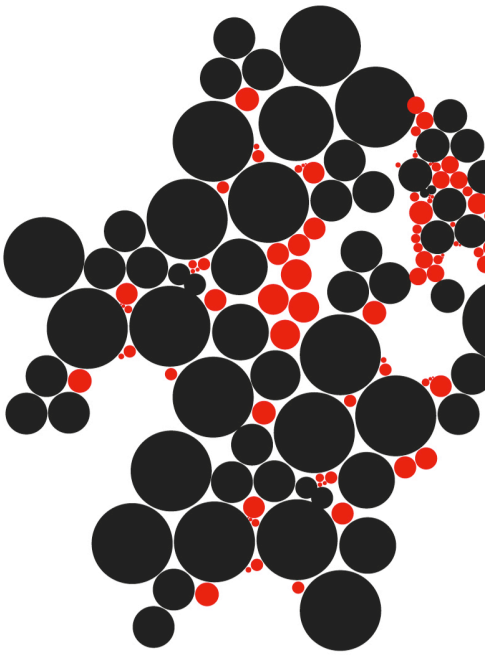

WHAT DOES OPEN INNOVATION IMPLY FOR HIGH-TECH SMES?

AN EMPIRICAL STUDY AND ANALYSIS ON MOTIVES, CHALLENGES AND CONSEQUENCES

by Maarten Munster

UNIVERSITY OF TWENTE.
SCHOOL OF MANAGEMENT & GOVERNANCE
NIKOS / OOHR

EXAMINATION COMMITTEE
R.P.A. Loohuis, MBA
Prof. dr ir. P.C. de Weerd-Nederhof

MASTER THESIS
AUGUST 2011

Master Thesis

What does Open Innovation imply for high-tech SMEs?

An empirical study and analysis on motives, challenges and consequences

Maarten Munster

University of Twente
School of Management & Governance
NIKOS / OOHR

August 25, 2011

Graduate student

Name	:	Ing. Maarten M.G. Munster
Student ID	:	s0161551
Email	:	maartenmunster@gmail.com

Graduation committee

Chairman	: Raymond .P.A. Loohuis, MBA
Email	: r.p.a.loohuis@utwente.nl
Second supervisor	: Prof. dr ir. Petra C. de Weerd-Nederhof
Email	: p.c.deweerd@utwente.nl
University	: University of Twente, the Netherlands
Faculty	: School of Management & Governance
Department	: NIKOS / OOHR

ACKNOWLEDGEMENTS

This report is my final thesis and is written to obtain my Master of Science degree in Business Administration at the University of Twente in the Netherlands.

Although it is my name figuring on the cover, the realization of this research is certainly not a one-man show. Imperceptibly I have created, built and used a network in which several people contributed nuggets of wisdom that built my knowledge. I want to acknowledge my gratitude to all that helped me deliver this product.

In particular, I wish to express my sincere gratitude to my supervisors at the University of Twente, Dries Faems, Raymond Loohuis and Petra de Weerd-Nederhof, who provided insights that guided and challenged my thinking. More generally, I would like to thank all the concerning employees of the University of Auckland for fully cooperating with my research. My special acknowledgements go to professor Rainer Seidel, for his guidance and support. I would also like to convey my appreciation to the companies who kindly agreed to be part of the case studies. Without the generous contribution of those companies and individual participants, this study would not have been possible. Finally, I would like to thank my family and friends for their encouragement and support.

Writing this report already shows the value of a good network, the delivery of this product was a joint effort. I made use of the 'network' around me to come to new insights, something I was not able to do on my own. But I am not the only one facing this issue; every day organizations struggle to come up with new products or get new insights and the value of a good network is becoming clearer. In this thesis report, I have focused on a particular phenomenon in this development dubbed open innovation.

I have tried to write this report easily digestible for an audience familiar with and interested in academic discourse about innovation in high-tech SMEs. For the lay reader with interest in managerial consequences, I devoted a special section at the end of this report. Should you have any questions when reading this master thesis, please do not hesitate to contact me.

Kind regards,

Maarten Munster

Dronten, the Netherlands | August, 2011

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

GLOSSARY

Open Innovation	The use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. Open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology (Chesbrough, 2003).
Process innovation	New or significantly improved methods, equipment and/or skills used to perform the product/service
Product innovation	New or significantly improved characteristics of the product/service offered to customers
Knowledge spill over	A non-rival knowledge market externality that has a spill over effect of stimulating technological improvements in a neighbour through one's own innovation
Incremental innovation	Small improvements in existing products and operations that let them operate more efficiently and deliver ever-greater value to customers (O'Reilly and Tushman, 2004).
Radical innovation	Radical advances that profoundly alter the basis for competition in an industry, often rendering old products or ways of working obsolete (O'Reilly and Tushman, 2004).
External networking	Drawing on or collaborating with external partners to support innovation processes, for example external knowledge or human capital
Outward IP licensing	Selling or offering licenses or royalty agreements to other organizations to better profit from your intellectual property, such as patents, copyrights or trademarks
Inward IP licensing	Buying or using intellectual property, such as patents, copyrights or trade marks, of other organization to benefit from external knowledge.
Outsourcing R&D	Buying R&D services from other organizations, such as universities, public research organizations, commercial engineers or suppliers.

LIST OF ACRONYMS

R&D	Research & Development
SMEs	Small and Medium-sized Enterprises
High-tech	High technology
Low-tech	Low technology
Medium-tech	Medium technology
Cfi – programme	Competences of innovation - programme
CEO	Chief Executive Officer
CFO	Chief Financial Officer
CTO	Chief Technological Officer (also R&D manager)
IP	Intellectual Property
IPR	Intellectual Property Rights
OEM	Original Equipment Manufacturer

ABSTRACT

The term open innovation has become a major buzzword in innovation management. But behind the buzz is a sustainable message: Successful innovation is not solely performed internally within a firm, but in a cooperative mode with other external actors. Sources of external input for innovation are plentiful, including market actors like customers, suppliers, competitors and the scientific system of university labs and research institutions. The core idea of a new era of open innovation is the integration of these actors in a flexible and informal way beyond the traditional notion of innovation alliances or contract research. Such a range and complexity of activities can bring its own challenges in terms of the effort required to make Open Innovation happen, often drawing upon the valuable time of key staff and stretching the organization in a variety of new directions. While this phenomenon has been recognized at large multinational companies (Chesbrough, 2003) the applicability at Small and Medium-sized Enterprises (SMEs) is less clear. This formed the point of departure for this research. Open Innovation was defined as "how the company works with external actors outside the organization to foster innovation" and the focus has been on the adoption of open innovation at high-tech SMEs. The study has led to some revealing insights into motives to – challenges resulting from – and consequences of - open innovation: from the potential pitfalls, to the opportunities presented by working with external expertise. An innovation scan consisting of relevant and proven scales has been used to collect quantitative data on the respective cases (N=38), its innovation performance and its relations to external actors. Subsequently, qualitative data has been gathered by the selection of four high-tech SMEs, on which an in-depth study about motives, challenges and consequences has been conducted. The results show that in the quantitative analyses no significant differences could be found in the adoption of open innovation at low- and high-tech SMEs. However, it did show that SMEs in general have relatively small networks and innovative relationships seem to evolve around natural supplier/customer collaborations. These relationships indicated to be very intensive, meaning they holster a lot of innovation. This was confirmed in the multiple case study, with the addition that some collaboration with universities took place on an exploratory basis. Furthermore, motives to engage in open innovation were identified, including: opening new markets, entering new technological domains, market research and cost reduction by early customer integration. Also de-motives were quoted such as preventing imitation and sticking to the company's own business. Challenges were found in the typical lack of resources to pursue an open innovation strategy, risk, proximity of partners and backseat/driver seat dynamics. Finally, consequences for high-tech SMEs were highlighted. Many authors describe open innovation as being a new phenomenon, bus as argued in this thesis, companies never have or had a fully closed innovation system. Open innovation is a paradigm switch fuelled by the increasing globalization and improving information technologies, high-tech SMEs can participate in this landscape, but will have to find their own place.

