increases the possibilities in marrying new knowledge into existing structures. In addition, a wide range of technologies also mitigate the risks of lock-ins in existing or particular technology trajectories (Van de Vrande, 2013).

Similar to Van de Vrande's (2013) theory about balancing technology sourcing portfolios, Rothaermel and Alexandre (2009) argue the necessity of an ambidextrous technology sourcing to enhance the innovative performance of a firm. Their study shows that there is an inverted U-shape relation between performance (both financial and innovative), technology sourcing mix, and absorptive capacity, see figure 4. Technology sourcing mix can be seen as the ratio between external technology sourcing over the total technology sourced (internal and external), which they also refer to as technology exploration. The essence of their study proclaims that high financial performance and innovativeness is achieved by a well balanced portfolio of technology sourcing mix and that greater level of absorptive capacity commensurately increases the benefits of ambidexterity in technology sourcing. Hence, the higher absorptive capacity, the higher ambidextrous leverage and thus performance. In other words, an even technology sourcing mix is to prefer, while overly strong emphasize to either external or internal sourcing could have a negative impact on performance.

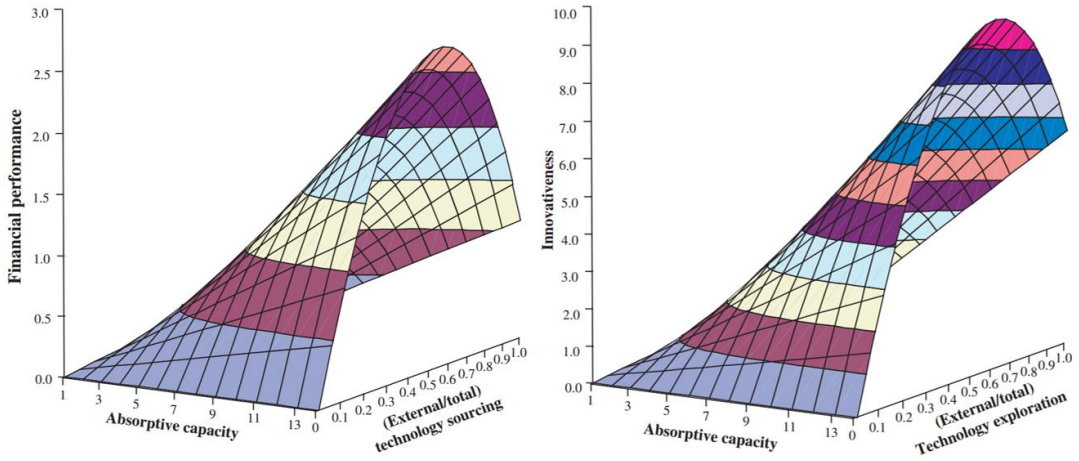

Figure 4. Moderating effect of absorptive capacity on relationship between technology sourcing mix and firm financial performance and innovativeness. Reprinted from "Ambidexterity in technology sourcing: The moderating role of absorptive capacity" F. T., & Alexandre, M. T. (2009). Organization science, 20*(4), 759-780.*

University Collaboration

Lee (2000) concluded from surveys that collaborations between universities and companies resulted in benefits related to access to new research and also product development. A majority of industry managers described these benefits as substantial or considerable (Lee, 2000). Howells et al. (2012) found that although many companies were hesitant of the benefit and suitability of university partnerships, it did in fact positively and significantly impact their innovative performance. The effect was reduced but still significant in partnerships with research institutions (Lee, 2000). Especially the development of product innovation showed strong benefits, while process innovations were less significant (Lee, 2000). Hanel and St-Pierre (2006) found that collaboration had a positive impact on the originality of innovations, as well as their perceived economic performance of a product.

Greitzer et al. (2010) found in their study that although 50% of collaborations between universities and companies resulted in major outcomes for the company such as new intellectual property of potential benefit or solutions to problems, a minority were further exploited and put to use by the company. In order to maximize the potential benefits derived from a university-company collaboration, Greitzer et al. (2010) proposed seven practices. The practices are not particularly complicated, but instead emphasize that the companies need to spend time and effort in continuously managing the long term relationship as well as clearly stating and explaining what the partners want to get out of the collaboration (Greitzer et al., 2010). Important is also that the collaborations make sense strategically and that the employees are made aware of what the collaboration aims to achieve (Greitzer et al., 2010).

2.5.3 Strategy and Leadership

Stringer (2000) describes that to stimulate radical innovation in large companies, it is important to make radical innovation a strategic and cultural priority. Managers can challenge the organization's efforts and set high targets. By highlighting the shortcomings in the number of radical innovations that are developed, a sense of urgency can be created amongst the employees to generate more exciting ideas.

O'Connor and Veryzer (2001) studied how companies link advanced technologies to market opportunities. By studying successful radical innovation projects, they identified several drivers that initiated and sustained visions that ultimately resulted in, or perpetuated, these projects: The first identified driver is that senior management can energize innovative activity by communicate the importance of innovation as a competitive tool (O'Connor & Veryzer, 2001). O'Connor and Veryzer's (2001) study revealed that the original opportunity recognizer did not see an application for his/hers division, but consciously knowing about the firm's innovation ambition, the scientist brought the opportunity to other R&D divisions where they seeded a radical innovation effort. Another example revealed that commercialization of several new product platforms came from a CEO's request to find businesses in the "white spaces between our existing lines of business". A final example shows that devoting corporate budget to high risk activities and issue a call for the 'next big thing' can also be sufficient.

According to O'Connor and Veryzer (2001), the second identified driver is the articulation of stretch goals, which enables senior management to shape directions of innovation efforts. Stretch goals can be seen as clearly articulated problems that needs to be solved, and are sometimes referred to as 'holy grails' (O'Connor and Veryzer, 2001). For example, expressions like "find the next solution to the problem of the mile-high building" and "find applications for broad-band" are typical examples of stretch goals (O'Connor and Veryzer, 2001). Furthermore, they argue that it is

not necessary to articulate stretch goals prior to anything else happen. In some cases, they follow discovery.

2.6 ACTIVITIES IN THE FRONT END OF INNOVATION

This section expands on the three activities discussed in the analytical framework: *opportunity identification*, *idea generation*, and *idea selection*. The study describes the respective activities, but acknowledges the occasional difficulties in separating them. In order to understand how activities in the front end are executed, existing theories and relevant examples are provided.

2.6.1 Opportunity identification - identifying new technologies and ideas

Opportunities can both be radical and incremental and can emerge in many ways, e.g. as a response to threat from competitors, breakthrough (technological) possibility (Klepper, 1996) to gain competitive advantage, etc. (Koen et al., 2001). Hence, opportunity identification is about defining market or technology arenas a company want to participate in (Koen et al, 2001). Lastly, there are lots of methods and techniques to identify opportunities and to mention all of them would be too exhaustive, thus only a few are presented. Despite what method a firm use, a wide network of customer interaction and collaborations with other companies and universities often improves this activity (Cooper and Edgett, 2008; Koen et al., 2001).

Trends and technology foresight

Identifying trends and threats in the external environment is a popular method of finding new potential products (Cooper & Edgett, 2008). Cooper and Edgett (2008) note that the process of identifying trends are mostly informal and unstructured and although a company could be aware of new trends, the challenge lies in using the information to create something substantial.

Furthermore, Phaal et al. (2004) claim that companies need to be aware of the impact of future technologies and markets in order to identify potential threats and opportunities, as well as the ability to ensure that the existing and future resources of the company reflect their present and future needs. Reger (2001) similarly describe the importance of anticipating future technological developments and its related opportunities and threats. He claims that the fast changing environment and shorter lifecycles of innovations, diffusion of new technologies from certain branches into other ones, and fusion of different technologies are just few reasons why following technical development is important. Reger (2001) names the process - to understand how technological threats and opportunities can be identified - as technology foresighting, but recognizes other common terms such as technology monitoring and technology scouting. There are plenty of methods regarding technology foresight - Porter et al. (2004) list over 50 different available methods - but Porter (2010) mentions how different types require different methods, and that they should be tailored to the specific objective of a company. Regardless of what a company wants to achieve by technology forecasting, Porter (2010) recommends a combination of both qualitative and quantitative approaches. Moreover, Reger (2001) identified the most commonly used information sources in technology foresighting:

Formal information sources	Informal information sources
• journals • reports • patents and licenses • venture capital or start-up market • internal and external databases • external consultants • statistics	• exhibitions • different experts • participations in R&D programs • cooperation with other institutes or universities • information from internal networks • personal contacts • customer surveys • job rotation • hiring the best people

Figure 5. Information sources in technology foresight. Adapted from "Technology foresight in companies: From an indicator to a network and process perspective," by G. Reger, 2001, Technology analysis & strategic management, 13(4), 533-553.

Opportunity identification revolves around understanding and anticipating the future (Koen et al., 2002; Phaal et al., 2004; Porter et al., 2004). Koen et al. (2002) claim that the most effective methods, tools, and techniques regarding opportunity identification are: technology and customer trend analysis, roadmapping, competitive intelligence analysis, market research, and scenario planning. Phaal et al. (2004) argue in favor for technology roadmapping techniques, claiming that these methods are flexible techniques that provide structured means (often graphical) for communicating and exploring the relationships of developing and evolving markets, technologies, and products over time. Technology roadmapping techniques are widely used by firms in terms of long-range and strategic planning and provide a focused scanning of the environment, and track the performance of technologies (Phaal et al., 2004). However, Phaal et al. (2004) claims that the many of the benefits of roadmapping lies in the actual process of constructing and tailoring the roadmap, where people from different divisions are brought together to share perspectives and information.

Finding radical opportunities

Cooper (2011) suggest that mature companies must look for bold innovations rather than innovations in existing scarce competitive markets. Similar to radical innovation, he defines bold innovation as "breakthrough products, services and solutions that create growth engines for the future". For example, he describes Apple's iPod as a bold innovation, where they identified an attractive strategic arena, i.e. the MP3 industry, and applied their capabilities to solve existing user problems, resulting in a plug-and-play MP3 ecosystem.

In order to identify bold innovation opportunities, Cooper (2011) suggest that firms must move away from existing arenas, e.g. mature technologies, flat markets, and tired product categories, and instead define new possible strategic arenas that offer more extensive growth possibilities. This is achieved by a two-pronged attack: *external analysis* and *core competency assessment* (Cooper, 2011). Initially, an analysis of external opportunities is necessary, meaning that firms must scan markets, sectors, and industries that might serve as a fertile ground for the company's innovation effort (Cooper, 2011). More specifically, these arenas should somewhat be adjacent to existing business(es), or at least be an area where the firm can leverage their existing competences to advantage. Secondly, the firm must assess their strengths in a solid core competency assessment in order to highlight unique leveragable capabilities (Cooper 2011). This two-pronged attack should result in a considerable list of strategic arenas on what to pursue and focus in terms of identifying opportunities. Cooper (2011) conclusively suggest that managers can rate arenas based upon two key dimensions/questions: "(1) *Can you leverage your core competencies, assets and strengths to advantage in*

this arena? (2) How great are the opportunities - market size and growth, technological possibilities and potential for profit?"

Furthermore, Laursen and Salter (2006) introduce two concepts to extend the conceptual understanding of innovative search process: *external search breadth* and *external search depth*, i.e. number of external search channels/sources and how deeply and extensive each channel is utilized. They found that external search depth is often related to radical innovation. In early fluxive product/technology lifecycles, also known as the era of ferment, it is necessary to draw deeply from a small number of key sources as only few have sufficient knowledge about the underlying technologies for further product evolution (Laursen & Salter, 2006).

Despite where and how deep one searches, Ardichvili et al. (2003) further argue that there lies a big importance in who scans the environment, both internally and externally. Based upon entrepreneurial theory, they suggest that some individuals are more sensitive to market needs or problems, and that the explanation lies in the heterogeneity of each individual. Similar to Cohen and Levinthal's (1990) theory of absorptive capacity, Ardichvili et al. (2003) also argue about the dependence on individual background and experience.

The third driver, according to O'Connor and Veryzer (2001), is that scientists' and researchers' understanding of business implications when technical possibilities appear. Hence, making sure that scientists is fully aware of commercial sense in discoveries and being able to articulate it to higher management is important, especially in terms of opportunities outside firm's current markets (O'Connor and Veryzer, 2001).

2.6.2 Idea generation

Idea generation is where an identified opportunity is developed into a concrete idea (Koen et al., 2001). This iterative process can send ideas back to just being opportunities as well as creating new ideas and opportunities (Koen et al., 2001). Idea generation can both be a formal and informal process, and can occur independently or in an evolutionary manner between several people (Koen et al., 2001). Previous research promote the generation of new ideas in formal brainstorming sessions in different compositions, such as in nominal, in team structures, as well as in hybrid structures (Diehl and Stroebe, 1987; Giotra et al., 2010; Paul & Yung, 2000). The uses of idea competitions or idea markets are also used to generate new ideas. Brainstorming sessions, workshops and idea competitions can all gain from including customers or lead users (Von Hippel, 1986; Piller & Walcher, 2006).

Brainstorming sessions and workshops

Brainstorming and workshops are well known concepts for gathering people to generate new ideas or solutions to problems. Many researchers have however demonstrated and criticized the lack of effectiveness of such brainstorming sessions (Bouchard & Hare, 1970; Diehl and Stroebe, 1987; Giotra et al., 2010; Paulus, 2000), and instead suggested nominal techniques or hybrid structures. Other researchers note that brainstorming can be effective under certain 'right' settings (Paulus & Yung, 2000).

Diehl and Stroebe (1987) demonstrate three factors which explain why brainstorming may not be as effective as generating ideas individually rather than in a group: free riding, production blocking, and evaluation apprehension. The first phenomenon described by Diehl and Stroebe (1987) is free riding, where a subject in a group 'free rides' on other group members' contributions. Diehl and Stroebe (1987) suggests that individuals will be less motivated to contribute to a group when it is harder to identify what any individual have contributed, and when the effort will be collectively

assessed. The second factor which negatively affects group brainstorming is evaluation apprehension (Diehl & Stroebe, 1987). The authors mean that the fear of negative evaluations from other group members will prevent the subjects to share the more original ideas (Diehl & Stroebe, 1987). The third factor suggested by Diehl and Stroebe (1987), production blocking, occurs when a subject in a group is unable to verbalize an idea when it occurs. This results in that the subject potentially forgets the idea or suppresses it, as it is perceived less relevant or original at a later time (Diehl and Stroebe, 1987). Furthermore Diehl and Stroebe (1987) suggest that other group members' ideas may distract and interfere with the subject's own ideas or suggestions. Production blocking was found by Diehl and Stroebe (1987) to be the largest contributor of production loss in brainstorming.

An alternative to conducting brainstorming sessions or group discussions is to let the participants generate ideas individually before engaging with each other, so called hybrid structures, which could combine the benefits of individual and group sessions effectively (Diehl and Stroebe, 1987; Girotra et al., 2010). Unlike previous research which has mostly focused on the number of ideas generated and their average quality, Girotra et al. (2010) also define performance to include the 'best ideas' generated. Girotra et al. (2010) suggest that companies would rather prefer to have many bad ideas and one outstanding idea, compared to many good ideas. Girotra et al. (2010) found that the 'best ideas' generated in hybrid structures were better than the 'best ideas' generated by the team. This was driven by the fact that the hybrid structures not only generated three times as many ideas per unit of time, but that the ideas were also of significantly higher value (Girotra et al., 2010).