1 INTRODUCTION

1.1 Relevance

Today's manufacturing industry not only has to respond to the economic fluctuations, it also has to take in to account the recent technological, global and workforce trends. Nowadays, the new manufacturing environment is characterized by intense global competition, rapid technology changes and product variety proliferation (Pun, 2004). As a result, manufacturing companies have to deal with more demanding customers, greater competitive intensity, and increased complexity in production technology and coordination (St. John et al., 2001). Companies have started to look for new ways to increase the speed and effectiveness of their innovation approaches. Developing a steady stream of new products or services is essential for most companies and very few can do this by only using their own resources and must look for potential collaborators outside their own company to provide the technologies, skills or knowledge they lack. Cooperation with other organizations increases the innovation performance of organizations (Chang, 2003; Hanna & Walsh, 2002; Ritter & Gemünden, 2003, 2004; Rothwell, 1991; Salman & Saives, 2005), but managing this more collaborative approach – known as 'open innovation' – demands a range of skills and capabilities that many firms do not possess. Chesbrough (2003) first coined the term open innovation as an emerging new paradigm in innovation research in his book 'Open Innovation' (2003). He defined open innovation as:

> "*The use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. Open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology*."

This is a paradigm shift from the traditional vertical integration model where internal R&D activities lead to internally developed products that are then distributed by the firm. The open innovation paradigm treats Research & Development (R&D) as an open system. Open innovation suggests that valuable ideas can come from inside or outside the company and can go to market from inside or outside the company as well. This approach places external ideas and external paths to the market on the same level of importance as that is reserved for internal ideas and paths to the market in the earlier era (Chesbrough et al., 2006). Open innovation embraces a wide range of initiatives including:

- Accessing new technologies, know how, intellectual property and ideas from external sources such as other companies, universities, inventors and innovation 'brokers' through partnering, licensing and joint ventures.
- Effective integration and exploitation of these external elements into innovative new product, process and service developments.
- Collaboration on innovation with suppliers, customers, industry networks and competitors.
- Spinouts, venturing and out-licensing to gain value from ideas and technologies that do not fit the core strategy of the company.

Chesbrough (2006) acknowledges that open innovation has achieved a certain degree of face validity within at least a small portion of large companies in high-tech industries. Large companies are in a relatively stable, structured business environment and resource availability facilitates research. However, the volatile environment and limited resources

of a Small and Medium-sized Enterprise (SME) impede 'good' research and it therefore remains an open question whether the concept of open innovation applies to SMEs. SMEs remain socially and economical important, since they represent 99% of all enterprises in the EU, providing around 65 million jobs (EC, 2003).

Although SMEs enjoy unique advantages related to their business culture and flexibility, the lack of resources is a constraint for exploiting their innovative capabilities (Freel, 2000; Hanna & Walsh, 2002; Kaufmann & Tödtling, 2002). It is hard for SMEs to outperform their – larger - competitors. As a result, SMEs face huge challenges; they have to design and make technology intensive products, and they have to capture the imagination of customers worldwide. Such products have to be attractive, innovative and competitive in the global marketplace. Is it possible for SMEs to use open innovation to achieve such important ambitions? Or is open innovation only reserved for large companies?

1.2 Two research groups: University of Twente/Auckland

In most nations, SMEs are the most common form of business organization and represent a vital component of the nation's economy. For that reason, the University of Auckland and the University of Twente have independently started research groups to support national and regional SMEs with their innovation issues.

Innovationz is a New Zealand-based research group closely linked to the University of Auckland. Their goal is to establish a sound understanding of the manufacturing industry from a theoretical as well as a practical perspective through the exploration and identification of the factors and issues that have an impact on the innovation capability of a manufacturing SME. The group ultimately wants to help the New Zealand-industry to become more innovative and develop and maintain international competitiveness.
The research approach of Innovationz is mainly based on an inside-out approach. In this perspective, the research group tries to investigate how manufacturing SMEs in New Zealand can exploit their R&D and innovation capabilities to develop innovative new proprietary products. Most of the research is conducted through Action Research. In the past, this embedded form of case study has already delivered significant practical benefits to both the primary case organization as Innovationz.

Simultaneously with Innovationz' efforts, the OOHR and NIKOS departments of the University of Twente in the Netherlands have established a similar project. This project, dubbed 'Competences for innovation' (Cfi), aims at improving the innovation capacity of SMEs in the eastern region of the Netherlands. The research group follows the competence-based view of firms (Lado & Wilson, 1994; Freiling, 2004), which is also an inside-out approach built upon the resource-based view. To help the participating companies, research is conducted by in-depth longitudinal case studies, in which data collection is done by surveys and interviews. The starting point of this method is the assessment of a participating company with an innovation scan. After this, core topics for common interest are identified, and through follow-up interviews methods are developed for the enlargement of the organization's innovation capacity.

Although the research objective and research approach of the two research groups are rather similar, their methodology differs. While the research of Innovationz is mostly done through action research, Competences for innovation uses surveys and interviews in longitudinal studies. Conversely, the viewpoints of the two project groups show some dissimilarity. Innovationz aims to leverage the innovation capacities by making the

business process more understandable through visualization, and using metaphors to make theory easier to digest. Competences for innovation, on the other hand, tries to improve the organization's innovation competences by finding contradictions or 'misfits' in the organization by using academically verified scales. These academic scales are built upon different topics that are related to the innovation process, and address a variety off issues the company in question has to deal with.

Nonetheless, both research groups acknowledge there is much to learn on the functioning of innovation at SMEs. The work of NIKOS/OOHR's Cfi-program is complementary to the work of the Innovationz team. It can be argued that the joint problem both research groups struggle with is to develop a better understanding of innovation practices at SMEs. This thesis has been executed at both departments and gathered data from either side on the motives and challenges in engaging open innovation at high-tech SMEs.

1.3 Research objective and questions

SMEs are traditionally an unpopular subject to study due to its vagueness and non-standardized principles. This thesis wants to establish a sound understanding of this area from a theoretical as well as a practical perspective through the exploration and identification of the motives and challenges and that have an impact on the adoption of open innovation principles at a high-tech SME. My interest goes to examining the adoption rate of open innovation at high-tech SMEs. Therefore:

"The objective of this research is to create a better understanding of the adoption of open innovation at high-tech small and medium-sized enterprises"

From this, the following research questions can be derived:

1) *What is the adoption rate of open innovation at high-tech SMEs?*

2) *What are the motives for high-tech SMEs to engage in open innovation?*

3) *What challenges do high-tech SMES face when managing open innovation?*

4) *What are the consequences for high-tech SMEs to engage in open innovation?*

The research questions are a systematic breakdown of the research objective; a more elaborated explanation leading to the deduction of these questions is discussed in the theoretical framework. First a quantitative analysis will be initiated to find an answer for the first question. Secondly, a multiple case study on four case organizations will be conducted to answers the second, third and fourth research question. Together, the answers to these questions will provide the answer to the main objective. Furthermore, from these findings conclusions will be drawn and suggestions will be generated which need to be validated in future research on the subject of open innovation at high-tech SMEs. The topic of this thesis can work in a complementary way for both the Innovationz group and the Competences for innovation project and add value to the overall approach the projects aim for.

2 THEORETICAL FRAMEWORK

Starting this research, a thoroughly inquiry of all relevant and recent developments on open innovation at SMEs will be conducted to get a comprehensive understanding of the subject. This theoretical framework is composed of multiple parts; it will start off with defining high-tech organizations and small- and medium-sized enterprises, followed by the characteristics of high-tech SMEs. Subsequently, the concept of open innovation is discussed and within the open innovation chapter the asserted openness is described before coming up with an analytical framework. Finally, high-tech SMEs are added to the mix converging both subjects so that there is a scientific base underpinning the research questions.

2.1 High-tech small and medium-sized enterprises

This research will particularly look at open innovation at high-tech SMEs. SMEs have been variously defined which created a certain amount of confusion, complicating analyses and studies of SMEs. Hence, before diving into open innovation, SMEs will be defined so there is a good understanding of what is being discussed. Also, the specific characteristics of high-tech SMEs will be highlighted.

2.1.1 Definition of small and medium-sized enterprises

If enterprises fulfil the criteria laid down by the European Commission (2003) they qualify as micro, small and medium-sized enterprises, as summarized in table 1.

Enterprise size	Headcount	Turnover	or	Balance sheet total
Medium	< 250	≤ €50 million		≤ €43 million
Small	< 50	≤ €10 million		≤ €10 million
Micro	< 10	≤ €2 million		≤ €2 million

Table 1: operationalization of small and medium-sized enterprises (EC, 2003)

In addition to the staff headcount ceiling, an enterprise qualifies as an SME if it meets either the turnover ceiling or the balance sheet ceiling, but not necessarily both. Micro-sized and large enterprises will be left out of this study.

2.1.2 Definition of high-technology enterprises

The notion of 'high-tech' has become a frequently used category, which is generally applied to classify differences in the industry. The OECD (2004) classifies technology in high-, medium high-, medium low- and low-tech industries. This definition is based on the share of sales spent on research and development (R&D) in different industry sectors. Various scholars (Hirsch-Kreinsen et al., 2005; Von Tunzelmann and Acha, 2005) criticized the usefulness of this classification arguing that the concept of low-tech and high-tech refers to industry sectors in general, not to single firms. However, depending on the degree of intra-sectorial heterogeneity, a sectorial approach might be misleading because it reflects an industry average and ignores differences within the sector.

Legler and Frietsch (2007) propose a classification based on sectorial R&D expenditure. Unlike the older OECD definition (2004), which distinguishes between four different sectorial R&D intensities, this classification consists of three classification categories.

The innovation scan, developed by the University of Twente, distinguishes the same categories and assumes a broader range, see table 2.

Type of enterprise	Percentage of turnover spent on R&D
High-tech	> 10 %
Medium-tech	5 – 10 %
Low-tech	< 5 %

Table 2: OOHR's definition of high-, medium- and low-tech enterprises (2009)

This is merely a quantifiable distinction between low-, medium- and high-tech enterprises where technology is considered as the overall discriminating variable. Low-tech SMEs are by definition relatively inert due to their low levels of investment in R&D. Hirsch-Kreinsen et al. (2008) show that low-tech firms are nevertheless quite dynamic technologically. The authors provide evidence that these sectors draws heavily on high-tech sectors; generate substantial innovation themselves (though these activities may not be captured in R&D statistics) and are an important element in the innovativeness and effectiveness of regional and transnational industrial value chains. Furthermore, low-tech firms benefit from diffused technology that sprouted earlier in other high-tech firms and/or universities and do less science-based research (Hirsch-Kreinsen et al., 2008), which explains the biased metrics. But as there is fundamentally less generation and exchange of knowledge in low-tech enterprises in the first place, the category is considered not relevant for my study.

2.1.3 Characteristics of high-tech SMEs

In spite of the diversity and the complexity of conditions every SME is in, they do have particular characteristics that set them apart from their larger counterparts. There have been multiple studies on the strengths and weaknesses of SMEs in their organization of innovation processes (e.g. Vossen, 1998; Acs and Audretsch, 1990). This work concludes that innovation in SMEs is hampered by lack of financial resources; little opportunities to recruit specialized workers and small innovation portfolios so that risks associated with innovation cannot be spread. Kleinknecht (1987, 1989) also found that informal R&D activity plays a larger role in small firms than in larger enterprises. The smallness of a SME is the obvious characteristic and limits the company's economies of scale. This not only occurs in production and management, but also in marketing (i.e. setting up and utilization of channels of communication and distribution) and in transaction costs (i.e. costs of search, contact, contract and control of performance) (Nooteboom, 1993). In his study, Nooteboom (1993) identified some core characteristics and derived properties and resulting strengths and weaknesses, see table 3.

Characteristics	Strengths	Weaknesses
Intertwined ownership and management	Motivated management/commitment	
Integration of tasks in worker; variation and improvisation	Motivated labour	
Few and simple procedures; personal, direct, oral internal communication	Low costs and little distortion of internal communication	
Personal and close relations with customers	Capacity for customization	
Few hierarchal levels; short communication lines	No bureaucracy; internal flexibility; little filtering of proposals	Limited career opportunities

Craftsmanship	Unique or scarce competencies	Technical myopia
Tacit knowledge	Appropriability (hard to copy)	Limited capacity for absorption of new knowledge/technology
Idiosyncratic perception	Originality of initiative	Unopposed misapprehensions
Few products and markets		Little spread of risk, limited synergy
Small volume of production		Diseconomies of small scale
No staff functionaries		Lack of functional expertise
Lack of managerial time		Ad hoc management, short term perspective
Much authority and many functions in one hand		Vulnerability of discontinuity of management and staff
Low level of abstraction		Lack of information
Product or technique orientation		Errors in marketing and strategy
Possible lack of finance		Lack of means of growth

Table 3: strengths and weaknesses of SMEs (Nooteboom, 1993)

The weights of the derived characteristics, and hence strengths and weaknesses, vary with the conditions, capabilities, motives and goals of SMEs. Also, the characteristics or traits by themselves do not explain behaviour of SMEs; different characteristics may emerge in different circumstances. As firms grow from small through medium- sized to large size, the characteristics disappear or turn into their opposites. Notably, there has to be more delegation; bureaucracy grows; additional layers of hierarchy arise or formal procedures for planning; coordination or control are instituted; specialists appear; communication becomes more structured; formal and documented and knowledge becomes more explicit (less tacit) and formal. Tacit knowledge yields both a weakness, in lack of capacity to absorb new information and strength, in protection of unique knowledge or skills against copying by competitors (Nooteboom, 1993). Other characteristics also yield both strengths and weaknesses. Craftsmanship can yield a unique technical competence, which may serve as a strong competitive advantage. But often it also yields technical myopia, with a fatal lack of attention to commercial or financial conditions.

The strengths and weaknesses suggest appropriate core strategies (Nooteboom, 1993): innovation yielding new products, where scale effects are not yet in force, or/and niche markets with customized products, where scale effects do not appear. Both strategies avoid the weaknesses from small scale and moderate the weakness of limited spread of risk, lack of functional expertise and managerial resources. It will be interesting to see if open innovation can add new strategies for SMEs specifically.

2.2 Open innovation

The concept of open innovation was briefly introduced in paragraph 1.1 and will now be deepened to create a better understanding. The virtual opposing concept of closed innovation will be the point of departure in the view of founding father Henry Chesbrough (2003). Subsequently, I will delve into the asserted openness of innovation. The chapter will be concluded with an overview of current research in open innovation and operationalization of the concept.

2.2.1 Open innovation basics

The general idea of open innovation is that a single organization cannot innovate in isolation. It has to engage with different types of partners to acquire ideas and resources from the external environment to stay ahead of competition (Chesbrough, 2003; Laursen and Salter, 2006). Traditionally, firms rely on internal R&D to create new products, which successively are a strategic asset and represent a considerable barrier to potential new entrants. This process in which firms discover, develop and commercialize technologies internally has been labelled as 'closed innovation' (Chesbrough, 2003). For a long time, closed innovation has been a very successful way used by companies to sustain a competitive advantage in their different businesses. However, the innovation landscape has changed considerably: good ideas are widely distributed with no firm having a monopoly, venture capital is abundant nowadays and the acceleration of the product life cycle has turned intellectual property (IP) into an increasingly perishable asset.