Paulus and Yang (2000) however found in a study of 120 people that group sessions under certain 'right' conditions can in fact enhance performance of creativity and innovation relative to individual brainstorming in small groups. Positive results are achieved when the participants of diverse knowledge have time to direct their attention and process other ideas, as opposed to only focusing on generating ideas (Paulus, 2000; Paulus & Yang, 2000). When attention to other ideas is encouraged and motivated, the building on the ideas of others in interactive groups create more novel and feasible ideas (Kohn et al., 2011). The opportunity to reflect and add on other ideas after they were formulated by other individuals positively affected the outcome (Paulus & Yang, 2000). Another factor which improves the results of group sessions is the use of facilitators to manage the group interactions (Paulus, 2000). Paulus and Yang (2000) suggests that electronic brainstorming could achieve similar positive results, as long as the participants have the time to both contribute to other ideas as well as generating ideas individually.

Workshops and brainstorming are not limited to employees. Including customers and lead users in workshops and in brainstorming sessions can produce products that are truly novel and valuable to a future market (Von Hippel, 1986; Hienerth et al., 2007; Cooper and Edgett, 2008). Hienerth et al. (2007) suggest that the most radical ideas come from workshops with lead users with actual user experience. Workshops and brainstorming sessions with users is also perceived by executives to be highly effective in generating new ideas (Cooper and Edgett, 2008). To identify what customers do not remember or find significant to articulate themselves, a company can use the highly effective ethnographic research, where customers are observed for extended periods of time (Koen et al., 2002; Cooper & Edgett, 2008).

Idea competition

Soukhoroukova et al. (2007) presents three factors from previous research that affects the average quality of new product ideas; "(1) a large number of product ideas and idea creators, (2) group decisions instead of individual decisions, and (3) methods that combine the creation of ideas with

their evaluation". Piller and Walcher (2006) suggests that companies should use the knowledge of their customers in idea competitions. Idea competitions invites a targeted group to submit contributions on a specific topic within a certain timeframe (Ebner et al., 2009). By making a topic more or less specific, or demand different grades of elaboration, the type of submissions can be controlled (Piller & Walcher, 2006). In a study investigating idea competitions with users by Ebner et al. (2009), they found that it is important to have a wide enough topic to generate discussion and a mixture of extrinsic and intrinsic motivations to motivate participation. The effectiveness of idea competitions with a large quantity of external participants is questioned by Cooper and Edgett (2008), who speculates whether it is only effective for technologically simple products.

Most commonly, researchers investigate idea competitions on the basis of integrating and generating ideas from customers or preferably lead users. An alternative focus would simply be to arrange idea competitions internally, to tap and generate ideas from the employees. For internal idea competitions to become successful they need to be properly constructed and managed with clear directions (Cooper and Edgett, 2008).

2.6.3 Idea selection

In order to succeed with innovation, efficient idea generation and the availability of ideas are necessary, but can be insufficient without an effective idea selection (Nijstad & De Dreu, 2002). It is necessary, or even crucial, to master the ability to pick out the best ideas from a pool of different options (Faure, 2004; Rietzschel et al., 2010) as it will affect the future health of the business (Koen et al., 2002). However, it is proven that idea generators in general perform poorly in terms of creative idea selection (Rietzschel et al., 2010); Faure, 2004).

Furthermore, Koen et al. (2002) claim that no single procedure guarantees good idea selection. Many companies use formal portfolio management methods while others leave it up to individual choices of self-generated ideas. In terms of front end of radical product innovation, the former method can be difficult due to lack of information and understanding about the ideas (Koen et al., 2001). Koen et al. (2002) further explain that idea selection is an iterative activity including multiple passes through idea generation and opportunity identification.

Nominal versus group idea selection

Idea quality can be interpreted in many different ways. One common way is to judge an idea by its originality (new or unusual) and feasibility (usefulness) (Rietzschel et al., 2010). Another way of analyzing idea quality is to judge it by its frequency of all ideas generated (Putman & Paulus, 2009). Nevertheless, Putman & Paulus (2009) did a study with 120 participants with the aim to analyze brainstorming activities and the selection of ideas. Their study showed that nominal groups, compared to brainstorming groups, on average selected ideas with a higher degree of originality. However, both groups rarely picked out the best idea when analyzed by independent raters. Faure (2004) did a similar study where she concluded that there is no distinction between interactive and nominal groups in terms of quality of the selected ideas, and that the best ideas were seldom selected.

Rietzschel et al. (2010) further studied possible explanations of poor performance in idea selection. Based on the study's result, dual nature of idea selection affect the outcome. Hence, when participants were told to select the 'best idea', it often yielded in more feasible ideas. On the contrary, when other participants was prompted to select the most 'creative ideas', they were more motivated to choose ideas based upon originality. Rietzschel et al. (2010) discuss that originality is not something people think of spontaneously as they intuitively think about if ideas can or should be adopted. Conclusively, they discuss that poor selection performance can be explained by people

selecting ideas on the belief of adoption, i.e. people have a stronger preference for selecting ideas that should or could be adopted. Finally, Rietzschel et al. (2010) stress the importance of clear selection criteria and that it is needed to be most beneficial in creative idea selection.

Methods for decision making at the front end of product innovation

The initial phase of idea selection if often an individual judgement, based on a gut-feeling (Koen et al., 2002). Although no single most effective idea selection procedure exists, it is still necessary to have some formal decision process, and give feedback to any person who submits an idea (Koen et al., 2002). A lack of visibility and follow-up results in low incentives for people to submit more ideas, and ideas might disappear (Koen et al., 2002). However, they suggest that formal processes only work if there is a process owner supervising the process and if there are visible support from management. Furthermore, Koen et al. (2002) claim there are no right idea selection for highly novel projects (yet), but Portfolio methodologies can to some extent be useful.

R&D Portfolio management

When ideas are identified and projects are briefly initiated, firms can find themselves in crossroads on what to pursue or proceed with. As R&D projects contain many risks due to uncertainties and high stakes, portfolio management is vital for successful product innovation (Cooper et al., 1999; Stummer & Heidenberger, 2003). Cooper et al.'s (1999) define portfolio management as "a dynamic decision process, whereby a business's list of active new product (and R&D) projects is constantly updated and revised. In this process, new projects are evaluated, selected, and prioritized; existing projects may be accelerated, killed, or deprioritized; and resources are allocated and reallocated to the active projects." Cooper et al. (2001) also presented eight key reasons cited by senior management why Portfolio management is critical; it help firms to maximize return, maintain competitive position, forge a link between business strategy and project selection, achieve focus, achieve balance, prioritize, and provide better objectivity in project selection.

Cooper et al. (1999) did an extensive research about how 205 U.S. based companies managed their portfolios in terms of both practices and performance. Their study showed that firms often combine different portfolio management methods or techniques, where some are more popular than others. They rank the most recognized methods by popularity as follows:

Method	**% of firms**	**Brief description of method**
Financial methods	77,3%	Projects are determined and ranked by their profitability, i.e. NPV, Payback period, IRR, etc.
Business strategy methods	64,8%	Allocation of funds among projects is based on the business' strategy. Business strategy determines how funding is split into categories, e.g. markets, product lines, or type of projects
Bubble diagrams	40,6%	Projects are plotted into an X-Y-diagram (where X- and Y-axis depend on interest, e.g. probability of success)

Scoring models	37,9%	Projects are rated based on a number of criteria which in turn yields a project score. Prioritization is based upon highest score.
Checklists	20,9%	Project evaluation is based on yes or no questions where each project must exceed a certain number of yes to be continued.

Table 1. Most recognized and popular methods of R&D Portfolio Management. Adapted from "Generating breakthrough new product ideas: Feeding the innovation funnel," By Cooper, R. G., & Edgett, S. J. (2009), Product Development Institute.

Despite their popularity, financial methods do not yield the best portfolio performance (Cooper et al., 1999), and are unsuitable for novel projects (Koen at al., 2002). Cooper et al. (1999) argue that financial models in isolation produce portfolios containing too many projects in relation to firm's existing resources, low-value projects, and gridlock in the pipeline. Instead, they argue in favor for strategic approaches which tend to produce better portfolios as they have various performance metrics.

In a more detailed study, Cooper et al. (2001) show why the best portfolios outperformed the rest: Initially, the outperformers' portfolios are highly aligned with their strategy. Their portfolios also contain very high value projects, meaning that they are good in selecting ideas. Cooper et al. (2001) continue by arguing that outperforming companies has an R&D spending which reflects the firm's strategy and that their projects are finalized on time. Finally, outperformers' portfolios contain both the right number of projects in relation to resources and a good balance of projects, i.e. long-term and short-term, high risk and low risk, etc.

Conclusively, Cooper et al. (2001) argues that companies that show proficiency in portfolio management hold four common denominators: Firstly, these kinds of companies and managers take portfolio management seriously and see it as very important. Secondly, they have an explicit and formal method for portfolio management, i.e. it is well-defined with clear rules and procedures, consistently used to all projects within the firm. Thirdly, in contrast to the worst portfolio managers, the proficient companies tend to rely much less on financial metrics and instead lean toward allocation based on business strategy. Finally, their portfolio tends to be even greater than average in terms of multiple portfolio methods, meaning that these firms acknowledge that no one method yields a perfect result. In Cooper et al.'s (2001) study, it is revealed that the proficient portfolio management firms on average use 2.43 different techniques, compared to 1.83 of the inferior performers.

Innovation Portfolio

Nagji and Tuff (2012) found that strong innovation track record and outperformance are accomplished by having an articulated and clear innovation ambition; having the right balance of core, adjacent, and transformational initiatives across the firm; and managing various initiatives with tools and capabilities. They further present an own-developed tool called Innovation Ambition Matrix, which present three distinctively innovation ambitions, see figure 6.

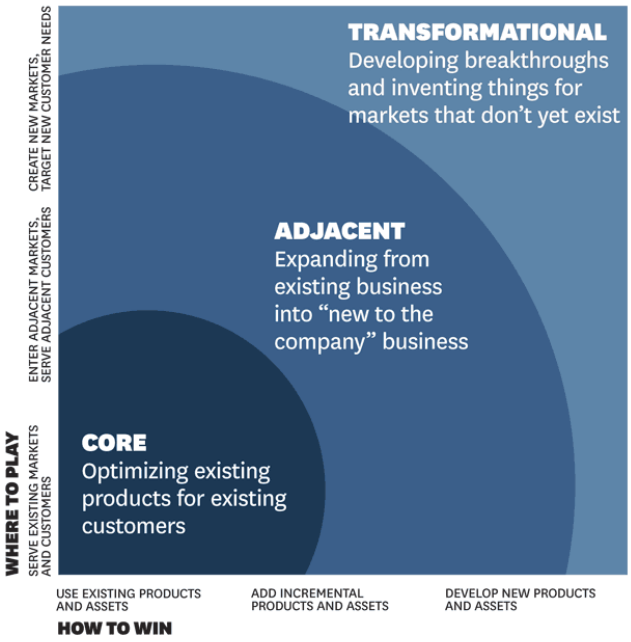

Figure 6. Innovation Ambition Matrix. Reprinted from "Managing your innovation portfolio," By Nagji, B., & Tuff, G. (2012), Harvard Business Review, 90(5), 66-74.

Briefly explained, the 'core' area can be identified as the incremental zone whereas efforts are characterized by incremental changes/improvements to existing products and/or incremental steps into new markets (Nagji & Tuff, 2012). The 'adjacent' area, on the other hand, contains innovations that involve leveraging existing resources and capabilities into new spaces and uses. The requirements of adjacent innovation is to gain fresh insights into customer needs, market structure, demand and technology trends, competitive dynamics, etc. Lastly, the 'transformational' area represents new offers or even whole new businesses. These are innovation that makes the headlines such as breakthroughs, e.g. iTunes, Starbucks in-store experience, etc. (Nagji & Tuff, 2012). Conclusively, in order to excel in what Nagji & Tuff (2012) call "total innovation management", firms must simultaneously invest in all three areas and manage the balance between them. They further stress that the Innovation Ambition Matrix's power lies in the exercises it facilitates and that it offers no inherent prescription. Hence, this tool gives managers the possibility to surveillance existing projects and the quantity of each ambition, as well as a way to discuss overall ambition of the firm's innovation strategy (Nagji & Tuff, 2012).

Nagji & Tuff (2012) further discuss the perfect balance between the different ambitions by providing examples from the industrial, technology, and consumer goods sectors. They found that industrial companies that balanced 70% 'core', 20% 'adjacent', and 10% 'transformational' tended to outperform their peers in terms of Price/Earnings-premium. They further claims that this correlation can be a good starting point to discussions rather than a rule of thumb.

3 METHOD

This section presents how the study was conducted, including how the data collection was performed. Moreover, the method is criticized and pros and cons are discussed.

3.1 RESEARCH APPROACH

Initially, the working procedure consisted of gaining knowledge regarding the subject by reading articles and discussing with supervisors. The gained knowledge acted as a foundation for the interviews and more thorough data search. The interviews were conducted sporadically during the spring semester. Initially, more general interviews with BillerudKorsnäs were conducted to gain knowledge about front end activities and perceived difficulties. This knowledge, combined with relevant literature, facilitated an interview guide for the other conducted interviews.

The formulation of the research topic was initiated together with BillerudKorsnäs. The study was born from a wish of the Chief Technology Officer (CTO), and the supervisor of this project, at BillerudKorsnäs to understand different front end activities to achieve radical innovation at other companies. The study was determined to examine the front end of innovation of similar companies in terms of industry and maturity to BillerudKorsnäs, as well as to explore theory on existing methods and tools. The study could therefore be described as a descriptive study (Saunders, 2011). Together with BillerudKorsnäs, some general interesting areas in the front end of innovation were scoped which would be further explored.

Three external companies were interviewed throughout the study. The supervisor at BillerudKorsnäs requested that two of these, ABB Corporate Research and Sandvik Coromant, were interviewed. Before the initiation of the study, the supervisor at BillerudKorsnäs had identified these companies as interesting to learn more from, due to the fact that these were perceived to be successful innovators in B2B industries. The third company that was interviewed, Bombardier RCS, was suggested by one of the authors to the supervisor at BillerudKorsnäs, who approved. These three external companies constituted the external empirical observations of the study. Together with the supervisor of BillerudKorsnäs, data from these three companies were deemed to sufficient to answer the purpose of the study, namely to provide insight into different approaches to the front end of innovation.

As it is important in a descriptive study to clearly understand the phenomena before collection of data (Saunders, 2011), appropriate theory was reviewed. The theoretic search increased the understanding of what constituted the front end of innovation, including activities and factors which facilitate them. An analytical framework, based on the previous theory and articles within the academic fields of radical innovation, innovation management, 'fuzzy front end', and the front end of innovation, was created to analyze the front end of (radical) product innovation in the observed companies. The model was used both to scope appropriate fields of study as well as a theoretical lens in the discussion. However, in order to make the framework comprehensive, some theories was excluded based on their perceived relevance to the purpose. The approach could be described as deductive as theory was developed prior to the data collection (Saunders, 2011). However, no specific theory was to be observed or tested, but mainly an analytical framework which guided the exploration of areas.

Activities and facilitating factors described by previous research are many, thus a focus on certain activities or facilitating factors that were most relevant for BillerudKorsnäs was necessary. Initial interviews with BillerudKorsnäs influenced and changed the analytical framework used to

understand and analyses other companies and their processes. This process could instead be described as inductive, where empirical findings guided the development of an analytical framework. As activities became more clear and structures more obvious in the collection of data from external companies, the theoretical and analytical framework was further changed. Dubois and Gadde (2002) describe abductive studies, where a framework is modified throughout the duration of a study, as a result from empirical findings and theoretical insights. The abductive framework therefore works as a combination between inductive and a deductive approach, and was used in this study.

3.2 RESEARCH METHOD AND DATA COLLECTION

There are both quantitative and qualitative methods to collect information, where quantitative methods emphasize information based in numbers, and qualitative methods based in words (Saunders, 2011). Qualitative methods are used when there is need for wider reasoning or to analyses phenomena that are difficult to quantify (Grix, 2010). Qualitative methods include such as interviews and literature studies (Grix, 2010).

The lack of extensive and accessible information regarding the front end of innovation in the concerned companies of this study prompted the use of interviews. Notably, the information gathering from the companies relies to some extent on the interviewees' memory, and personal perception in certain areas, which can impair the information objectiveness. However, due to the inability to quantitatively measure the innovative effectiveness of a process or tool in the front end of innovation, the subjective opinions and perceptions were valuable for the study. The purpose of the study is not only to understand general processes, but also its perceived effectiveness. As the use of interviews have been necessary to access the relevant information, the method is appropriate for the purpose of the study.

3.2.1 Sampling

This study has used a combination between convenience sampling and judgement sampling. *Convenience sampling* is the selection of the most accessible subjects, and the least costly in terms of time and money for the researcher (Marshall, 1996). Marshall (1996) however warn that convenience sampling might lead to a poor quality of data and a lack of credibility. The second approach is *judgement sample*, where the sample is selected based on what the researcher finds to be the most productive to answer the research question (Marshall, 1996). The judgement by the authors and choice of the sample is determined by "the researcher's practical knowledge of the area, the available literature, and evidence from the study itself" (Marshall, 1996). Most of the interviewees were early identified by the corporate contact at BillerudKorsnäs, as he had a great interest in their companies' processes and front end activities. The external companies are focused on business to business in mature industries and have historically been successful innovators. As the selection of interview subjects were accessible and not costly in times of resources for the authors, the sample could be viewed as a convenience sample. However, as those people were the most productive and suitable to answer the research questions, they were also sampled based on a judgement by both the authors and the corporate contact at BillerudKorsnäs. The supervisor at BillerudKorsnäs was well connected with the external companies which enabled access to executives and managers with broad knowledge in the research areas. Contact with the some of the interview subjects was initiated by the supervisor at BillerudKorsnäs and continued by the authors. Potential interview subjects were asked by the authors whether they wanted to participate. Some did, and others suggested other people with knowledge that could be interested, so called *snowball sampling*. Apart from contacts initiated by the corporate contact at BillerudKorsnäs, the study

interviewed another company. The interviewee was chosen on the basis of accessibility and suitability, as one of the authors had previously worked at the same company which faced relatable challenges as BillerudKorsnäs.

The following people were interviewed in this study:

BillerudKorsnäs:

- Chief Executive Officer (CEO) - CEO of BillerudKorsnäs since merger between Billerud AB and Korsnäs AB, 2012. Previously CEO of Billerud AB.
- Chief Technology Officer (CTO) - Previously R&D Director at Korsnäs AB
- R&D Manager - 6 years of experience within BillerudKorsnäs. Former role as Manager Process Technology. R&D Manager since 2 years
- R&D Project Leader - 2 years of experience. Recently promoted to R&D Manager Fiber Materials.
- Director of BK Venture – 8 years of experience at BillerudKorsnäs. Previously Project manager.

Sandvik Coromant:

- Director R&D Technology Platforms - 19 years of experience in Sandvik. Has worked with R&D, engineering development, product manager and development. Director since 8 years
- Principal R&D Expert - 30 years of experience in Sandvik. Former roles as R&D Manager, Business Development Manager, General Manager.

Bombardier RCS:

- Head of Innovation and Knowledge Management - Worked at Bombardier RCS for 16 years. Previously Head of New Solutions.

ABB Corporate Research:

- R&D Manager - Worked at ABB since 1998. Head of Corporate Research in Sweden since 2014.

3.2.2 Interview method

Grix (2010) describes three types of interviews: structured, semi-structured and unstructured. A structured interview is the least flexible, where questions set beforehand are asked in a predetermined manner (Grix, 2010). With a high degree of standardization, the process allows for comparison of responses from a number of different interviewees. A structured interview is however less suitable to handle the discovery of the unexpected (Grix, 2010). A more flexible alternative to the structured interview is the semi-structured interview approach. Here, the interviewer has questions in mind, but allows for a more flexible flow, without a specific order between the questions. This type of interview is more capable of handling the unexpected, and allow for detours from the predetermined questions (Grix, 2010). The interview is however structured to such degree that comparing answers is possible. The third approach, the unstructured interview, lacks a predetermined list of questions, and instead base the questions on loose concepts discussed during the interview (Grix, 2010).

The purpose of the interviews in this study was to understand the front end activities of radical product innovation in different companies and how they go about structuring them. It was therefore important to be able to relate and compare methods and approaches between the companies. It was also important to identify whether a company did something radically different than other companies or from previous theory. The interviews conducted in this study therefore had a semi-structured approach to facilitate the comparison between different companies, while allowing for a flow of unexpected information, not identified beforehand. Collectively, eight interviews were conducted at four different companies, each interview averaging a length of 1.5 hours with follow up questions over e-mail. Four interviews were conducted at BillerudKorsnäs, two at Sandvik Coromant, and one at Bombardier RCS and ABB respectively.

The questions examined a mix between both concrete and abstract concepts and methods. In order to identify what a specific company did differently than others, broad questions were asked and time was given for interviewees to uninterrupted illustrate concepts or tools. In order to avoid contamination by the interviewers, questions exploring reasoning behind choices were asked as open ended questions, focusing on asking the interviewees 'why'. Concepts or phenomena that were identified in theory or from the interviews were added to the questions for subsequent interviews. The list of questions was therefore a living document where concepts and tools were added, abandoned, or expanded on. Also, depending on the title and background of the interviewees, questions were focused on areas in which the interviewee was believed to have relevant knowledge. Recording of interviews were used whenever permission was given. This allowed for full divided attention to understanding answers and follow-up-questions as well as minimizing misunderstandings or misinterpretations.

3.3 RESEARCH QUALITY

The quality of qualitative research is much harder to assess compared to quantitative research (Tracy, 2010). As qualitative data are mainly gathered by interviews and publications, it is often based on the subjective interpretation of the source, and an absolute truth is never the case (Bryman & Bell, 2003). Hence, reliability and validity of a qualitative study is much harder to assess (Saunders et al., 2012).

As this study is based on a company specific topic, it is not generalizable by definition (Bryman & Bell, 2003). However, the provided examples of how mature firms can work with front end activities of radical product innovation can aid other mature firms. This study has mainly collected data and information by literature review regarding radical innovation, innovation management, 'fuzzy front end', and the front end of innovation, as well as data from semi-structured interviews. As a substantial part of this thesis is based on previous literature, it can to a large extent be generalizable. Also, as the provided examples of mature firms aids to understand how rather than what to do, the applicability is to some extent generalizable to mature firms. Hence, this master's thesis attains a high external validity/transferability (Bryman & Bell, 2003; Saunders et al., 2012)

Furthermore, this master's thesis has used respondent validation. After the interviews were conducted and translated into text, the respondent got the opportunity to control the processed version of the interview. Respondent validation gives a second opinion and judgement of the interpreted data collection, and thus gives an improved representation of the reality and increases the credibility (Saunders et al., 2012). Also, triangulation has been used in the literature review and to some extent in the interviews, i.e. several sources has been assessed for better understanding and to increase reliability. The usage of respondent validation and triangulation indicates a high internal validity/credibility (Bryman & Bell, 2003; Saunders et al., 2012).

Moreover, as the purpose have been reached with an analytical framework, semi-structured interviews with an interview guide, and a description of the research approach, using the same method would likely yield the same result, under the condition that the same firms were observed. Even though the authors was inexperienced within the field of front end of innovation, having the same prerequisites, i.e. five years academic experience of engineering and TME studies, are perceived to be sufficient. Also, the descriptive nature of this master's thesis lowers the complexity. In addition, the process of this study has to some extent been documented and some interviews have been recorded, which increases the reliability (Bryman & Bell, 2003). However, there is a possibility that the semi-structured nature of the interviews can follow different pathways resulting in slightly different result. Hence the dependability of the study is perceived to be moderate (Bryman & Bell, 2003; Saunders et al., 2012).

However, even though this study is argued to hold a sufficient research quality, it is important acknowledge that it is impossible to describe social phenomena as an absolute truth. Many scholars have different views on what criteria to use. Bryman and Bell (2003) argue that research quality can be assessed by its trustworthiness and authenticity. Trustworthiness can be assessed by examine the credibility, transferability, dependability, and the conformability (act in good faith). Authenticity is related to the political impact of research. Nevertheless, other scholars argue about other criteria such as worthy topic, rich rigor, sincerity, references, significant contribution, ethical, and meaningful coherence (Tracy, 2010). This report attains a high classification on most criteria, resulting in a high research quality.

3.4 METHOD CRITIQUE

Questions could be raised whether the sample size was sufficient to get a comprehensive and adequate understanding of the front end of innovation in the different companies. At ABB Corporate Research and Bombardier RCS, only one interview was conducted, and so naturally the understanding of the front end of innovation at those firms is less comprehensive than at BillerudKorsnäs where four interviews were conducted. The purpose of the interviews with ABB Corporate Research, Sandvik Coromant and Bombardier RCS, was mainly to identify and provide insight into alternative methods and organizational structures in the front end of innovation. The processes and methods discussed were concrete, and not subject to much personal interpretation. As the interviewees at those companies had extensive knowledge within the covered topics, a sufficiently comprehensive understanding of the front end of innovation could be built, despite the limited number of interviews.

4 EMPIRICAL OBSERVATIONS

The empirical observations are divided into two parts, where the first part describe the front end activities and its facilitating factors at BillerudKorsnäs, and the second part similarly describe the three external companies, ABB Corporate Research, Sandvik Coromant, and Bombardier Transportation Rail Control Solutions (Bombardier RCS). The structure of the empirical observations follow the analytical framework, and include the front end activities as well as the factors which facilitate them. The three external companies provide an external outlook from which examples can be drawn regarding alternative approaches and methods in the front end activities. Important to note is that the methods, activities, structures etc. presented in the following section is not exhaustive for each company, as the conducted interviews cannot capture all relevant information. Instead, the information presented can be viewed as an excerpt of the actual reality. Furthermore, due to the fewer number of interviews with the external companies, not all areas of the analytical framework were discussed with them.

The purpose of the empirical observations is to understand how the companies work in the front end of innovation to enable the development of radical innovation. Notably however, is that in most of the described activities, the interviewed companies do not separate between incremental and radical ambitions. The explanation for this is quite obvious however. As a company identifies an opportunity in an existing, or adjacent, market, it is not at all obvious at the start whether the innovation that fills the identified market gap will be radical or not. Importantly is however to see the opportunity at all, to enable for any radical innovations.

4.1 PART 1 - BILLERUDKORSNÄS

In this chapter, BillerudKorsnäs is described from the basis of the analytical framework. An understanding of the existing and planned processes and structures in the front end facilitate the understanding of the external companies. It is furthermore important to understand the conditions at BillerudKorsnäs in order to discern the applicability of methods and structures from the external companies.

BillerudKorsnäs is a company with a focus on pulp and board material for packaging, with approximately 4000 employees. In 2012, Billerud merged with Korsnäs to form what is today known as BillerudKorsnäs. As a part of the new strategy for the combined organization, BillerudKorsnäs made innovation a main pillar in accomplishing their mission and vision to "challenge conventional packaging for a sustainable future". BillerudKorsnäs has set ambitious goals in order to trigger radical product innovation. This has resulted in more long-term innovative planning and a restructuring of the R&D organization. It is believed that by setting high targets for which a solution is not obvious, the company can become more innovative. The projects have a long-term horizon, and it is up to the R&D organization to get them there, either through internal or external projects. The long-term goals have been broken down into smaller and smaller segments, where they can attempt to solve the identified problems.

4.1.1 Facilitating factors

The following section describes how BillerudKorsnäs has organized the innovative work regarding product and radical product development. Firstly, the structure is presented, followed by responsibilities, collaborations, and lastly how BillerudKorsnäs tries to stimulate the innovative work. The aim is to get an understanding of current struggles and possible areas of improvement.

Organizing for innovation

The CTO is responsible for strategy development involving three areas all related to innovation; Investment Management (IM), New Business Lab (NBL), and R&D. The IM department is responsible for assessing larger investments within the organization, i.e. both in terms of cost and strategic implications.

NBL is currently in the transition of becoming an internal venture division (BK Venture). Initially, the NBL department was the result of an ambition from the board of directors to become more innovative. NBL was given a high degree of freedom to explore radical ideas simultaneously as they would facilitate product innovation, business model innovation, and service and logistic innovation. In addition, NBL were to get the whole organization to think more innovatively. However, as NBL failed to live up to expectations, focus have changed and BK Venture has emerged. The idea with BK Venture is still to explore and find radical ideas, but also facilitate possible acquisitions that will benefit technology development. They will be given their own budget, and thus work with direct investments as venture managers and analysts.

The R&D department is scattered over their four biggest factories in Sweden. According to the R&D Director, the reason for the decentralized structure is to be close to the various production sites where testing can be effectively executed. Hence, they work close to the processes, production, and local sales departments as they claim that iterative work is necessary in developing projects. Each project consist of a project leader and team members with different backgrounds. As facilities produce different products, relevant competencies are located at their respective factory, but they still exchange information with each other when needed. The project team members' competencies range from developing engineers, lab engineers, and specialists.

As mentioned, BillerudKorsnäs is in the process of reorganizing their R&D department. One of many ambitions is to employ more people, including some specialists, to work with early development of what they call Greener Material Technologies (GMT). These GMTs was derived through an analysis of all current developing projects combined with what BillerudKorsnäs, together with industry experts and consultants, believe will constitute the future of the packaging industry. The GMTs can be identified as technology platforms and consist of seven dependent and independent technologies which BillerudKorsnäs have decided to combine into two technology excellence centers. According to the R&D director, the consensus behind the grouping is that they somewhat relate and that some of the testing of each area can be run in the same facilities.

The technology excellence centers' main responsibility will be trying to answer how BillerudKorsnäs can work with new technology within the GMT areas. Technology excellence centers will exist of knowledge building projects within very early development or technologies with a low Technology Readiness Level (TRL). The purpose of these projects is to create a knowledge base for different needs within the organization. They will have a high degree of freedom to explore and initiate internal and external research projects within these GMTs, and setting up clear ambitious goals. When technologies are sufficiently developed and ready for commercialization or found its application in existing offerings, they enter product roadmaps and product development teams and thus more formal product development. Regarding monetary aspects, it is not in the responsibility of the technology excellence centers, instead they will focus on technical development and performance. The long-term goal is to successfully integrate the GMTs within 10 years. During this period, it is thought to build a knowledge base and hopefully have spillovers that will run into developing projects along the way.

External collaborations and filling the knowledge gaps

BillerudKorsnäs' radical ideas and concepts are most often researched within clusters, in collaboration with universities and institutes as well as with their suppliers. This is because they have access to more advanced testing equipment and precise instruments and access to a more extensive contact network. BillerudKorsnäs and its previously separate entities Billerud and Korsnäs have a long history of collaborations with universities and other institutes. The Royal Institute of Technology (KTH), which has been a leading tree-research-institute has been an important partner. Another example is BASF, a leading chemical manufacturing corporation and supplier to BillerudKorsnäs, have a relatively much larger R&D function and knowledge within chemicals, which can produce radical effects for BillerudKorsnäs' products.

When BillerudKorsnäs has identified an interesting area of knowledge, there are many ways they have used in order to increase their own knowledge and capabilities in that domain. They have hired people with specialized knowledge, bought licenses or patents as well as buying a company. How they continue to develop the knowledge domain after an established interest is highly dependent on how BillerudKorsnäs first came about the knowledge or project itself, according to an R&D project leader. If a collaboration with a university has resulted in an exciting technology, it is likely that BillerudKorsnäs will continue to expand in the knowledge area through continued collaboration with the university.