An emerging paradigm in the innovation literature is open innovation. In this realm, firms use both internal and external pathways to exploit technologies and, concurrently, they scout different external sources of technology that can accelerate their innovation process. In addition to internal R&D, companies need to get access to external knowledge, such as start-ups, universities, suppliers, or even competitors to stay competitive in the long run. In open innovation, companies actively seek people of genius from both inside and outside the firm to provide fuel for the business model. In turn, open innovation suggests that inventive output from within the firm not be restricted to the current business model, but instead have the opportunity to go to market through a variety of channels (Chesbrough, 2006). The funnel-shaped diagram in figure 1 is a common representation of the open innovation process, exhibiting the in- and outflow of knowledge to accelerate internal innovation and expand the markets for external use of innovation, respectively.

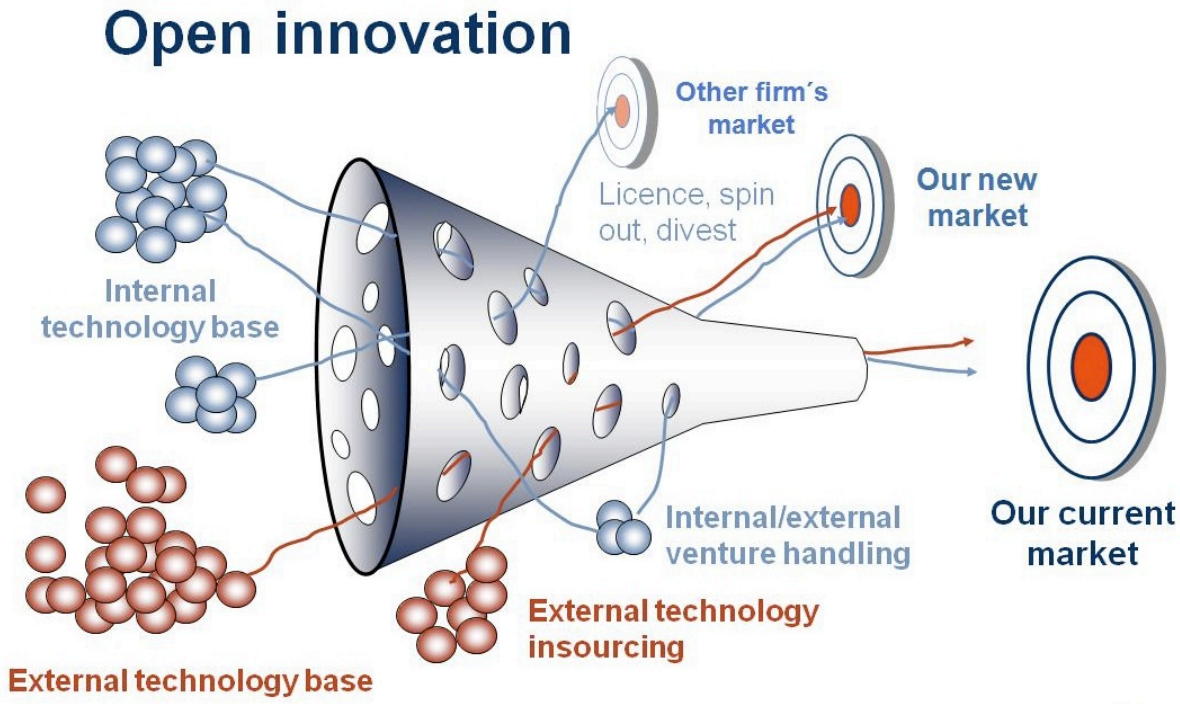

Figure 1: the open innovation paradigm for managing industrial R&D (Chesbrough, 2006)

In an open innovation process, projects can be launched from internal or external sources and new technology can enter at various stages. Projects can also go to market in many ways, such as out-licensing or a spin-off venture in addition to traditional sales channels (Chesbrough, 2003). To illustrate the vigour of open innovation, the following example appeals to the imagination:

> *One key reason for Procter & Gamble, a large multinational, to initiate open innovation programs was that they learned that for each of their 7,500 R&D people there were 200 people outside the company with equal skills and competences. An ignorant – and arrogant – company would ignore these 1.5 million people, arguing they do not matter, 'as they do not work for us'. P&G did not ignore this. They understood they should connect their own organization with the best and brightest from the outside world. (Huston & Sakkab, 2006)*

Organizations consider innovations as a major engine to enhance their performance and to strengthen their competitive position in the market. Many firms have paid most of their management attention to a greater focus on internal efficiencies of the development process, team structures, decision making and cross functional interaction. However, as more and more companies bring innovation straight to the heart of their corporate strategies, developing internal innovation capabilities is no longer sufficient to gain and sustain competitive advantage. Since innovation strategies look increasingly similar and commoditized, more and more organizations are trying to further improve their innovation performance through intensifying collaboration across industry networks and partnerships, opening up their innovation processes in line with the open innovation framework (Chesbrough 2003, 2006). Open innovation has taken on a more prominent role in light of the debate about globalization and the potential for the R&D function itself to become outsourced as the manufacturing function was twenty years earlier (Chesbrough, 2006).

2.2.2 The openness of innovation

Although open innovation is an emerging paradigm in the business landscape, it is not a completely new concept. Detailed studies of innovation processes note that firms have always sourced from outside. For example, in the late 19th century, Edison's laboratory - the Invention Factory at Menlo Park - displayed characteristics that in many regards had an open approach to innovation. The commercial development of electric lighting, for instance, was the product of a team of engineers that recombined ideas from previous inventions, collaborating with scientists, engineers, financiers and people in marketing outside the laboratory (Hargadon, 2003).

This calls for an understanding of how the relation between internal R&D and openness developed. Mowery (1983) explains how internal R&D emerged as a response to lower costs of organizing inside the firm compared to acquiring ideas and resources from the marketplace. Firms with significant investment in R&D can develop different organizational structures to streamline the innovative process. Firms can thus gain economies of scale and scope for their R&D (Henderson and Cockburn, 1996) stimulating more investment in R&D despite their reliance on external partners. One explanation is Cohen and Levinthal's (1989) suggestion of a dual role of R&D: to develop new internally and to create the absorptive capacity to track and evaluate developments outside firm boundaries. They observed that firms with high investments in R&D appear to be more able to benefit from 'spill overs' (Cohen and Levinthal, 1990). Traditional R&D organizations encountered difficulties when internal research generated spill overs that could not be internally commercialized. In some cases, such technology would be

licensed to others, but in the majority of cases it 'sat on a shelf' waiting either for internal development or its research proponents to leave the firm and develop it on their own (Cohen and Levinthal, 1990).

Another aspect of maintaining internal expertise is Rosenberg's (1990) argument about conducting R&D as a 'ticket of admission' to potential partners. Firms with plentiful resources and expertise are more attractive partners. In the alliance literature, for instance, there are many detailed examples of how firms gain expertise through creating relationships with reputable partners (Powell et al., 2005). To summarize, much of the literature views R&D as a necessary complement to openness for ideas and resources from external actors. It is less clear whether there could be a substitution effect, with openness replacing internal R&D. Firms vary in the extent to which they can screen, evaluate and assimilate external inputs to the innovation process, but research does underscore that there are substantial variations in the degree to which firms use external ideas (Laursen and Salter, 2006). Research has also shown that firms need competencies in areas related to their partners to assimilate and co-develop ideas that originate from external sources (Brusoni et al., 2001; Granstrand et al., 1997; Mowery et al., 1996). Internal capabilities and external relations are therefore complements rather than substitutes. Firms spend considerable time and resources on internal R&D; this leads to the question of what is the right balance between internal and external sources of innovation.

2.2.3 Inbound and outbound open innovation

It becomes clear that there are still a lot of loose ends in the open innovation domain. The existing literature presents the concept of openness in quite different ways; Laursen and Salter (2006a) associate openness with the number of external sources of innovation, whereas Henkel (2006) focuses on openness as revealing ideas previously hidden inside organizations.