Universities and institutes approach BillerudKorsnäs with suggestions of research collaborations that could be of interest for both parties. The R&D Project Leader note that external researchers often lack the ability to link potential benefits to the market, which remain BillerudKorsnäs' responsibility. Due to Swedish legislation, the Swedish government will provide grants or give subsidies which will lower the cost for BillerudKorsnäs to participate in these types of collaborations. This lowers the threshold to research more 'out there' or early TRL technologies, although it is often not money but time and staff that is the bottleneck. There is not much competition between BillerudKorsnäs and its competitors to participate in university collaborations, as all companies interested in a particular area of research are allowed to participate.

Stimulating innovation

According to the CEO of BillerudKorsnäs, it is highly important to communicate innovation. He explains that vision and mission statement combined with the overall strategy is a good communication tool. Having a pillar that points at innovation as one of the most import part of the overall strategy makes it clear that innovation is important for BillerudKorsnäs. He further explains that he strives to affect the innovative culture by talking a lot about innovation, show interest, and brace people not to lose 'the spark'. He visits production plants, makes sure that resources are given when needed, and he communicates that he want new ideas and that BillerudKorsnäs must constantly challenge their way of doing business. He also states that he ultimately want to use innovation to move away from being identified as fiber company, to become a material company. He believes that differentiation through innovation is preferable over cost leadership, or as he refers to it; "the curse of the mature industry".

The CEO of BillerudKorsnäs further argues the importance of people. In order to initiate innovative work, he argues that it is better to start with "this is what we want to do" rather "we can do this". The R&D Director of BillerudKorsnäs further fills in that the CEO truly believes in his people as he gives them a lot of responsibility and that he even used to present BillerudKorsnäs' organization scheme inversely, with him in the bottom and the organization above him.

4.1.2 Activities

The following section describes how BillerudKorsnäs find, generate, and select ideas. The aim is to get an understanding of current struggles and possible areas of improvement.

Opportunity identification

One of the main function of the business teams is to oversee the product portfolio, i.e. what products they offer today and what products they want to sell in the future (within two and five years). This analysis is then translated into a map which ought to communicate current situation and what products and needs there are/might be in the future. Customer needs are identified by the market and could for example be a more stiff and robust material. Also, needs emerge from trends, e.g. environmental, and competitors, i.e. if a competitor develops a product that is better than BillerudKorsnäs', then a need for improvement arise.

BillerudKorsnäs rely to some extent on their employees to find opportunities. Someone might have overheard something at a conference, or learnt something from a presentation. Someone else identified something new a competitor has done and has attempted to understand how. To search for new technologies and share ideas is however not formalized, but remains up to the interest and curiosity of the individual. BillerudKorsnäs also have organized patent and benchmarking studies.

The employees have the freedom to spend time to search for interesting ideas, but the R&D project leader stress the fact that not all can indulge in free work, and that working according to structure is imperative. His suggestion would be to work on the basis of 80/20, where 80 percent of the work should follow in a structured manner and 20 per cent would be spent exploring passion projects or similar activities.

Generating ideas

According to an R&D project leader, in product meetings and in general discussions, many diverse ideas are brought forward from team members. To share ideas is encouraged, and the ideas come from many different sources. The skill to 'sell' ideas internally is important according to the R&D project leader, and a lack of such skills requires the idea generator to find someone to help them sell it. Herein lies the importance of attentive managers to catch ideas that is generated throughout the organization. An important factor in the willingness of employees to share ideas is the responsiveness to ideas.

The sharing of ideas and thoughts between the R&D functions at different plants is not structured. Instead they rely on informal exchanges in addition to inviting people of requested expertise in certain meetings. According to the R&D Director, this creates a dependence on senior managers and spider in the web personalities, especially perhaps in the R&D functions, to understand and connect the dots between different knowledge bases and competences in the company. This is facilitated by programs with information about R&D employees' capabilities across the company.

The R&D project leader describes how the company has attempted to organize idea generating workshops. He recognizes the potential benefit and purpose of these workshops, but criticizes the way they have been conducted. He describes how the resulting ideas are often similar in terms of character, cool and 'far out there' but not necessarily suitable for the company or feasible. The problem, he identifies, is that the participants lack a solid foundation or connection to the problem and related technologies and processes. A lack of structure and a 'start from blank' method affects the resulting ideas negatively. By including participants with a clear connection to a clearer problem or product idea would generate better ideas, according to the R&D project leader.

BillerudKorsnäs has also experimented with IT programs to facilitate idea sharing and idea generation, which, according to the R&D project manager, only reached little success. The R&D project manager mentions three factors which can explain the limited impact. Firstly, the participants were encouraged to provide feedback and ideas in specific campaigns in which the R&D project leader felt he had little expertise, and he did not have the ability to start his own campaigns. Secondly, the R&D project manager stated that there was a lack of pressure from higher management to commit and use the program, although some notifications encouraged people to contribute. Thirdly, the R&D project manager suggested that the relative small R&D organization meant that a large share of the employees needed to participate actively in order to get a significant amount of responses.

The Director of BK Venture further describes how the company found more 'far out' ideas by combining experience and external help. He says that as ideas generated within the organization are rarely radical, the task was submitted to the board of directors to find the next 'big things'. They proceeded by narrow the search to packaging and then generated ideas both internally and with the help of methods conducted by consultants. From this process, they concluded in three radical ideas/phenomenon that they are going to pursue, which in turn hopefully will spillover ideas into side projects. The CEO roughly states that; if you aim to reach Mars, and do not reach your target, you may reach the moon and hopefully learn many things on the way. These projects are called 'moonshot projects'.

Idea Selection

The manager of the technology excellence centers will have full responsibility on what to explore as long as it fulfills the long-term goals, which in turn will be monitored by the R&D Director. The R&D Director stresses the importance of freedom with responsibility in order to be innovative. Though, at the moment, they do not have a specific procedure on what criteria to divest current research and start new ones, and whom to take the decisions. The R&D Director points out that this is one of the biggest problem of today, i.e. "dare to kill your darlings (projects), or someone else's darlings".

The planned scenario is to have the R&D management team extract the most interesting projects. The level of interest will be determined by projects' strategic relevance to the business units, e.g. one unit focus on growth while another focus on more offerings. But of course, the R&D Director stresses the importance of money and resources being a significant variable to the equation. BillerudKorsnäs have a product council which consists of senior management and two plant managers. The product council operate as a forum where the R&D Director and the CTO will present current projects and, with the help of the management team, prioritize which projects to proceed with. Also, the product council will assess questions about exploring or proceeding with new technology areas.

The Director of BK Venture explains how they assess radical ideas by plotting them based on technical closeness and business closeness. They then define an area which they want to further explore, e.g. products/phenomena with low technical closeness but high business closeness.

The CEO explains how he assess ideas/projects if there is a clear market. However, he would prefer to have a more systematic approach. He further expresses that he prefer to bet on one "horse" rather than all of them, but with a backup plan, i.e. that knowledge spillover will result in something else. In terms of selecting what to acquire, he stresses the importance of trusting the management of the targeted company. He argues that if you are pursuing technologies that may

not be close to the existing businesses, it is important that the targeted company can deliver the expectations.

4.1.3 Case examples

The Director of BK Venture mentions one example how BillerudKorsnäs were in the search of a new business area to complement their two existing business divisions of that time. Prior to the merger of Billerud and Korsnäs, the board of directors prompted business developers at Billerud to investigate and research the trend of sustainable energy. Through scanning, they obtained information that a global energy provider was looking for alternative fossil free fuels for regulation power for their wind turbines. According to the Director of BK Venture, this seemed like a natural and logic area to enter as they were competent in handling large amount of sustainable material and possessed a production plant with excessive heat, i.e. synergies in terms of cost of investment. Hence, it was technically and economically viable and, in addition, the market was huge and it was a global trend. They succeeded in developing a product, but it was later abandoned when the merger of BillerudKorsnäs occurred. The reason was that Billerud got their third business area along with Korsnäs main focus.

4.2 PART 2 - EXTERNAL OUTLOOK

The following section describe the external companies, ABB Corporate Research, Sandvik Coromant, and Bombardier Transportation Rail Control Solutions (RCS) on the basis of the analytical framework. The purpose of these interviews is to provide an external outlook (to BillerudKorsnäs) and highlight examples of how other mature companies in Sweden approach the front end of innovation. Throughout the duration of the study, the interview guide has changed. New areas of interests have originated in interviews, which have changed the questions asked in subsequent interviews. Also, fewer interviews have been conducted at the external companies compared to BillerudKorsnäs. Thus, the empirical observations are not as comprehensive and thus do not absolutely follow the analytical framework, and some areas may be omitted.

4.2.1 ABB Corporate Research

The research at ABB is carried out in several centers across the world. The biggest center is the ABB Corporate Research Center in Västerås, Sweden, where 25-30% of all of ABB's research is conducted covering eight of ABB's nine focus areas. The research is mainly focused on the development of technologies and material to produce comprehensive concepts. The responsibility to productify a concept is the product development.

Facilitating factors

The following section describes how ABB Corporate Research stimulate and organize innovative work, as well as collaborations they utilize. Firstly, the stimulation of innovative work is described, followed by how ABB Corporate research is organized and what collaborations they are engaged in. The aim is to get an understanding of current struggles and solutions to obtain possible learnings for BillerudKorsnäs.

Stimulating innovative work

The R&D Manager at ABB Corporate Research claims that a culture of creativity is ingrained in the walls of the company which builds upon the successful history of the company. Being creative and finding new exciting opportunities is not something that the managers need to actively communicate to its employees, although it is encouraged. The trick to be successful, the R&D manager says, lies not in only hiring creative people or mold new employees, but to strike a balance between creativity and structure. An excessive focus on creativity would deflect attention from the regular work, according to the R&D Manager.

What is important, according to the R&D Manager, is hiring people with diverse backgrounds. This increases the innovative capability as the points of contact available to the company, which is a necessity for discovering or connecting pieces of information, increases. Although diversity is beneficial, the employees need to have a minimum set of knowledge in order to successfully approach a problem, and a majority of the employees at the research function have PhDs.

A diverse composition of project team members allows for formal and informal contact between the project members. In order to facilitate the contact between different project teams, the R&D manager brings all employees together twice a year for a strategic brief, which at the same time provides the opportunity to (under a few hours over coffee) share what everybody has been up to in the past six months. This is greatly appreciated and allows the employees to inspire each other and discuss and solve problems together.

The R&D manager does not believe in formally reserving time for creative work as he believes it does not deliver the desired results. Free time would risk being exploited by employees doing unrelated things or simply going home. Instead he believes that time to be more creative is already

available in the projects for those who wish to use it. This is something that is expected to some extent by the company.

Organizing for innovation - Nine technology areas

ABB's research is based on nine technology focus areas, many of which have been set for 20 years or more. The decision to remove or include an area of research is decided by the CTO and head of divisions, and is based on how advanced ABB is in the area and the impact on ABB's products. The relative share of money spent on projects in a particular area is also regarded.

ABB has varying goals for the different technology areas. In some areas, ABB strive to be in the forefront of research, ahead of competitors as well as universities in terms of knowledge and product performance. The R&D manager note that ABB's investment in key technology areas can be upwards of 10 times more than universities or competitors. In areas where ABB's competitors have their primary research focus, ABB's strategy is instead to be a capable fast follower. In these areas, the skill of ABB Corporate Research is to identify what type of technology that needs to be incorporated in their products to satisfy the demand of their customers. The Research Area Manager ensure that there is a variety between long-term and short-term projects in each focus area to ensure short-term and long-term success.

Technology venture function

The CTO at ABB is responsible for overseeing the corporate research as well as the technology venture function. This function make strategic acquisitions of technologies or companies which they have deemed interesting. Only a few people know which areas and companies that are deemed interesting, and the list is updated continuously.

The R&D manager claims that buying a stake in a company is the best way to bring in a new technological area. Investee companies are often outside of ABB's key technology areas. By acquiring small stakes in numerous companies, ABB can monitor and track multiple new exciting technologies while remaining agile. The R&D manager claims that investments and acquired start-ups are best kept at an organizational distance from the larger organization initially, as reporting demands and internal politics can damage the smaller company. Should the technology or knowledge be determined to be critical in their products, the company can be slowly integrated in ABB. Otherwise, it can be divested or made into a supplier.

The choice between buying or collaborating with a company and developing it themselves, has to do with the question of knowledge, feasibility, cost, and also an analysis of the value chain. If they identify a possibility to occupy a lucrative part of the value chain, and they have the ability to develop the necessary factors themselves, ABB will do it themselves.

External collaborations

ABB cooperates with close to 70 universities across the world. Some strategically chosen universities are so called partner universities which ABB work more closely with. A university is often focused on a specific technology area. ABB sponsors PhDs and adjunct professors to research specific areas, but make sure that there is no overlap between their own research and the research undertaken at universities. The purpose of collaborating with universities is to scout and research long term disruptive technologies and most importantly, to train people and subsequently hire them to collect the gathered knowledge and expertise.

ABB participate in strategic alliances with selected companies. These types of collaborations are between business units and is more product than research oriented, with the ambition to launch a

product offering. ABB also participates in strategic technology developments with a number of firms. ABB has rarely been involved in joint ventures, except for exceptional cases in China where national regulations forced it upon them.

Activities

The following section describes how ABB Corporate Research identifies opportunities and generates ideas. The aim is to get an understanding of current struggles and solutions to obtain possible learnings for BillerudKorsnäs.

Opportunity identification:

Identifying and sharing technologies, exciting scientific discoveries, or just any idea is the responsibility of every employee. The company does not have any specific structure to ensure that this takes place, but encourage it. Each employee has its own circle of contacts and some might attend conferences or read different publications which can inspire idea generation. In addition, the company has a specific technology watch which according to the R&D manager, gives good coverage of certain interesting areas. Business units can also identify interesting areas, and request further research by the research function. These areas are according to the R&D manager usually quite obvious.

When a new exciting technology or a new trend is identified, ABB does not necessarily initiate research efforts immediately. Instead, they monitor the progress and development of the technology. Should the performance of the technology reach, or be predicted to reach, a certain threshold, ABB launches a research effort to 'catch up'. ABB can also determine when they should initiate research based on predictions on when a market will be sufficiently large. The challenge lies in the timing when research should commence. According to the R&D manager, ABB understands from experience approximately how long it takes to develop a new technology and where it will be in a period of time, and can therefore accurately predict when to initiate their own research. When the decision to begin research is made, ABB has significant resources at their disposal to dedicate to a specific mission, which enables them to relatively quickly 'catch up'.

The biggest challenge in innovation, according to the R&D manager, is identifying the disruptive technologies. Disruptive technologies often come from the 'side', i.e. from unexpected technology areas, which makes it more difficult to identify and make sense of its potential impact. In an industry which is relatively slow and conservative, such as the energy sector or products for large factories, disruptive technologies are more easily identified as the organization has more time to register and understand changes, according to the R&D manager. To be successful in identifying disruptive technologies, the R&D manager suggests that an organization needs to have an awareness of what is going on in related markets in combination with a natural sense of curiosity. The organization should however be careful to draw hasty conclusions, and should spend a significant amount of time conducting pre-studies. The identification of disruptive innovations or technologies is therefore, according to the R&D manager, limited by the available resources.

The R&D manager describes how 'wild and crazy' ideas, i.e. radical ideas, usually amounts to nothing tangible. Most importantly, an idea needs to be feasible and have a potential market. The R&D manager claims that the most important aspect of innovation is understanding the articulated and unarticulated needs of the customer. In his experience, wild and crazy ideas often fails to meet that mark. Sometimes, presenting 'wild and crazy' ideas to a customer can even have the opposite effect, namely that the customer becomes annoyed. According to the R&D manager, if necessary, the company can define a specific area and request more 'out there' ideas, creating a creative

atmosphere. Also, 'wild and crazy' are generally identified in other companies, and is therefore the responsibility of the venture function.

According to the R&D Manager, there is no inherent conflict between newly developed or identified technologies and existing technologies which could potentially be cannibalized on. The R&D manager notes that all new technologies in some way or another competes with existing technologies. It is the responsibility of the product manager to decide when to introduce and incorporate new technologies in products. The decision to introduce new technology is a tradeoff between getting money back on the previously developed technology, and satisfying the current and future needs of the customers.

Idea generation

In order to transform an identified opportunity or technology to a concrete idea, teams can engage in workshops, or simply bring attention to the discovery to a more senior manager. Ultimately, the R&D manager selects which opportunities that should be further researched through a pre-study, based on a combination of many factors such as potential utility, market attractiveness, perceived quality, strategic fit, and accumulated experience.

4.2.2 Bombardier RCS

Rail Control Solutions (RCS) is one of several divisions of Bombardier Transportation, which in turn, combined with Bombardier Aerospace, constitutes Bombardier Corporation. RCS is headquartered in Sweden and has approximately 4,000 employees worldwide, primarily working in Sales, Engineering & Product Development, Safety Assurance, Service and Maintenance. In terms of innovative work, RCS believes that innovation should be driven by the market and have therefore placed the function under Business Development.

Stimulating innovation

The Head of Innovation & Knowledge Management explains that innovative work at RCS is rooted in their definition of innovation; "a change that creates value to the customer or society." The definition follows for all kinds of innovation and enables idea generation and sharing. However, he expresses that they make a clear distinction between development and innovation, where development regards linear technology life-cycles.

The Head of Innovation & Knowledge Management further stresses the importance of people. He describes that networks and key personas are important enablers for innovative work as they connect people with ideas with people that possess applicable knowledge and/or resources. His own role is to stimulate the innovative culture and manage the innovative work by being the "spider in the web". He influences his personnel by inspiring, empowering, advising, guiding, and taking calculated risks. He stresses the importance of having the means to take risks to invest money in ideas that do not necessarily reach the market, as long as the investment is retrieved through ideas that do reach the market, and that "financial freedom with brains" is an important enabler for innovation.

The Head of Innovation & Knowledge Management further argues that one of the most challenging parts of innovation is not to generate ideas, but to make people drive through their own and others' ideas. Appointed resources that drive innovation across each function or Region of the organization are recognized as Innovation Champions and they are characterized by having an interest in innovation combined with a management or leadership role. As far as local resources in Sweden, he further discusses that the Swedish culture of being modest and "low profile" is a possible explanation as to why some people might not be willing to push their ideas through. Thus,

he believes that it is important to stretch people out of their comfort zone. Hence, he is often present to help people with ideas and pitches, tries to involve the idea generator as long as possible, and sometimes even motivate people to further pursue their ideas.

Opportunity identification and Idea Generation

In order to identify opportunities, the Head of Innovation & Knowledge Management explains that RCS look at the existing customer base and try to understand what unarticulated problems they have. Hence, understanding the customer and their customers is a good procedure to anticipate future needs or presenting solutions that might bring more value to the customer, according to him.

Furthermore, according to the Head of Innovation & Knowledge Management, there are two streams to funnel ideas; top-down or bottom-up. The top-down approach focuses on finding ideas within predefined domains outside the firm boundaries, i.e. certain people are responsible to scan the external environment, for example market trends, competitor intelligence, etc. These domains are defined through several concepts and tools which elucidate technologies and their proximity to RCS. This is further presented in the form of a technology radar that reveals technologies and technology domains that are farfetched and those that are close to RCS. They also assess these technologies based on their TRL. The Head of Innovation & Knowledge Management explains that RCS usually adopts new technologies in later TRL stages, which he believes can be improved as competitors often are involved earlier.

In terms of bottom-up, the Head of Innovation & Knowledge Management explains that ideas may as well come from within all levels of RCS. He claims that RCS is focusing on developing an organizational culture that fosters idea sharing, i.e. a mentality of "if you have an idea, let me know". He further explains that one of his many roles is to collect ideas throughout the organization. One of his idea collecting approaches is to have periodical innovation campaigns, where he announces internally that they are looking for innovative ideas within a fixed time frame. Employees are then given the opportunity to articulate their ideas for him whereas feedback is given and seed funding might be handed out. He also explains that seed funding is not necessary monetary, and that time is an effective tool, i.e. handing out time to further investigate and explore ideas. If the idea is good enough, the person gets the opportunity to pitch their idea for the President of RCS, which is something the Head of Innovation & Knowledge Management believes incentives people. These campaigns also give people a chance to refine their ideas and network within RCS.

Furthermore, the Head of Innovation & Knowledge Management described idea generation, prior to his appointment to the function, as characterized by lower transparency. He explains that people developed ideas "under the radar" and concepts popped up from nowhere, which he refers to as "submarines". Some people even funded idea development from their own pocket. He changed this by bringing transparency via campaigns, awards and communication.

Idea selection

The Head of Innovation & Knowledge Management describes that pre-selecting ideas at an early stage often relies on "gut feeling". By mandate, he has the responsibility of a portion of the R&D budget dedicated to ideation, which he can allocate to various ideas for seed funding as he sees fit. Once concepts have matured up as a result of seed funding (pre-study report, proof of concept, prototype), ideas are discussed at board meetings with the President of RCS, usually as part of an innovation campaign and selecting the winners. The President has the executive call to decide whether to proceed with product development. The Head of Innovation & Knowledge

Management further explains that RCS focuses on financially viable/attractive ideas backed up by a business case, rather than 'cool ideas'.

Furthermore, Bombardier Transportation drives a number of so-called transversal innovation programs which involve several of the divisions due to the extent of their application on larger railway systems, or the shared benefit of developing competence and know-how in particular domains (e.g. big data, 3D printing, cybersecurity).

Further development
The Head of Innovation & Knowledge Management explains that they operate in what can be seen as a conservative industry. There are however distinctions between customers, where some are more inclined to innovation and risk taking than others. These customers are particularly important in terms of testing new ideas and eventually taking ideas to the market. As RCS lack their own railway infrastructure, i.e. field testing facilities, they often rely on certain customers to test new products. Thus, customers are important drivers for innovation.

4.2.3 Sandvik Coromant
Sandvik Coromant is part of the Sandvik Machining Solution division, which in turn is part of the global Sandvik Group. Sandvik Coromant is a global provider of tools, tool solutions and know-how within the metal processing industry. They are headquartered in Sweden, has approximately 8.000 employees, and is present in 130 countries.

Facilitating factors
The following section describes how Sandvik Coromant has structured the early phases of product innovation, how they stimulate innovative work, and what collaborations they are engaged in. The aim is to get an understanding of current struggles and solutions to obtain possible learnings for BillerudKorsnäs.

Structuring the early phases of product innovation
Sandvik Coromant is currently transitioning into a new structure and approach of working with the early phases of innovation. Four generic knowledge areas will be created, governed by technology boards. This initiative was initiated two years ago with pre-studies and planning as the organization was not pleased with the old proceedings due to several reasons: Initially, line managers had different view, low transparency, and unsystematically procedures on how to work with early phases, i.e. some valued and allocated time for it while others did not. They also wanted to depart from the heavy focus on product development, meaning that they had too much focus on stage-gate models. The Principal Project Manager further explains that testing ideas needs to be given time, especially explorative ideas, and that old procedures did not clearly facilitate it. Lastly, they were stuck in a 'silo behavior', meaning that they did not achieve the level of knowledge sharing they wanted, i.e. directing ideas to the right sources and reusing old knowledge in an effective way.

The Principal Project Manager further explains that the new structure aims to work with and facilitate generic knowledge building in low TRL technologies (1-3). The four generic knowledge areas are derived from Sandvik's key competence areas. This will be realized with existing resources via a virtual organization independent of the line organization. Existing R&D structures and line processes will be intact, while this new virtual organization will clarify what ideas to develop in these structures. Also, in this virtual organization, new roles are created in form of technology area managers which will be given mandate to decide and steer workings within these generic knowledge areas. They will operate within defined scopes extracted from annual strategic and technology

roadmapping exercises. These exercises will bring attention to existing knowledge gaps, what is needed to overcome these, and suggestions on how to proceed within the following 12 months. Furthermore, the generic knowledge building will aim to find new solutions and ideas within these respective areas, simultaneously as deliver solutions to existing development projects. Hence, it will be more clear and systematic on what to do in the early phases of innovation. Technologies beyond TRL 3+ will require thorough planning and more defined new product development will take place.

The Principal Project Manager further explains that these technology area managers has a formal role and will devote roughly half of their time to it, simultaneously as combining their existing roles as technical experts, with own research and/or advising other development projects, or line managers on a lower level. These roles were hand-picked based on certain competence profiles/requirements, meaning that they needed to reach a certain level of strategic mindset, leadership, accountability, networking (internal and external), drive, etc. Hence, they were not only assessed by their technical know-how.

Above these technology area managers, two different levels of boards are organized. At the top there will be a main technology board which will have the main responsibility. Below, four technology area boards have a more narrow focus on respective key technology areas, which in turn consist of several generic knowledge areas, where technology area managers will be positioned. These boards will aim to connect what is strategically needed for the businesses and will have the responsibility to distribute funding down the 'hierarchy', i.e. into technology areas and more specifically into interesting projects. What to fund will further be prioritized based upon the earlier mentioned technology roadmaps. The strategy set by the technology board influence the front end phases of product innovation. Should the technology board request a 100% increase in performance of the next generation of products, the R&D director says that this naturally put an emphasis on more radical technologies.

The R&D director at Sandvik Coromant sees many advantages to the new structure. The clustering of knowledge building will increase the transparency, which will make it possible to achieve a better balance, coordination, and control over activities in different generic knowledge areas and TRL levels. The clustering will also in turn reduce any duplication and strengthen the collective knowledge building. The technology boards will, due to the greater control, be able to make more conscious decisions on what to prioritize. An overview of the entire technology portfolio also makes it possible to make a better risk contra possibility assessment. Furthermore, the new structure creates the conditions necessary to improve the exchange of research efforts. It will be easier to identify possible synergies between the generic knowledge areas, and where they could benefit from working more closely together. Moreover, the R&D director sees clear benefits in a more efficient handover between the technology and product development. By building a strong knowledge base, it will become clearer what works and what does not, and how that can be achieved. The knowledge created in the generic knowledge areas will be made available for the entire company through seminars, reports and internet portals, which has previously been difficult to coordinate.

Venture initiative

One part of Sandvik, Sandvik Materials Technology (SMT), used to have an internal venture initiative with the aim to actively connect technology with potential business opportunities. This initiative lived for approximately 7-8 years and had its own department containing several ventures. The Principal Project Manager was responsible for one of these venture units, and she explains that they called it venture as it compromised taking risks and invest in all kind of solutions where

novel technology was coupled with business. This was done separately from the traditional line organization, i.e. both in separation from R&D departments and 'everyday processes'. The aim was to create focus, but also to stimulate a culture different from before, i.e. dissociation from old mentality of keeping costs down, sticking to budgets, etc. Hence, venture managers were given freedom to take more risks than line managers. The Principal Project Manager further explains that this venture initiative had mixed results where some ventures successfully delivered new business segment while others fail to deliver value.

This venture initiative in SMT was put down due to several reasons. Many ventures matured over time and was extracted into own business areas or forged into other existing business areas, while others were laid down. Conclusively, Sandvik was pleased with the venture initiative's achievements and was no longer necessary. Today, any acquisitions in small companies with interesting technologies related to Sandvik Coromant is made by the division Business Development.

Stimulating Innovation

In order to stimulate innovation, the Principal Project Manager stresses the importance of an open climate. She believes that when ideas are brought up, it is important not to rebuke, and instead encouragement and trust should be given to the idea generator. For example, if a technology area manager believes in an idea, it is necessary to informally challenge him or her on the subject and if they sufficiently succeed in arguing and verifying, they should be given the opportunity to further explore.

Furthermore, The Principal Project Manager further believes that acceptance of failure is necessary, meaning that if one does not succeed or fulfill what is expected, it is right to put down the research. Instead, she believes that it is important to learn from downturns and build upon those experiences. She continues to explain that in order to achieve groundbreaking technologies it is necessary to pursue several paths acceptingly knowing that many initiatives will fail.

In terms of degree of freedom, the Principal Project Manager expresses that full freedom is not possible, but as long as free time is spent on developing value for the firm it is encouraged. As earlier mentioned, what is relevant to pursue is defined through strategic roadmaps and freedom to operate within these boundaries can vary, but she stresses that researchers should strive to deliver knowledge and solutions to needs rather than explicitly to certain developing projects.

Collaborations

The R&D Director describes the importance of collaborating with external companies, research institutes, and universities. The key reasons for collaboration are to complement technology and market capabilities, as well as to speed up the learning process. The longer distance between where a company wants to be and where they are today, the greater importance of collaboration. Historically, Sandvik Coromant has been very successful in developing the greater parts of a value chain of a new product and its related knowledge independently. Apart from developing products, Sandvik Coromant has also developed the machines which produce the products. The benefits of doing everything in-house is the tight coordination between process and product, while the drawbacks include a slower development. More recently however, the R&D director says that they utilize collaborations to a greater degree.

When learning about a technology, the question arise whether to enter partnerships, develop together, or acquire a technology or a company. Factors such as the size of the potential acquisition, the importance of the technology, and the maturity of the technology are important to consider, according to the R&D Director. He also says that in the early phases of a new technology, it is

more probable that Sandvik Coromant would jointly develop. Should several alternative novel technologies exist which could potentially be attractive for Sandvik Coromant, he claims that they would try and understand all technologies before settling on a specific solution.

University collaborations

University collaborations give leverage to what Sandvik Coromant does not explore internally. Hence, it enables a wider research portfolio and a larger volume, according to the Principal Project Manager. She further explains when internal knowledge building are insufficient, and knowledge gaps arises, they know whom to turn to and successively enter university collaborations and research programs. She also stresses the importance of understanding what each collaboration and program will achieve and what research volume they accesses. She further believes that it is important to have own personnel present for optimal knowledge obtaining and networking. Conclusively, even though Sandvik Coromant is world class performer in research, according to the Principal Project Manager, strategically important areas need to be aided with external collaborations. However, she further explains that Sandvik Coromant's research expertise pressure external research to hold a certain level of performance, and that they hand-pick universities and researcher they know are on the frontier of certain research.

Activities

The following section describes how Sandvik Coromant identifies opportunities, generate, and select ideas. The aim is to get an understanding of current struggles and solutions to obtain possible learnings for BillerudKorsnäs.

Opportunity identification and idea generation

According to the Principal Project Manager, identifying opportunities partly relies on being active in external contexts. Being attentive in other contexts, i.e. anywhere outside the firm, gives insights on trends and hypes, which in turn stimulate ideas. The R&D Director mentions activities such as actively monitoring new technologies, technology and social trends, patents, and new market players. He also suggests attending conferences to understand market constellations, network and gain insights in who has relevant technologies.

Close contact between business units and key customers also generate ideas. These are mainly managed by account managers, but there are occasions where R&D people are present during customer meetings. According to the Principal Project Manager, R&D people might note things that passes salespeople and account managers, e.g. in customers' processes, which in turn results in interesting ideas. There is a risk, according to the R&D Director, that customer interaction mainly leads to incremental innovation. By cooperating or engaging with the customer's research team, Sandvik Coromant can identify more radical opportunities, and get a better comprehension of future needs.

However, even though they are actively attentive, the Principal Project Manager notes that she would prefer a more systematic approach in terms of capturing insights from employees in contact with external entities. She discusses the difficulties in directing ideas to the right source and that good ideas might be shared in the wrong forum. Hence, transparency is highly important which will be enabled by the new structure, she believes, where employees knowingly will turn, or lead other people, to technology area managers.