As mentioned in paragraph 2.2.1, open innovation is based on two main pillars. On the one hand, open innovation stresses the importance to use external technologies to advance internal innovation projects. On the other hand unless a firm decides to commercialize the outcome of an internal innovation project via its own distribution channels, it should go to market via external pathways. In both cases ideas, technologies or knowledge flow through the semi-permeable corporate membrane.

To characterize the different flow patterns, Gassmann and Enkel (2006) use the term outside-in (integrating external knowledge, customers and suppliers) and inside-out (selling IP and bringing ideas to market by transferring them to the outside environment). Chesbrough and Crowther (2006) use similar expressions. They distinguish inbound and outbound open innovation. Whereas inbound open innovation represents the practice of utilizing external sources of innovation, such as suppliers, customers, or universities, outbound innovation refers to profiting from bringing ideas or technologies to market via pathways that lie outside the firm's boundaries. These pathways might be even located outside the current businesses of the firm.

Gassman and Enkel (2006) further distinguish a third core process of open innovation: the coupled process. The coupled process combines "the outside-in and inside-out processes by working in alliances with complementary partners in which give and take is crucial for success". But Gassman and Enkel (2006) also conclude that although all three processes are necessary to successfully embark on an open innovation strategy, firms usually focus on one primary process while more or less integrating elements of the

others. For the ease of illustration and discussion, this thesis will only distinguishes between inbound and outbound processes, see table 4.

	Inbound innovation	**Outbound innovation**
Focus	Outside-in	Inside-out
Description	- Knowledge and idea creation outside of the company - Customer /supplier integration - External technology sourcing	- Commercialization of own ideas and technologies outside the company - Licensing of own IP - Multiplication of own technologies - Cross-industry innovation
Capability	Absorptive capability	Multiplicative capability

Table 4: inbound and outbound innovation (Gassmann & Enkel, 2006)

This overview encloses the current research on open innovation and forms a concrete handle to start the analysis. I will use this scheme to measure open innovation at the case organizations. The concepts will be further explored in the following paragraph.

2.2.3.1 Inbound innovation

The inbound innovation decision has traditionally addressed the firm's choice to either innovate internally or acquire technology from external resources (e.g. Kotabe, 1992; Noori, 1990). A firm then has to make a classical 'make' or 'buy' decision, which is grounded in transaction cost economics. Traditionally, the boundaries of the firm are given and it is difficult to anticipate all possible contingencies, and to set prices. In these cases, interactions are assumed to be organized in firms rather than in the marketplace (Williamson, 1975). However, the increasing complexity of this decision and the growing need for interdisciplinary R&D requires moving beyond the 'make' or 'buy' dichotomy (Howells, James and Malik, 2004). Furthermore, sources of technologies are diverse. As a logical consequence, firms need to employ different mechanisms to make these technologies accessible (Burgelman, Christensen and Wheelwright, 2004). This thesis, therefore, follows the definition of Nicholls-Nixon and Woo (2003). According to them, inbound innovation "refers to the firm's approach to developing new technological capabilities, both in terms of the use of in-house R&D and through the use of external technology sourcing 'linkages' or 'strategic technology alliances' such as R&D contrast, licenses, joint ventures, minority equity investment, and acquisitions (Nicholls-Nixon and Woo, 2003)." To stimulate inbound innovation, Gasmann & Enkel (2006) argue that absorptive capacity is necessary. Absorptive capacity is the firm's "ability to recognize the value of new information, assimilate it and apply it to commercial ends" (Cohen & Levenithal, 1990) Thus, a firm needs to have prior knowledge - built within internal R&D processes - in order to identify relevant technologies outside its boundaries, or as Rosenberg (1990) states: it takes "a substantial research capability to understand, interpret and to appraise knowledge that has been placed upon the shelf". But absorptive capacity is not only crucial for identifying and evaluating external technologies. It is also required to implement these external technologies into the internal innovation process.

This type of openness refers to acquiring input to the innovation process through the market place. Following this reasoning, openness can be understood as how firms license-in and acquires expertise from outside. Chesbrough et al. (2006) claim that firms scan the external environment prior to initiating internal R&D work. If existing ideas and technologies are available, the firms use them. Accounts of corporate R&D laboratories show that they are vehicles for absorbing external ideas and mechanisms to assess, internalize and make them fit with internal processes (Freeman, 1974).

2.2.4 Outbound innovation

This type of openness refers to how internal resources are revealed to the external environment. In particular, this approach deals with how organizations reveal internal resources without immediate financial rewards, seeking indirect benefits to the focal firm. It shows how organizations commercialize their inventions and technologies through selling or licensing out resources developed in other organizations.

Chesbrough (2003, 2006) discusses how firms can benefit by commercializing inventions by selling or licensing-out ideas that might previously have been ignored. Some firms have developed an excess of patents because of incentives used in R&D to encourage patenting—often without considering business relevance (Nerkar, 2007). By selling or out-licensing, firms can more fully leverage their investments in R&D, partnering with actors skilled at bringing inventions to the market place. Gassmann and Enkel (2006) discuss how some firms adopt different 'inside–out' processes to externalize internal knowledge and invention to the market place. Research suggests that licensing out inventions and technologies is becoming more common. Some firms have even made it a strategic priority to out-license technologies and inventions (Fosfuri, 2006).

There are some success stories portrayed in the literature, but there are often many obstacles that prevent firms from selling or licensing-out technologies (Rivette and Kline, 2000). Market failure sometimes occurs because inventors are reluctant to reveal their developments. Arrow (1962) suggests the significant challenge involved in reaching agreements based on information, when two or more parties are involved. When an inventor is keen to license its information to a potential licensee, it is necessary to reveal some information to the potential customer. This 'disclosure paradox' implies that the potential licensee receives the information without paying for it and could – in principle – steal the idea. Arrow argued that such problems cause market failures because they make inventors reluctant to reveal their technology or knowledge. The market for technology literature has argued that there are significant transaction costs involved in transferring technologies between organizations. As a consequence, the potential of selling technologies in the market place has not been fully leveraged (Gambardella, Giuri, & Luzzi, 2007). Gambardella et al. (2007) even suggest that the market for technology could be close to 70% larger should some obstacles be overcome. An obstacle that often prevents firms from out-licensing technologies is that they have difficulty anticipating the potential value (Chesbrough and Rosenbloom, 2002). Firms may be over-committed to where they have invested resources; another organization may be better equipped to independently commercialize it. Chesbrough and Rosenbloom's analysis of Xerox illustrates how the combined market capitalization of spin-offs and other external commercialisations subsequently overtook the value of Xerox. With this potential, it is clear that a deliberate strategy may need to be in place. Lichtenthaler and Ernst (2007) suggest that while many firms are open to licensing technologies, they lack a conscious strategy for bringing this into practice.

The exploitation of knowledge outside the company is related to the company's capability to multiply and transfer its knowledge to the outside environment (Gasmann & Enkel, 2006). The capability to multiply innovation by external exploitation is strongly connected to firm's knowledge transfer capability and the selection of appropriate partners. Only if the company is able to codify and share its knowledge with the external entity, will the commercialization of ideas be successful. But also the strategic selection of partners that are willing and able to multiply the new technology is an important element of the multiplicative capability of the firm.

2.3 Open innovation at high-tech SMEs

Open innovation has achieved a certain degree of face validity within at least a small portion of high-tech industries but not so much in small and medium-sized enterprises, as mentioned in paragraph 1.1. Given the limited size of SMEs, it is suggested that a mind-set to look for genius becomes even more important, recalling the example of P&G in paragraph 3.4.1, where for each R&D employee, 200 others were available. In this paragraph, the latest research on open innovation at high-tech SMEs will be summarized followed by the first research question. Secondly, motives, challenges and consequences for high-tech SMEs will be identified to motivate the remaining research questions.