Sandvik Coromant also use technology and strategic roadmaps, which are annually updated in each technology area. The roadmap include a basic assumption of factors which could affect a technology area and the existing relative knowledge level in comparison to the external environment. The development of the roadmap identifies necessary actions, technologies which needs to be understood, patents that need to be filed, etc. The roadmap therefore works as a way to identify the future opportunities based on how the environment is going to change, and what measures should be taken to ensure success. New information can prompt changes to the technology roadmap.

Furthermore, Sandvik Coromant also has something they call Idea Management which aims to generate ideas via specific idea themes. During specific time periods all employees are welcomed to share ideas and solutions. An appointed committee is then responsible for collecting all ideas, sort them, and present them to a management team, which in turn pick out the most interesting ideas and delegate them as assignments to certain driven people. Idea Management has three employees who collectively work 1.5 full time equivalent. Apart from organizing idea competitions, they work to facilitate the idea process, from encouraging employees to think differently to create ideas. Idea management can also organize workshops where they work with techniques for idea creation. The R&D manager claims that the way to create bold ideas is to gather people with fundamentally different perspectives, together with someone who can facilitate the generation process.

In terms of more radical ideas, the Principal Project Manager explains that these has emerged from within the R&D department. She further describes that these ideas started off as regular research activities which were brought into other contexts where management team saw business potential. These were in turn developed via competence centers and some of them were even transformed into own business areas.

Idea selection

In terms of selecting ideas, Sandvik Coromant wants to distance themselves from depending solely on the management team to decide. Instead, the assessment and prioritization of ideas are delegated to technology area managers that will have authority under supervision. The aim of this structure is not to kill ideas too early and thus incentivizing people not to be afraid of getting ideas rejected by the management team.

The technology area managers will base their selection on strategic roadmaps, which are developed by themselves, but rooted in Sandvik Coromant's needs. These strategic roadmaps will be the communication to higher boards and management teams, describing what ideas/projects that are being/going to be initiated and what knowledge gaps they aim to fill. More specifically, what kind of testing are executed, what hypotheses they aim to synthesize, and what result they are expecting. Hence, the overall requirement from the technology area managers is that they thoroughly evaluate ideas, concretesize for understanding and communicating, and predefined a purpose prior to continued development.

The Principal Project Manager explains that technology area managers will foremost focus on the technical improvements and values of ideas rather than monetary aspects. They will not focus on doing formal estimations and calculations about future profits in these stages. The Principal Project Manager stresses that too much emphasis on business cases in early phases of innovation kill ideas too early and proposing that people must estimate markets for technologies at low TRL is unreasonable. Instead, it is sufficient to describe with words what the idea or technology will

provide and from a discussion conclude if it is worth to pursue. However, she argues that for later TRL stages business case is relevant.

The Principal Project Manager further explains how she personally evaluate ideas by assessing the needs and what the idea can conduce to. She also expresses that ideas need to fit into larger context, i.e. the strategic needs of the company. If ideas meet these criteria, she direct that person or idea in the right direction, i.e. it is not necessary the idea generator that should further develop the idea. However, she stresses the difficulties and challenges in shifting project ownership and making people enthusiastic about other's ideas. She also discuss the difficulties in killing passion projects. In the end, it is up to the technology boards what to pursue, otherwise there is a chance that passion projects are stuck in loops, i.e. not getting anywhere. However, researcher will still be given the opportunity to argue before it is laid down, and that even if their projects are killed it is still a chance that some people might continue nevertheless.

Case examples

The Principal Project Manager further describes the example of how they proceeded when 3D-printing emerged. Even though they did not fully understand the technology, they knew it would cause possible problems or opportunities for the future, and thus initiated an investigation to understand what it concretely implied and how they could utilize it. The Principal Project Manager further stresses that even though it might not affect them directly, one still need to understand how it can affect the customer base, and if it is a possible substitution to current offerings. She further explains that when technologies of this size and importance occur, it might be hard for one employee to handle the investigation. Instead, they set up a competence center with several Sandvik divisions to create a critical mass and to share responsibilities. These competence centers are supported with equipment needed to explore and thoroughly investigate the new technology. In the end, it is thought that each division will collect and bring back intelligence on possible threats and opportunities. The Principal Project Manager also expresses the possibility of acquiring small companies that have sufficient skills and knowledge regarding the investigated/ventured technology. However, she further explains if acquisition is on the table, it needs a business perspective, i.e. a business opportunity, and not solely to fill knowledge gaps.

When graphene emerged, they almost immediately entered a consortium where they positioned employees to follow the development. The aim is to constantly be up to date and to get feedback when it is applicable to Sandvik Coromant's businesses. The consensus of pursuing development in graphene is that it is rooted in the constitutional competence of Sandvik Coromant, i.e. advanced material technology. If something happens within the frame of material engineering, Sandvik Coromant wants to be present. A subdivision of Coromant did not know what graphene would be most optimally used for. In order to generate ideas, the subdivision set up an external idea competition. A problem, which the R&D director noted, was that before you have sufficient knowledge of a new technology area, assessing the feasibility of ideas is difficult.

Another example is Internet of Things (IoT), a phenomena that has emerged and escalated during the past years. Like other technological hypes, Sandvik Coromant realized that they needed to investigate this area as it probably will affect their business, both in terms of threats and opportunities. Today, they have appointed resources, i.e. recruited new competencies, to investigate and explore how they can turn IoT into opportunities. In this case, it was necessary to recruit new people as the majority of developers at Sandvik Coromant are material and machinery engineers and lack ICT competence. However, the Principal Project Manager stresses the importance of mixing new and old competencies to increase the possibilities to fit new technologies into current

offerings. She further explains that even though one cannot predict exactly how IoT will affect Sandvik Coromant, they initiate work by partly knowing potential needs and what technologies they need to learn to integrate, e.g. sensors, streaming data, big data, etc.

5 ANALYSIS AND DISCUSSION

The following section analyses and discuss a selection of the findings from the empirical observations. As mentioned in the empirical observations, the described methods, structures and processes in the observed companies are not necessarily exhaustive. The selected areas of discussion include the front end activities identified in the analytical framework: *opportunity identification*, *idea generation*, and *idea selection*. These include distinct methods and facilitating factors such as the *organizational structures*, *external collaborations and knowledge*, and *strategy and leadership*. How external collaboration influence all activities throughout the front end is discussed under *filling the knowledge gaps*. The observations of the external companies, ABB Corporate Research, Sandvik Coromant, and Bombardier RCS, are in each area summarized, and viewed through a theoretical lens to build an understanding of the alternative methods and the facilitating factors. Subsequently, they are compared and contrasted to the existing (and planned) activities and methods in the front end of innovation at BillerudKorsnäs. A combination based on the theory as well as the perception of the interviewees, give insights of the potential effectiveness of similar solutions or approaches to activities at BillerudKorsnäs

5.1 OPPORTUNITY IDENTIFICATION

Company	*Opportunity identification activities*
BillerudKorsnäs	Actively identifying opportunities is the responsibility of technology excellence centers, BK Venture, Business teams, and the R&D department. Sources include conferences, presentations, competitors, customers, scanning disruptive technologies etc. Technology excellence centers scan predefined technology areas (GMTs) and Business teams and the R&D department focus on market driven product development. Business areas can be identified by management.
ABB Corporate Research	Opportunity identification is the responsibility of all employees, who identify new technologies, scientific discoveries etc. from conferences, publications and circle of contacts. Business units identify opportunities from customers, and the venture function track and monitor new technologies in small companies. A technology watch gives good coverage of specifically chosen areas. Different technology areas call for different types of scanning. Some areas attempt to identify radical opportunities while other identify existing customer needs.
Sandvik Coromant	Opportunity identification is guided by the technology and strategic roadmapping exercises. Identifying opportunities, trends, hypes and understanding market constellations relies on being active and attentive in external contexts. Sandvik Coromant also monitor new technologies, patents, and new market players.
Bombardier RCS	To identify opportunities, Bombardier RCS try to understand the articulated and unarticulated needs of their customers as well as their customer's

	customers. There are also certain people responsible for scanning the external environment including competitors, trends, technologies etc. within predefined domains. These domains are defined through concepts and tools which map technologies and their proximity to RCS.

Table 2. Brief summary of Opportunity identification

Identifying opportunities entails envisioning the future (Koen et al. 2012). Opportunities seed idea generation and is a driver for initiating radical product innovation projects (O'Connor and Veryzer, 2001). The following section map and analyze examples of how the external companies identify opportunities and discuss possible lessons for BillerudKorsnäs to consider.

5.1.1 Where and how do the observed companies identify opportunities?

The external companies describe similar sources of information and methods of scanning the external environment. Their employees read scientific publications, participate in conferences and presentations, monitor disruptive technologies, benchmark competitor's products, and engage with customers, suppliers or other external contacts. Generally in the three external companies, this is not structured but rather encouraged. This requires a clear communication of the firm's innovation ambitions from the senior management (O'Connor and Veryzer, 2001).

The observed companies do not rely on a single method to identify opportunities. Similar to what Cooper and Edgett (2008) revealed in their study, the observed companies popularizes Voice-of-Customer methods to recognize opportunities. For example, Sandvik Coromant have R&D employees present during business meetings with customers, to notice opportunities that might otherwise have been overlooked. The background of the R&D employee enables a different point of view (Cohen & Levinthal, 1990). Furthermore, ABB similarly describe that opportunities can be identified from business units which has closer contact with the customers, but note that they are often more related to products and quite 'obvious' areas. Bombardier RCS mentions that they collaborate with advanced customers in testing and developing ideas. However, focusing on current customer needs and markets are inappropriate for radical product innovation (O'Connor & Veryzer, 2001), and can blind firms from disruptive innovations (Bower & Christensen, 1995). Instead, O'Connor and Veryzer (2001) and Von Hippel (1998) suggest interaction with lead-users that might see problems ahead of the main market, and forecasting the trajectory of present technologies. Similarly, the R&D director at Sandvik Coromant says that the way to develop for the future is through collaboration with the customers' research function rather than directly with the customer.

The external companies all emphasize the importance of being attentive to the external environment. They use various but similar sources of information and methods to access these. Reliance is often placed on the employees to keep their eyes and ears open. The various methods used suggest that there is no absolute superior method, which BillerudKorsnäs could utilize, from which to identify radical opportunities. Identifying radical opportunities is no obvious matter, regardless if it is finding radical technologies or combining technologies in any way. As expressed by the R&D Manager at ABB Corporate Research, disruptive technologies come from the 'side' of where you normally look. What the external companies do is enable the identification of these radical opportunities. To do this requires an awareness of what is going on around the company. As expressed by the R&D Manager at ABB Corporate Research, to identify radical opportunities, an organization needs to have an awareness of what is going on in related markets in combination with a natural sense of curiosity. Making this a shared responsibility and a strategic priority

throughout BillerudKorsnäs can enable the identification of radical opportunities or technologies, but not necessarily produce them.

In addition to attempting to identify more radical opportunities, BillerudKorsnäs strive to leverage their resources to create radical products. To achieve more bold innovations, Cooper (2011) suggest a two-pronged attack in finding arenas with major growth possibilities. Initially, it might be necessary to broaden the search to anything that serves as a fertile ground to BillerudKorsnäs' innovation effort. More specifically, these arenas should at least be adjacent to packaging, or where BillerudKorsnäs can leverage their resources and/or capabilities. Secondly, it is necessary to assess the core competency of BillerudKorsnäs in order to thoroughly understand unique capabilities that can be leveraged in other markets, applications, and sectors.

5.1.2 Facilitating opportunity identification for radical product innovation

According to the Principal Project Manager at Sandvik Coromant, the challenge of opportunity identification is not only knowing where to scan, it is capturing employees' insights. Sandvik Coromant has structured a virtual organization which aims to increase the transparency of all front end activities of innovation, and thus facilitate the capture of opportunities and ideas within certain domains. Knowing whom to turn to as well as submitting opportunities and ideas at this virtual organization resembles Leifer et al.'s (2001) theory about innovation hubs. Providing transparency and clarity in where to turn is especially important, as the people who generate ideas often do not recognize its potential (Leifer et al., 2001). Also, to stimulate radical innovation and identifying radical opportunities, it is necessary to structure for encouraged risk-taking which could achieved by ambidextrous organizations (O'Reilly and Tushman, 2004).

Additionally, Ardichvili et al. (2003) argue the importance of delegating right responsibilities to right people as individuals differ in terms of sensitivity to market needs and problems. Similarly, Sandvik Coromant acknowledge that not all individuals are suitable as technology area managers. They assess their technology area managers beyond know-how such as their internal and external network, drive and leadership and believe that this will increase the number of qualitative opportunities.

There are possible lessons for BillerudKorsnäs to learn in this instance. BillerudKorsnäs share similarities with how other successful radical product innovation projects, as described by O'Connor and Veryzer (2001), stimulated the opportunity identification: The CEO clearly communicates the importance of innovation, being present and personally interact with employees, as well as articulating stretch goals such as 'moon shoot projects'. Also, the separate nature of BK Venture resembles an ambidextrous organizational structure (O'Reilly & Tushman, 2004). However, it is necessary to acknowledge Sandvik Coromant's perceived difficulties of capture insights in order to obtain more opportunities in general, as well as radical opportunities. The initiated restructuring of technology excellence centers can achieve this. The leaders of these technology centers should be assessed not only by the technological know-how, but other factors as well.

5.2 IDEA GENERATION

Company	*Idea generation activities*
BillerudKorsnäs	Ideas are discussed in meetings but no formalized sharing process exist. Instead, idea generation and sharing rely on informal networks. BillerudKorsnäs have previously used IT programs to facilitate sharing and generating of ideas. Also, workshops to generate ideas have been conducted.
ABB Corporate Research	In order to move from an identified opportunity to a concrete idea, teams can engage in workshops, or simply bring attention to a discovery to a more senior manager. ABB Corporate Research also create the conditions for informal generation of ideas by forming diverse project teams, as well as organizing events where employees from different departments can share experiences and discuss problems.
Sandvik Coromant	The Idea Management at Sandvik Coromant generate ideas through idea competitions and organized workshops. Has also used crowdsourcing for idea generation (Graphene).
Bombardier RCS	Bombardier RCS generates ideas (radical and incremental) through periodical campaigns where employees contribute all types of innovative ideas. These ideas are further built upon by the organization and the idea-generator.

Table 3. Brief summary of Idea generation

The external companies share many similarities in their approach to generating new ideas. A method observed in Sandvik Coromant and Bombardier RCS was the use of internal idea competitions. Other approaches include organizing workshops and stimulating generation through informal networks.

5.2.1 Idea competitions

As valuable ideas can come from anywhere in the organization, it is important to be attentive to all employees (Cooper & Edgett, 2009), which, according to interviewed R&D managers, is achieved by idea competitions. Bombardier RCS and Sandvik Coromant engage in similar internal idea competitions, with the purpose of generating and bringing attention to ideas throughout the organization. Idea competitions allow people to generate ideas nominally before they are assessed and further built upon by other people, which is effective and delivers the 'best' ideas (Giotra, 2010). In Bombardier RCS, participation is incentivized by the opportunity to present your idea in front of upper management, as well as rewards in form of time to further explore the idea. Although offering extrinsic rewards has been shown to affect creativity negatively (Griffiths-Hemans and Grover, 2006), the rewards' main objective is to allow for further idea development which can be argued to be rooted in intrinsic motivation.

All ideas that are submitted are given feedback, which is important to maintain a flow of ideas (Koen et al., 2002). According to the Head of Innovation & Knowledge Management, this allows further buildup of ideas by managers or people with more extensive knowledge of radical ideas.

The idea competitions also increase the awareness of what others in the organization are working on. Leifer (2000) described how people who have identified an idea may not understand its potential, and so by surfacing ideas and letting others have inputs can improve the idea.