2.3.1 Adoption rate of open innovation

Chesbrough & Crowther (2006) conducted a small study to see how companies outside the high-technology sector adopted open innovation principles, however their sample was skewed towards larger companies. Although Chesbrough and Crowther (2006) argue that large firms could differ from small firms in their adoption of open innovation, only a small number of studies on open innovation within smaller firms exist. For instance, Henkel (2006) examines both small and large firms, but focuses only on companies that develop open source software. Lecocq & Demil (2006) study the U.S. table top role-playing game industry, which is a highly fragmented industry with SMEs as the main players. Furthermore, Christensen et al. (2005) illustrate the role of small companies over the life cycle of the technology. They also show that firm size does influence the innovation strategy and value capturing ability of firms on new technology.

Concluding, it is unclear how many SMEs actually take up the open innovation approach, therefore this issue will be addressed in conjunction with the openness of the innovation process in the first research question;

> *Research question 1: what is the adoption rate of open innovation at high-tech SMEs?*

2.3.2 Motives in engaging open innovation

The companies that do pursue an open approach to innovation hold different motives. In their short study on open innovation outside high-tech companies, Chesbrough & Crowther (2006) their respondents identified a number of catalysts that drove the organization to accept a more open environment. The single most common reason is the belief that utilizing more technology from outside the firm is critical for profitable growth. Other influences include the need for external technologies to maintain or improve product margins and a perceived lack of ability to meet corporate growth objectives missing alternative external technologies. A few of their respondents viewed open innovation as a way to monitor potentially 'disruptive technologies' that may threaten existing businesses. Increasing the company's speed to market for developing new products was also mentioned, while cost reduction appeared to be a secondary driver.

As SMEs do not have internal R&D labs and cannot rely on rooted technological competences. They have to make systematic use of the competences of suppliers, customers, complementors (Nalebuff and Brandenburger, 1996) and other actors in the value system. Furthermore, SMEs can use their network to find missing innovation resources, and due to their smallness they will be confronted with the boundaries of their organizations rather sooner than later (Van de Vrande, 2009).

Van de Vrande et al. (2009) executed a comprehensive study investigating the use of open innovation practices at SMEs in a systematic way and made an attempt at identifying the motives that drive firms to get involved in open innovation and the barriers that they face when pursuing a more open approach towards innovation. Particular for SMEs, they demonstrate the most important motives to pursue open innovation are market-related ones. Many SMEs believe it is necessary to use a broad set of methods to meet the ever-changing customer demand and to prevent the firm from being outperformed by competitors or new entrants.

Large companies will be looking to partner with early stage companies as part of their open innovation strategy. Therefore open innovation is suggested to be an essential topic for SMEs too, who need to understand how to make the most of open innovation and to help them form partnerships with large companies. Within this environment SMEs can be an important source of ideas for larger companies. Technology-based SMEs typically lack the strategic and operational rigidities that sometimes restrain innovation in established firms. On the other hand, SMEs have limited resources and often struggle to access the complementary assets they need to get their ideas to market. Bringing together SMEs and larger firms in mutually beneficial partnerships seems an obvious solution.

Research question 2: What are the motives of high-tech SMEs to engage in open innovation?

2.3.3 Challenges in engaging open innovation

Where the motives are clear for SMEs to engage in open innovation, the actual application of a more open approach to innovation can bring some surprises to the company. Research might be limited, but still several challenges have been identified faced by organizations adopting open innovation.

According to Chesbrough & Crowther (2006), effective adoption typically requires two critical challenges: The first is the Not Invented Here-syndrome (NIH) (Katz & Allen, 1982), a natural negative response to innovations and inventions from sources outside the venture's own research and development activities. Chesbrough et al. (2006) added a variant dubbed the Not Sold Here-syndrome (NSH). Arguing that 'if we don't sell it, no one should'. Which is rooted in the surface perception that if the organization cannot find sufficient value in the technology, it is highly unlikely that anyone else can either. Their second adoption challenge for open innovation concepts involves sustaining internal benefits from adopting the concepts. The organization appeared to require practices that are highly focused and aligned with overall business objectives.

The main barrier to open innovation found by Van de Vrande et al. (2009) lies in the organizational and cultural issues, which arise when SMEs start to interact and collaborate with external partners. Other challenges are for example located in evaluation, there can often be difficulties in evaluating external rather than internal ideas, as there is much less first-hand information available on external ideas (Menon and Pfeffer, 2003). Furthermore, the internal view of the technology's potential is likely biased by the business model of the company (Chesbrough and Rosenbloom, 2002). Lastly, a potential challenge is found in collaborative innovation as Boschma (2005) identified various forms of 'proximity', which are essential for effective collaboration.

Although some challenges are known, most of them are identified at larger companies. Other challenges may appear when SMEs are to engage in open innovation. Therefore, my third research question will explore more challenges asking:

Research question 3: What challenges do high-tech SMES face when managing open innovation?

2.3.4 Consequences of engaging open innovation

Engaging open innovation is suspected to bring a lot of benefits to the company, but what are the effects of opening up the innovation process? The final research question is dedicated to find an answer to this:

Research question 4: What are the consequences for high-tech SMEs to engage in open innovation?

3 RESEARCH METHODOLOGY

This chapter puts apart the research method used for collecting data for this thesis with the purpose to provide insights on the approach that has been used and what specific steps have been taken in order to be able to answer the research questions. The data collection is twofold: quantitative and qualitative. For the first research question, a quantitative analysis of a data set is required. Data for this study was drawn from the innovation scan on SMEs based in the Netherlands. From this data, four cases were selected to answer the second, third and fourth research question. Qualitative interviews were held to do so.

In addition, the goal of this study is to make sense of the situation and to investigate phenomena without explicit expectations (Schutt, 2006). The purpose of sense making is to orient new circumstances and events to present environments (Weick, 1995). Sense making is a retrospective process that involves embellishing the meaning of cues by linking them with more general ideas, as well as elaborating on them by invoking past experiences to explain them (Weick, 1995) in this case to advance the understanding about motives, challenges and consequences for high-tech SMEs to engage in open innovation. In the previous chapter the theoretical framework is provided that serves as preliminary information for executing the innovation scan and setting up the qualitative interviews. The latter two methods are discussed in more detail in the sections below, followed by a sample selection.

3.1 Innovation scan

The innovation scan is a scientific-tool developed by the faculty of Management & Governance at the University of Twente and enables to draw a picture of the innovation and cooperation competences of a company. Based on this scan, points of interest can be highlighted that might block the organisation's way to generate competitive advantage, or actually enable this. The scan is roughly divided in three themes: internal organisation, external orientation and human resources. In this thesis, the tool is used to collect basic data of the company and distinguish between low- and high-tech SMEs. Differences were found between both groups and subsequently four high-tech cases were selected for a qualitative research.

The scan is based on a survey and consists of two parts. The person that has a general overview over the development of the company during the years answered the first part; often this was the R&D manager or CEO. Multiple persons, commonly other members of the management team or belonging to middle management, filled in the second part. In total the survey took up 1 to 1.5 hours of time, all answers were treated with greatest confidentiality. The innovation scan was executed by the NIKOS & OOHR departments of the University of Twente, who distributed it amongst participants of the "Innovatie Benchmark Oost-Nederlandse Maakindustrie (IBOM)"-project. The database contained 63 companies.

3.2 Sample data

With the data from the innovation scan a sample could be extracted, useful for this thesis. The results date from February 2010. Furthermore, data of the pilot studies in New-Zealand cases were added, these results date from autumn 2009.

Enterprises that fulfilled the criteria laid down by the European Commission (2003) qualify as micro, small and medium-sized enterprises, see also table 1 in paragraph 2.1.1. In table 5 the cases staff headcount is reflected with the frequency, percentage and categorized in type of enterprise. In addition to the staff headcount ceiling, the turnover ceiling or balance sheet ceiling are met too. Since this study only focuses on small and medium-sized enterprises a first selection is made here, eliminating the 'Micro' and 'Large' enterprises from the sample.

Headcount	Frequency	Percentage	Type
< 10	11	16.9%	Micro
10 – 50	23	35.4%	Small
50 – 250	27	41.6%	Medium
> 250	3	4.6%	Large
VALID	64	98.5%	
MISSING	1	1.5%	
TOTAL	65	100%	

Table 5: innovation scan results – firm size

Low-, medium- and high-tech enterprises were discriminated on percentage of turnover spent on R&D activities as stated in paragraph 3.1.2. In table 6 the distribution is given of the previous established sample. Two cases had zero per cent investment in R&D and ten cases were missing, these are left out. Furthermore the cases appear to be skewed towards low-tech enterprises covering almost ¾ of the total number of cases. For the sake of this research, medium- and high-tech SMEs were merged to create a better offset against the low-tech enterprises.

Type	Percentage of turnover spent on R&D	Count	Percentage
Low-tech	1-5 %	27	71.1%
High-tech	> 5 %	11	29.0%
TOTAL		38	100%

Table 6: SMEs and percentage of turnover spent on R&D

The above sample was used to answer the first research question. From the high-tech companies, four were selected for the remaining research questions. Subsequently, a multiple case study was initiated.

3.3 Multiple case study

With the data gathered from the Innovation scan, four cases were selected for further the qualitative investigation: Vesper Drive, Adepto, Melior and Frendo. The number of cases is determined by the time constraint for this thesis. The goal of a multiple case study is to investigate the patterns that have been gathered with use of the innovation scan and to examine how the cases relate to theory. The case studies are formal studies, in which data is gathered by interrogation/communication (Cooper & Schindler, 2003). There was no power to produce effects in the variables under study, because the design is ex post facto. The research environment is a clear field setting, in which typical cases are investigated in order to get a broad and in-depth insight on the matter.

Babbie (1998) defines a case study as 'the in-depth examination of a single instance of some social phenomenon', or as Cooper and Schindler (2003) put it 'case studies place more emphasis on a full contextual analysis of fewer events or conditions and their interrelations'. Case studies are useful as they provide answers to 'how and why' questions about a contemporary set of events over which the researcher has little or no control (Yin, 1987). To give good insights on the motives and management challenges faced within the organizations an in-depth examination is required. The case studies were executed as a qualitative field research. A qualitative field research is useful for several topics such as relationships, roles, practices, organizations and settlements (Babbie, 1998).

Yin (1987) provided six sources of evidence in case studies; documentation, archival records, interviews, direct observations, participant observation and physical artefacts.
To start with, corporate websites have been skimmed for information for a proper preparation on the conversations to follow. Annual reports have been ploughed and the innovation scan was used to detect possible pressure points, with this information an innovation benchmark report was written for each case company.

The innovation benchmark report gives a brief overview of the company's innovation capacity. The reports are subdivided in three main chapters: organizing innovation, human resource management and external orientation. Every chapter starts with a short theoretical introduction, followed by results of the scan. General conclusions were drawn and recommendations given in order to answer the question asked beforehand; "To what extent does the company master to innovate on its own and which points of improvement can be identified?" For the selected cases, interviews were requested in which first the innovation benchmark reports were discussed; the participants found the discussions helpful and enlightening.

3.3.1 Qualitative interviews

The selected cases were subject to a qualitative interview to find more deeply structured (Pentland, 1999) data leading into answers for explaining the differences between the cases and finding motives and challenges. A qualitative interview is a suitable method to deal with topics about organizational life and this method is known for its flexibility; it can both cover topics in detail as in the broad sense.

Interviews were held to facilitate a targeted and focused direction for the case study and were an essential source for case study information (Yin, 1987). The interviews have been semi-structured, preventing respondents to answer the way they think the interviewer wants them to answer, a so-called survey research bias (Babbie, 1998). This means that specific topics revealed from the innovation scan are nominated for exploration during

the interview and informally grouped in topics and questions that the interviewer can ask in different ways to the interviewee (Lindlof & Taylor, 2002). This helped the researcher to focus an interview on the topics at hand without constraining them to a particular format. Since it was semi-structured, there was still a degree of freedom that helped the interviewer to tailor his questions to the situation, and to the people that were interviewed (Lindlof & Taylor, 2002).

The interviewee was the person who filled in the first part of the innovation scan, overseeing the development of the company during the years. The interviews took place face-to-face. To make it as comfortable as possible for the interviewee, the interviews were held at the company itself and the specific outcomes have been remained confidential, allowing the interviewees to speak freely. Before the interview was conducted, the protocol was explained, including confidentiality, and asked if interviewee agreed on taping the interview (none refused). One interview was carried out per case and lasted two hours on average. The interview started with discussing the results of the innovation scan, highlighting the interesting points and asking for feedback on the report. Hereafter the interview started, a list of interview questions can be found in appendix 9. The interviews were transcribed and sent to the interviewee for verification. Recording and transcribing the interview provide a more accurate rendition of an interview than any other method (Yin, 1987). If needed, questions were asked in succession via e-mail or phone to clear out misconceptions.

3.3.2 Data analysis

To analyse the large amounts of data, a selection was necessary. Data analysis has been done following a two-step approach. In the first step, the cases have been described in light of the theory and analysing the specific setting of the case. This way it was possible to become intimately familiar with each case as a stand-alone entity (Eisenhardt, 1989). Within the case description the motives and challenges of engaging in open innovation have been discussed, allowing unique patterns to emerge to accelerate the cross-case analysis. The second step is actively searching for cross-case patterns. The tactic of selecting dimensions and to look for within-group similarities coupled with intergroup differences has been used (Eisenhardt, 1989). This analysis resulted in knowledge on what motives and challenges organizations face in engaging open innovation. When the practical findings are linked to the current theoretical insights in the discussion, conclusions can be drawn and be added to the open innovation science.

4 RESULTS

This chapter will discuss the results of the quantitative research. It starts off with the innovation performance of low- and high-tech SMEs, followed by the adoption rate of open innovation. A 95% confidence interval is used at all times and relations are significant at $p<0.05$. Lastly, four cases are selected for the multiple case studies.

4.1 Innovation performance

Innovation performance is used as a control variable and measured in the following ways: innovation indicators, stability of the environment and the strategic positions towards innovation. Together, those results reproduced the need for innovation.

4.1.1 Innovation indicators

The percentage of turnover spent on new, improved and unaltered products in both low- and high-tech SMES renders if the companies are actually innovating their products, see table 7.

		New products / services	Improved products / services	Unaltered or slightly altered products / services
Low-tech (N=22)	*Mean*	9.86%	14.86%	75.27%
	Std. Dev.	9.05	15.05	21.34
High-tech (N=11)	*Mean*	19.18%	16.82%	64.00%
	Std. Dev.	18.58	4.62	17.72
	Significance	0.060	0.679	0.142

Table 7: percentage of turnover spent on new, improved and unaltered products (in 2009)

The results are not significant, meaning there is no difference between the product portfolios. These results should translate themselves to the distribution of R&D budget over exploitative and explorative innovations projects, see table 8. In exploitative innovation projects the emphasis lies on activities like standardization, optimization, fine-tuning and stepping up production. It was expected that low-tech SMEs invest more in exploitative innovation projects, for improved or slightly altered products, but the results are not significant. In explorative innovation projects the emphasis lies on activities like fundamental research, experiments and developing the first prototypes. High-tech SMEs have it balanced out quite well, appearing to be ambidextrous organizations but no significant difference can be found with low-tech SMEs.