An alternative to internal idea competitions could be to integrate users, as suggested by Piller and Walcher (2006). Sandvik Coromant, for example, used crowdsourcing to generate potential ideas for the use of graphene. As focusing too much on developing for existing customers risk the creation of mainly incremental ideas, it is important to identify and include lead users (Von Hippel, 1986; O'Connor & Veryzer 2001).

The potential of internal and user-involved idea competitions are demonstrated by the observed companies as well as in theory. An R&D project manager at BillerudKorsnäs notes however that they have tried similar idea campaigns online, which have not been successful. He suggested that the problem could be related to a narrow topic, limited pressure from management to participate, and few participants. By including more employees or users outside the internal R&D function (Piller & Walcher, 2006), or experimenting with topic specificity (Ebner et al., 2009; Piller & Walcher, 2006) BillerudKorsnäs could potentially reach greater success.

5.2.2 Workshops and brainstorming sessions

Sandvik Coromant and ABB Corporate Research have used workshops to generate ideas sporadically, but none describe it enthusiastically. The Idea management at Sandvik Coromant organize workshops ad hoc, with specific techniques for idea creation, which have been somewhat successful. The R&D manager at Sandvik Coromant claims that the way to create bold ideas is to gather people with fundamentally different perspectives, together with someone who can facilitate the generation process. Paulus (2000) suggest that diverse skills and a knowledge overlap between the participants are needed to evaluate the contributed ideas. Similarly identified in Sandvik Coromant, Paulus (2000) also emphasize the use of facilitators to manage the interaction. The inclusion of lead users in workshops can also produce truly novel products that are valuable for the market (Hienerth et al., 2007; Cooper and Edgett, 2008). Furthermore, regardless whether a workshop is conducted internally or include lead users, a hybrid structure - where ideas are generated individually before the workshop and subsequently discussed - produce the 'best' ideas (Girotra et al., 2010).

BillerudKorsnäs have previously conducted internal workshops to generate radical ideas. An R&D Project Manager at BillerudKorsnäs describe that the generated ideas have not been viable, which he suggested have been due to a lack of structure and a connection between the participants and the problem. By drawing lessons from ABB Corporate Research, Sandvik Coromant and from theory, BillerudKorsnäs could potentially increase the benefits of conducted workshops.

5.2.3 Stimulating the sharing and generating of ideas

A number of the enquired external firms encourage and enable the informal exchange of opinions and experiences between employees. These types of informal networks and interaction between employees can improve the generation of ideas (Björk & Magnusson, 2009; Griffiths-Hemans & Grover, 2006). ABB Corporate Research hold biannual strategy meetings to facilitate contact between employees. The informal exchanges that occur enable networking and idea generation through the sharing of experiences and ideas between employees, according to the R&D Manager. The Principal Project Manager at Sandvik Coromant recognize the benefit of discussing ideas over coffee, but emphasize the importance of transparency, as it minimizes the risk of ideas being discussed in the 'wrong' forums where they amount to nothing. Other observed firms rely to a greater extent on so called spider-in-the-web personas, often managers, that connect employees

with people with relevant knowledge. This could create a dependence on spider-in-the-web persons, and require them to be sufficiently knowledgeable and connected to realize where an idea should be directed. Companies can attempt to facilitate the informal interaction between its employees by increasing formal collaboration between divisions and by creating supporting communities (Björk & Magnusson, 2009; Griffiths-Hemans & Grover, 2006).

BillerudKorsnäs have through its recent restructuring of technology excellence centers increased the transparency and provided a forum for where ideas within certain domains naturally can be discussed. To enable further generation of ideas, BillerudKorsnäs can arrange formal events where the R&D department, which is spread out over many locations, can exchange information and experiences.

5.3 IDEA SELECTION

Company	*Idea selection activities*
BillerudKorsnäs	Ideas are mainly selected based on strategic relevance, but also financial aspects. Radical ideas are assessed and selected by their technical and business proximity to BillerudKorsnäs. They do not have a specific procedure on what criteria to divest current research and start new ones, and whom to take the decisions. Idea selection is often based on gut feeling.
ABB Corporate Research	An idea needs to be feasible and have a potential market. Selection is highly based upon experience
Sandvik Coromant	Selection will be based on strategic roadmaps, based on Sandvik's needs. Responsibility to assess and prioritize ideas under supervision is handed to technology area managers. Selection is not based on formal estimations or calculations of future market, but on perceived realized benefit.
Bombardier RCS	Selecting ideas in early stages often relies on gut feeling. Ideas are often discussed at board meetings with the president of Bombardier RCS, who has the executive call if to proceed. Bombardier RCS seldom focus on 'cool ideas' in favor of financially attractive ideas backed up by business cases.

Table 4. Brief summary of Idea selection

The empirical observation identifies that ideas often are distinguished into two overall categories: incremental ideas and radical/'far-out'/disruptive ideas. In terms of selecting ideas, the former category is less difficult due to lower uncertainties in terms of market and technology (Stringer, 2000). This section will discuss how the observed firms encounter opportunities and select what to further explore, as well as how the portfolio of ideas and R&D can be managed.

5.3.1 Selecting what to further explore

The observed firms share similarities on how to proceed in selecting ideas and what to further research. It is common to rely on one or few people to act as a primary filter to assess and select first encounters with new opportunities, as well as internal and external ideas. In terms of actively seeking and assessing ideas, initial screening and selection is often delegated to technology excellence center managers, technology area managers, Heads of Innovation & Knowledge Management, etc. Thus, it is highly important to address relevant people to these roles (Ardichvili et al., 2003; Reid & De Brentani, 2004).

Furthermore, these roles tend to have a high degree of freedom to initially decide what to further explore and research. However, selection is still supervised by reporting to higher management which can directly and indirectly influence what to proceed with (Rietzschel et al., 2010). Among the external companies, this is often informally done by discussing or articulating with different tools, but without clear criteria. However, Sandvik Coromant emphasizes that people working with knowledge building activities and early research should not select ideas based on monetary aspects. Similarly, Cooper et al. (1999), stress the importance of selecting R&D projects based on their strategic relevance in order to produce high performing R&D portfolios. Despite what procedures

a firm has, all observed firms in this study agree that in the end it all comes down to gut feeling and experience when selecting any kind of ideas in early phases of innovation.

BillerudKorsnäs has expressed difficulties in selecting ideas, both by the CEO and the R&D Director. They share however similarities with the external firms, but there are factors that needs to be considered. Similar to Sandvik Coromant, BillerudKorsnäs extract interesting project from technology excellence centers primarily based on their strategic relevance, which is proven to be effective (Cooper et al., 1999). Furthermore, as BillerudKorsnäs are adamant of finding radical innovations, it is important to clearly communicate what ideas the firm are looking for as it affects the selection (Rietzschel et al., 2010).

5.3.2 Selecting and Managing the Portfolio of Ideas and R&D Projects

Furthermore, there are several methods and techniques in managing the portfolio of ideas and what to prioritize. As mentioned earlier, Cooper et al. (2001) suggest that strategic methods are preferable, but they further explain that a combination of several is optimal, as no single method yield a perfect result. They also argue that portfolio management needs to be taken seriously, and that an explicit and formal method is necessary, meaning that all ideas should be assessed in the same manner. However, both Cooper et al. (2001) and Nagji and Tuff (2012) stress the importance of having a balanced portfolio. Nagji and Tuff's (2012) argue that the balance between core, adjacent, and transformational innovation ambitions should reflect what a firm wants to achieve.

Two of the external companies agree that in order to achieve radical innovation, risk needs to be acknowledged but accepted. The Head of Innovation & Knowledge Management at RCS and the Principal Project Manager at Sandvik Coromant stress the importance of pursuing several paths and acceptingly knowing that many will fail. Failure is not necessary related to losses, as experience might be valued as gained knowledge.

There are lessons to learn for BillerudKorsnäs regarding idea selection. BillerudKorsnäs can enhance idea/project selection and prioritization performance by increasing number of R&D portfolio management methods beyond the identified strategic and financial such as Scoring models, Checklists, and Bubble diagrams (Cooper et al., 1999). Also, as BillerudKorsnäs are more dedicated to find transformational innovations, this should be reflected in their portfolio balance, but also by their risk taking.

5.4 FILLING THE KNOWLEDGE GAPS

Company	*Filling the knowledge gaps*
BillerudKorsnäs	BillerudKornsäs fill knowledge gaps through internal research, external research with universities, suppliers and research institutes, and through hiring. BillerudKorsnäs also acquire companies and technologies through BK Venture. BillerudKorsnäs has also initiated a restructuring effort into technology excellence centers which can indirectly fill knowledge gaps.
Sandvik Coromant	Sandvik Coromant conducts research programs and collaborates with universities and external entities to fill identified knowledge gaps. Acquisitions to build knowledge are carried out, but not without a clear business motive. Sandvik Coromant is in the process of creating a new virtual organization, which is planned to highlight and facilitate the closing of knowledge gaps.
ABB Corporate Research	ABB collaborates with over 70 universities to research far-away radical technologies. The PhDs working with research programs are subsequently hired. ABB make strategic acquisitions start-ups and technologies through their venture function, often outside of their key technologies.
Bombardier RCS	Bombardier RCS collaborate with external entities in areas in which they have insufficient knowledge. Proven concepts and credible firms are important for Bombardier RCS. They describe themselves as more cautious in exploring new arenas.

Table 5. Brief summary of Filling the knowledge gaps

Understanding and internalizing external knowledge that is not known to the company is key to developing radical innovations (Green et al., 1995). In the observed external companies, opportunities and threats that emerge are often driven by new technologies. Radical innovations rely on knowledge in which the company is inexperienced (Green et al., 1995). Developing radical product innovation therefore requires an exploration of novel technology areas and the development of new technology bases (Vanhaverbeke et al., 2003). The need of filling knowledge gaps is apparent in the front end of innovation. A prerequisite to identifying opportunities and generating new ideas is knowledge and comprehension about a new or previously unknown technology. There are many approaches of filling the knowledge gaps, both identified in theory as well as in the observed external firms.

There are three alternatives for obtaining new technology: (1) acquire a company that already possess the technology, (2) independently develop the technology, (3) enter some form of alliance including joint ventures, licensing agreements and various forms of R&D consortia (Lambe & Spekman, 1997) All of the alternatives are used in the observed external companies to different extents. The observed external companies emphasize the importance of collaborations in filling knowledge gaps and expanding their knowledge base. Sandvik Coromant says that strategically important areas need to be aided with collaborations. Furthermore, the R&D Director says that the greater technological distance to a new area, increase the need for collaborations.

Firstly, ABB utilize their venture function as a way to research and understand new technologies outside of their key technologies that they have deemed strategically interesting. The R&D manager at ABB Corporate Research claims that buying a small stake in a company is the best way to bring in new technological areas. Secondly, Both ABB Corporate Research and Sandvik Coromant participate in university collaborations, which significantly impact the innovative performance (Howells et al., 2012). Sandvik Coromant make sure to have internal personnel active in the research program to internalize the knowledge that is built. The collaborations initiated by ABB are mainly employed to research disruptive and radical technologies at a clear distance from their own research. It is common at ABB to hire PhD students after completed research program to make sure that the knowledge enter the company. Thirdly, the Principal Project Manager at Sandvik Coromant describes an example with a new technology which they identified as a threat without a full comprehension of its implications. As the possible effects of the technology could affect many aspects of their business, a research effort was created, sourcing personnel from many divisions. The knowledge built from the effort was then brought back to respective divisions by the participants.

What the best course of action in obtaining and understanding new technology is not obvious. What achieves high financial performance and innovativeness is striking a balance between external and internal technology sourcing, as well as a high level of absorptive capacity (Rothaermel & Alexandre, 2009). At the same time, there are factors which influence what a company are most likely to choose. In the advent of a new potential disruptive technology, the uncertainty of its impact motivates firms to use alliances and joint development (Lambe & Spekman, 1997). The acquisition of a technology or company is more expensive as the price generally includes both the technology they desire and assets it does not need, but is motivated if a desire for greater control exists (Lambe & Spekman, 1997). The R&D manager at ABB Corporate Research says that the decision between acquisition or collaboration and internal development is dependent on factors such as knowledge, feasibility, and cost. If they can internally develop the necessary factors to occupy a lucrative part of a value chain, they will do it themselves.

There are two scenarios when BillerudKorsnäs want to increase their understanding of specific technology; a new technology emerges which could affect their business, or they want to combine their knowledge base with knowledge in another technology area to enter or create a new market. BillerudKorsnäs use the same methods identified in the external companies to fill knowledge gaps and increase their knowledge base, such as hiring experts and participating in research programs with universities and other external entities, as well as acquiring other companies. New technologies or concepts that emerge are usually researched through universities or collaboration with other external entities, to hedge against risk. According to the Project Manager at BillerudKorsnäs, the potential disruptive technologies in the business are few and slow. This opens up the choice to develop knowledge through internal research programs, to achieve greater control.

BillerudKorsnäs also attempt to leverage their capabilities in adjacent technology areas to create new markets. A more distant external knowledge base will increase the likelihood of generating creative and novel ideas (Bierly et al., 2009), but the importance of collaboration is greater, suggests the R&D director at Sandvik Coromant. A wish for more control over an eventual new product can prompt the use of acquisition. Finally, BillerudKorsnäs's recent initiated restructuring of technology areas into technology excellence centers achieves a concentration of internal knowledge bases. Similarly to the perceived benefits identified by Sandvik Coromant, centers of excellence suggests a possibility to increase synergies between different technology areas, as well as improving the understanding what is actually known by employees in each technology area. This suggests that

the ongoing restructuring could fill some knowledge gaps without the engagement of external entities.

5.5 POSSIBLE WAY FORWARD FOR BILLERUDKORSNÄS

As mentioned in the introduction, BillerudKorsnäs have due to intensified rivalry and recent developments in related industries, developed an increased sense of urgency to find radical product innovation. The earliest phases, or the front end, of radical product innovation, constitute the biggest learning opportunity for BillerudKorsnäs. Improving the front end is one of the biggest opportunities to advance the innovation process. Observations of external companies and previous research have provided examples of alternative approaches including activities and facilitating factors. The empirical observation shows that the firms actively try to manage the front end of innovation and acknowledge the value of mastering it. There are both similarities and differences between how the external companies work with the front end activities as well how they try to facilitate the process through organizational structures, external collaborations and through.

The observed mature firms have several ways of identifying opportunities, generate and select ideas at the front end of innovation, many which they share with each other and with BillerudKorsnäs. The observed firms do not rely on a single method, instead they emphasize the importance of being attentive to the external environment by employing, and delegating responsibilities to, open minded, driven, and curious people. Furthermore, they acknowledge the importance of listening to everyone in the organization, as all people can have identify interesting opportunities or generate ideas of great value. To make the innovative ambition known to the entire company and increase the transparency through organizational structures and discussion through idea competitions and meetings with different divisions is regarded as important by the external companies. A more direct approach to identify opportunities include understanding and mapping the capabilities of the company to try and apply it to other contexts.

Moreover, selecting ideas or what research to further pursue are not easily assessed. Several of the observed companies express that selection of early ideas and research is often based on gut-feeling which in turn is based on experience. The embryonic nature of ideas in the front end of product innovation makes the evaluation difficult. Hence, many of the observed firms does not rely on certain criteria or basis, instead they once again stress the importance of individuals, discussions, and experience. There are however possibilities in managing selection at the front end of radical product innovation by strategy and senior management communication. Hence, what higher management communicate and strategically prioritize, will have an affection on what individuals in the organization will select.

Furthermore, during opportunity identification, idea generation, and idea selection it is a constant challenge to overcome uncertainties and knowledge gaps. Similarly to the activities, the observed companies does not rely on a simple method, instead they use a combination of various channels to gain knowledge. Several of the observed firms express that when knowledge seems farfetched they might rely on acquiring knowledge through M&As or Strategic alliances, while familiar knowledge are more suitable for in-house development. The need for speed and control can determine the choice of method for filling the knowledge gaps, but maintaining balance between internal and external knowledge sourcing is vital.

In summary, radical innovations are generally hard to identify and create and whether a new product is radical is perhaps not even seen until after its launch. To realize an ambition of generating radical innovation is therefore no quick fix. Instead, it is important to make sure that

the company have the preconditions in place to enable the development of more radical ideas. These can include a combination of different activities and facilitating factors, which reinforce each other. It is difficult to assess what is the right way of doing something, or whether there exists one at all. However, from observing the external companies and studying literature, it is obvious that BillerudKorsnäs are doing many similar things to what others advocate. There are however some ways of working which are new. Whether these would be a good fit is up to BillerudKorsnäs to decide.

6 CONCLUSION

The study has provided examples of methods and activities in the front end of innovation, and a selection of factors which might facilitate them, from observed firms as well as from theory. Perhaps unsurprisingly, the observed companies show many similarities in the methods and activities used in the front end of innovation, and how they are structured. Distinct front end activities and methods have also been observed, both between BillerudKorsnäs and the external companies, as well as amongst the external companies.

This thesis comes to the conclusion that there are several activities, methods, and facilitating factors regarding the front end of radical product innovation. The observed companies do not rely on one single activity, method, or facilitating factor to enable radical innovation. Instead, they rely on a combination of individuals, informal networks, external collaborations and foremost experience in order to identify opportunities, generate ideas, and select ideas. In addition, they actively manage the facilitating factors by organizing to enable idea surfacing and sharing, utilizing various external collaborations, as well as making innovation a strategic priority.

What is identified through comparing the activities suggested in previous research or through observations in the external companies, is that there exist no universal truth on how to optimally find and generate radical ideas. Neither this study attempts to prove the superiority of one method or approach over another, or show the exact impact of a facilitating factor on the front end activities. How a firm should structure and carry out activities in the front end of innovation cannot therefore be determined solely on the observations of the observed companies or previous theory. It is up to each firm to experiment and feel their way to the optimal methods and activities for their specific situation/circumstance.

LIST OF REFERENCES

Ahmed, P. K. (1998). Culture and climate for innovation. *European journal of innovation management*, *1*(1), 30-43.

Ahuja, G., & Morris Lampert, C. (2001). Entrepreneurship in the large corporation: A longitudinal study of how established firms create breakthrough inventions. *Strategic Management Journal*, *22*(6-7), 521-543.

Ardichvili, A., Cardozo, R., & Ray, S. (2003). A theory of entrepreneurial opportunity identification and development. *Journal of Business venturing*,*18*(1), 105-123.

Benner, M. J., & Tushman, M. L. (2003). Exploitation, exploration, and process management: The productivity dilemma revisited. *Academy of management review*, *28*(2), 238-256.

Bierly, P. E., Damanpour, F., & Santoro, M. D. (2009). The application of external knowledge: organizational conditions for exploration and exploitation. *Journal of Management Studies*, *46*(3), 481-509.

Björk, J., & Magnusson, M. (2009). Where do good innovation ideas come from? Exploring the influence of network connectivity on innovation idea quality. *Journal of Product Innovation Management*, *26*(6), 662-670.

Björk, J., Boccardelli, P., & Magnusson, M. (2010). Ideation capabilities for continuous innovation. Creativity and innovation management, 19(4), 385-396.

Bouchard Jr, T. J., & Hare, M. (1970). Size, performance, and potential in brainstorming groups. Journal of applied Psychology, 54(1p1), 51.

Bower, J. L., & Christensen, C. M. (1995). Disruptive technologies: catching the wave (pp. 506-20). Harvard Business Review Video.

Bryman, A., & Bell, E. (2003). *Business research methods*. Oxford University Press, USA.

Chandy, R. K., & Tellis, G. J. (2000). The incumbent's curse? Incumbency, size, and radical product innovation. *Journal of marketing*, *64*(3), 1-17.

Chesbrough, Henry, Wim Vanhaverbeke, and Joel West, eds. *Open innovation: Researching a new paradigm*. OUP Oxford, 2006.

Christensen, C. M., & Bower, J. L. (1996). Customer power, strategic investment, and the failure of leading firms. *Strategic management journal*,*17*(3), 197-218.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative science quarterly*, 128-152.

Cooper, R. G. (2011). Perspective: the innovation dilemma: how to innovate when the market is mature. *Journal of Product Innovation Management*, *28*(s1), 2-27.

Cooper, R. G. (2013). Where are all the breakthrough new products?: Using portfolio management to boost innovation. *Research-Technology Management*, *56*(5), 25-33.

Cooper, R. G., & Edgett, S. (2008). Ideation for product innovation: What are the best methods. *PDMA visions magazine*, *1*(1), 12-17.

Cooper, R. G., & Edgett, S. J. (2009). *Generating breakthrough new product ideas: Feeding the innovation funnel*. Product Development Institute.

Cormican, K., & O'Sullivan, D. (2004). Auditing best practice for effective product innovation management. *Technovation*, *24*(10), 819-829.

Diehl, M., & Stroebe, W. (1987). Productivity loss in brainstorming groups: Toward the solution of a riddle. *Journal of personality and social psychology*,*53*(3), 497.

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

Ebner, W., Leimeister, J. M., & Krcmar, H. (2009). Community engineering for innovations: the ideas competition as a method to nurture a virtual community for innovations. *R&d Management*, *39*(4), 342-356.

Faems, Dries, et al. "Technology Alliance Portfolios and Financial Performance: Value-Enhancing and Cost-Increasing Effects of Open Innovation*." *Journal of Product Innovation Management* 27.6 (2010): 785-796.

Faure, C. (2004). Beyond brainstorming: Effects of different group procedures on selection of ideas and satisfaction with the process. *The Journal of creative behavior*, *38*(1), 13-34.

Fleming, L. (2001). Recombinant uncertainty in technological search.*Management science*, *47*(1), 117-132.

Galbraith, J. R. (2004). Designing the innovating organization Jay R. Galbraith. *How Organizations Learn: Managing the Search for Knowledge*, 202.

Girotra, K., Terwiesch, C., & Ulrich, K. T. (2010). Idea generation and the quality of the best idea. *Management Science*, *56*(4), 591-605.

Green, S. G., Gavin, M. B., & Aiman-Smith, L. (1995). Assessing a multidimensional measure of radical technological innovation. *Engineering Management, IEEE Transactions on*, *42*(3), 203-214.

Greitzer, E. M., Pertuze, J. A., Calder, E. S., & Lucas, W. A. (2010). Best practices for industry-university collaboration. *MIT Sloan Management Review*,*51*(4), 83.

Griffiths-Hemans, J., & Grover, R. (2006). Setting the stage for creative new products: investigating the idea fruition process. *Journal of the Academy of Marketing Science*, *34*(1), 27-39.

Grix, J. (2010). *The foundations of research*. Palgrave Macmillan.

Hanel, P., & St-Pierre, M. (2006). Industry–university collaboration by Canadian manufacturing firms*. *The Journal of Technology Transfer*, *31*(4), 485-499.

Hennart, J. F., & Reddy, S. (1997). The choice between mergers/acquisitions and joint ventures: The case of Japanese investors in the United States.*Strategic management journal*, *18*(1), 1-12.

Hienerth, C., Pötz, M., & Von Hippel, E. (2007, June). Exploring key characteristics of lead user workshop participants: who contributes best to the generation of truly novel solutions. In *Paper at the DRUID Summer Conference on Appropriability, Proximity, Routines and Innovation, Copenhagen, CBS, Denmark*.

Howells, J., Ramlogan, R., & Cheng, S. L. (2012). Innovation and university collaboration: paradox and complexity within the knowledge economy.*Cambridge Journal of Economics*, *36*(3), 703-721.

Khurana, A., & Rosenthal, S. R. (1998). Towards holistic "front ends" in new product development. *Journal of product innovation management*, *15*(1), 57-74.

Klepper, S., (1996). "Entry, exit, growth and innovation over the product life cycle". American Economic Review 86, 562–583

Koberg, C. S., Detienne, D. R., & Heppard, K. A. (2003). An empirical test of environmental, organizational, and process factors affecting incremental and radical innovation. *The Journal of High Technology Management Research*, *14*(1), 21-45.

Koen, P. A., Ajamian, G. M., Boyce, S., Clamen, A., Fisher, E., Fountoulakis, S., ... & D'Amoe, R. (2002). *Fuzzy front end: effective methods, tools, and techniques*. Wiley, New York, NY.

Koen, P., Ajamian, G., Burkart, R., & Clamen, A. (2001). Providing clarity and a common language to the" fuzzy front end". *Research Technology Management*, *44*(2), 46.

Kohn, N. W., Paulus, P. B., & Choi, Y. (2011). Building on the ideas of others: An examination of the idea combination process. *Journal of Experimental Social Psychology*, *47*(3), 554-561.

Lambe, C. J., & Spekman, R. E. (1997). Alliances, external technology acquisition, and discontinuous technological change. *Journal of product innovation management*, *14*(2), 102-116.

Laursen, K., & Salter, A. (2006). Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. *Strategic management journal*, *27*(2), 131-150.

Lee, Y. S. (2000). The sustainability of university-industry research collaboration: An empirical assessment. *The Journal of Technology Transfer*,*25*(2), 111-133.

Leifer, Richard, Gina Colarelli O'Connor, and Mark Rice. "Implementing radical innovation in mature firms: The role of hubs." *The Academy of Management Executive* 15.3 (2001): 102-113.

Leifer, Richard. Radical innovation: How mature companies can outsmart upstarts. Harvard Business Press, 2000.

Marshall, M. N. (1996). Sampling for qualitative research. *Family practice*,*13*(6), 522-526.

Martins, E. C., & Terblanche, F. (2003). Building organizational culture that stimulates creativity and innovation. *European journal of innovation management*, *6*(1), 64-74.

McDermott, C. M., & O'Connor, G. C. (2002). Managing radical innovation: an overview of emergent strategy issues. *Journal of product innovation management*, *19*(6), 424-438.

Mowery, D. C., Oxley, J. E., & Silverman, B. S. (1998). Technological overlap and interfirm cooperation: implications for the resource-based view of the firm. *Research policy*, *27*(5), 507-523.

Nagji, B., & Tuff, G. (2012). Managing your innovation portfolio. *Harvard Business Review*, *90*(5), 66-74.

Nijstad, B. A., & De Dreu, C. K. (2002). Creativity and group innovation.*Applied Psychology*, *51*(3), 400-406.

Nobelius, D., & Trygg, L. (2002). Stop chasing the front end process—management of the early phases in product development projects.*International Journal of Project Management*, *20*(5), 331-340.

Nonaka, I., & Konno, N. (1998). The concept of" ba": Building a foundation for knowledge creation. *California management review*, *40*(3), 40-54.

O'Reilly, C. A., & Tushman, M. L. (2004). The ambidextrous organization. *Harvard business review*, *82*(4), 74-83.

O'Connor, G. C., & Veryzer, R. W. (2001). The nature of market visioning for technology-based radical innovation. *The Journal of Product Innovation Management*, *18*, 231-246.

Paulus, P. (2000). Groups, teams, and creativity: The creative potential of idea-generating groups. *Applied psychology*, *49*(2), 237-262.

Paulus, P. B., & Yang, H. C. (2000). Idea generation in groups: A basis for creativity in organizations. *Organizational behavior and human decision processes*, *82*(1), 76-87.

Phaal, R., Farrukh, C. J., & Probert, D. R. (2004). Technology roadmapping—a planning framework for evolution and revolution. *Technological forecasting and social change*, *71*(1), 5-26.

Piller, F. T., & Walcher, D. (2006). Toolkits for idea competitions: a novel method to integrate users in new product development. *r&D Management*,*36*(3), 307-318.

Porter, A. L. (2010). Technology foresight: types and methods. *International Journal of Foresight and Innovation Policy*, *6*(1-3), 36-45.

Porter, A.L., Ashton, W.B., Clar, G., Coates, J.F., Cuhls, K., Cunningham, S.W., Ducatel, K., van der Duin, P., Georghiou, L., Gordon, T., Linstone, H., Marchau, V., Massari, G., Miles, I., Mogee, M., Salo, A., Scapolo, F., Smits, R. and Thissen, W. (Technology Futures Analysis Methods Working Group) (2004). Technology futures analysis: toward integration of the field and new methods'. *Technological Forecasting and Social Change*, *71(3)*, 287–303.

Putman, V. L., & Paulus, P. B. (2009). Brainstorming, brainstorming rules and decision making. *The Journal of creative behavior*, *43*(1), 29-40.

Reger, G. (2001). Technology foresight in companies: from an indicator to a network and process perspective. *Technology Analysis & Strategic Management*, *13*(4), 533-553.

Reid, S. E., & De Brentani, U. (2004). The fuzzy front end of new product development for discontinuous innovations: A theoretical model. *Journal of product innovation management*, *21*(3), 170-184.

Reuer, J. J., & Koza, M. P. (1998). Asymmetric information and joint venture performance. INSEAD.

Rietzschel, E. F., Nijstad, B. A., & Stroebe, W. (2010). The selection of creative ideas after individual idea generation: Choosing between creativity and impact. *British journal of psychology*, *101*(1), 47-68.

Rothaermel, F. T., & Alexandre, M. T. (2009). Ambidexterity in technology sourcing: The moderating role of absorptive capacity. *Organization science*, *20*(4), 759-780.

Saunders, M. N. (2011). *Research methods for business students, 5/e*. Pearson Education India.

Saunders, M., Lewis, P. and Thornhill, A. (2012). *Research methods for business students*. Harlow: Pearson Education Limited.

Soukhoroukova, A., Spann, M., & Skiera, B. (2007, March). Creating and evaluating new product ideas with idea markets. In *The Wharton School of the University of Pennsylvania, Marketing Department Colloquia*.

Stringer, R. (2000). How to manage radical innovation. *California management review*, *42*(4), 70-88.

Stummer, C., & Heidenberger, K. (2003). Interactive R&D portfolio analysis with project interdependencies and time profiles of multiple objectives.*Engineering Management, IEEE Transactions on*, *50*(2), 175-183.

Tracy, S. J. (2010). Qualitative quality: Eight "big-tent" criteria for excellent qualitative research. *Qualitative inquiry*, *16*(10), 837-851.

Tushman, M., & Nadler, D. (1986). Organizing for innovation. *California management review*, *28*(3), 74-92.

Utterback, J. (1994). Mastering the dynamics of innovation: how companies can seize opportunities in the face of technological change. *University of Illinois at Urbana-Champaign's Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship*.

Van de Vrande, V. (2013). Balancing your technology-sourcing portfolio: How sourcing mode diversity enhances innovative performance. Strategic Management Journal, 34(5), 610-621.

Vanhaverbeke, W., Berends, H., Kirschbaum, R., & De Brabander, F. (2003). Knowledge management challenges in corporate venturing and technological capability building through radical innovations. *Eindhoven Centre for Innovation Studies Working Paper*, *3*.

Vanhaverbeke, W., Duysters, G., & Noorderhaven, N. (2002). External technology sourcing through alliances or acquisitions: An analysis of the application-specific integrated circuits industry. *Organization Science*, *13*(6), 714-733.

Von Hippel, E. (1986). Lead users: a source of novel product concepts. *Management science*, *32*(7), 791-805.

Witzeman, S., Slowinski, G., Dirkx, R., Gollob, L., Tao, J., Ward, S., & Miraglia, S. (2006). Harnessing external technology for innovation. Research-Technology Management, 49(3), 19-27.

Zhao, H., Tong, X., Wong, P. K., & Zhu, J. (2005). Types of technology sourcing and innovative capability: An exploratory study of Singapore manufacturing firms. *The Journal of High Technology Management Research*, *16*(2), 209-224.