		Distribution of R&D budget (%)	
		Explorative innovation projects	Exploitative innovation projects
Low-tech (N=20)	*Mean*	40.25%	59.75%
	Std. Dev.	29.67	29.67
High-tech (N=11)	*Mean*	55.00%	45.00%
	Std. Dev.	27.30	27.30
	Significance	0.184	0.184

Table 8: distribution of R&D budget over explorative and exploitative innovation projects

4.1.2 Stability of the environment

The necessity to innovate is closely linked to the stability of the environment; the more volatile surroundings an organization finds itself in, the greater the need to innovate to meet customer demand and stay ahead of the competition. In the innovation scan the following questions were scored between 0 (minimum) and 4 (maximum): our organisation must frequently change its practices; the rate at which products are getting obsolete in the industry is high; actions of competitors are unpredictable; demand for the product is unpredictable; the production technology is subject to much change.

		Stability of the environment
Low-tech	*Mean*	1.98
(N=16)	*Std. Dev.*	0.62
High-tech	*Mean*	2.42
(N=9)	*Std. Dev.*	0.34
	Significance	0.058

Table 9: stability of the environment

The variable 'stability' is the average score of all items, as shown in table 9. Low-tech SMEs score between 0 and 2 points, which indicates a stable environment. High-tech SMES, however, scores above 2 indicating a volatile environment. The results are nearly significant, meaning high-tech SMEs have a greater necessity to innovate then low-tech SMEs do.

4.1.3 Strategic position towards innovation

To get a more in-depth look on how both groups deal with innovation and entrepreneurship, the concepts of proactivity, innovativeness, risk-taking and aggressiveness are measured in the innovation scan. Respondents could score several questions from 0 (minimum) to 4 (maximum), see table 10. All measures are not significant, but a score above or below 2 can set the groups apart.

		Proactivity	Innovativeness	Risk-taking	Aggressiveness
Low-tech	*Mean*	2.27	2.40	1.84	1.60
(N=15)	*Std. Dev.*	.87	.84	.59	.57
High-tech	*Mean*	2.63	2.26	2.186	1.83
(N=9)	*Std. Dev.*	.77	.74	.69	.83
	Significance	.312	.682	.211	.432

Table 10: strategic position towards innovation

The proactivity measure indicates to what extent an organization actively anticipates to opportunities in the environment. A score between 0 and 2 points indicate a low degree of proactivity; the company is being reactive. Whereas a score above 2 indicates the organization actively anticipates towards opportunities from the environment. Both low- and high-tech SMEs tend to be proactive as the results show.

The innovativeness of an organization indicates to what extent the strategic direction is orientated on developing new innovative products. A score between 0 and 2 indicates a low degree of innovativeness: the organization is more orientated towards exploitation. A score above 2 indicates that the organization places a strong emphasis on going

towards an innovative strategic direction. Interestingly, both low- and high-tech SMEs score above 2 and appear to be innovative.
The risk-taking item indicates to what extent an organization prefers projects with a high degree of risk and with chances of high revenue above those with a low degree of risk but normal and safe revenue. A score between 0 and 2 indicates that the organization prefers safe projects above risky projects. A score above 2 indicates the organization has the tendency to choose for riskier projects. This is where low- and high-tech SMEs differ greatly. High-tech SMEs seem to be more risk-takers.

The aggressiveness towards competitors refers to the extent an organization tries to exceed their competitors. The difference with proactivity is that this scale indicates how the organization anticipates to threats. A score between 0 and 2 indicates a low degree of aggressiveness, with the danger of being surpassed by competitors. A score above 2 indicates that the organization wants to stay on top of their competitors. Low-tech SMEs appear to be less aggressive then high-tech SMEs.

4.2 Adoption rate of open innovation

With the innovation performance of low- and high-tech SMEs in mind, the adoption rate of open innovation will be discussed. This is perhaps the hardest step to take, as there are no clear metrics available. The openness of the innovation process will be measured by the number of partners that is collaborated with in regard to innovation projects and the nature of these relationships. Unfortunately, the innovation scan only included measures for inbound innovation, and I was forced to leave out outbound innovation in the analysis. For the case study, however, both concepts will be included again.

4.2.1 Collaboration with partners

The first metric for the openness of the innovation process was measured is the collaboration with partners in regard to innovation projects during the past three years. These partners were divided over customers, consultancy firms, suppliers, competitors, universities, research institutions and/or companies from other industries. The respondents could score between 0 and 5 for each partner where the score represented a number of partners.

	Customers	Consultancy firms	Suppliers	Competitors	Universities or other research institutions	Companies from other industries
LOW-TECH (N=24)						
Mean	1.96	1.08	1.50	.33	.88	.64
Std. Dev.	1.16	.72	.98	.64	.79	.79
HIGH-TECH (N=11)						
Mean	2.64	1.18	1.27	.36	1.00	.82
Std. Dev.	1.50	.60	.69	.51	.78	.751
Significance	.153	.695	.488	.891	.667	.531
Score	0	1	2	3	4	5
# of partners	0	1-2	3-5	6-10	11-25	>25

Table 11: collaboration with partners

There are no significant differences between low- and high-tech SMEs and their collaboration as shown in table 11. However, some similarities can be found. Both groups on average work with only 1 or 2 consultancy firms. They also hardly work with their competitors; the same goes for universities, other research institutions and companies from other industries. The figures also show that for both low- and high-tech SMEs the networks are small, generally consisting of 1-5 external partners. Also the patterns appear to be similar with no group focusing more or less on a typical partner. The nature of these collaborations provides some more guidance. Table 12 shows the formality of the collaborations and the type of partnerships.

		Formality of relationship		Type of relationship	
		Informal	Formal	Explorative	Exploitative
LOW-TECH (N=21)	*Mean*	72.14	27.86	42.14	57.86
	Std. Dev.	31.45	31.45	28.70	28.70
HIGH-TECH (N=11)	*Mean*	45.00	55.00	49.55	50.45
	Std. Dev.	25.40	25.40	31.18	31.18
	Significance	.020	.020	.506	.506

Table 12: formality and type of partnerships

With the results of table 12, differences start to appear between the low- and high-tech SMEs. While there is no significant difference in the type of relationship (explorative/exploitative), there is in the formality of the relationship. Low-tech SMEs appear to have more informal collaborations, while high-tech SMEs have it more balanced.

4.2.2 Inbound innovation at SMEs

Gasmann and Enkel's (2006) reproduction of open innovation delves deeper into the subject with a focus on inbound and outbound innovation. The previously discussed variables already incorporate fragments of these concepts, in these paragraph some more are analysed. In table 13, the external idea searching qualities of low- and high-tech SMEs are shown. The minimum score on these items is 0, the maximum score is 4.

	LOW-TECH (N=19)		HIGH-TECH (N=9)		
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*	*Sign.*
We have a strategic policy that is aimed at looking outside the organization for interesting and/or potentially threatening developments	2.00	.94	2.44	.53	.201
We are aware of relevant technological developments…					
…in our own industry	3.05	.62	3.22	.67	.515
…in related industries	2.11	.86	2.56	.73	.193
…at universities / research institutes	1.42	.90	2.33	1.00	.023
We are actively probing the future, in the course of which we use techniques like scenarios	1.21	1.13	2.13	.84	.051
We make use of observing systems, which we employ to bring in new trend in to our strategic decision-making process	1.28	1.02	1.89	.93	.143
We actively search for signals that reside at the border of our company, e.g. subsidiary companies, joint ventures and suppliers	2.05	1.2	2.33	1.12	.566
External idea searching	**1.86**	**.49**	**2.41**	**.63**	**.023**

Table 13: external idea sourcing

The final 'external idea searching' variable is the average of all items and indicates a significant difference between low- and high SMEs. The results show that low-tech SMEs score between 0 and 2 indicating that they are missing chances on discovering new product ideas. Conversely, high-tech SMEs score above 2 indicating that the organization is actively searching the external environment for new ideas.
The final variable that is being looked at is the collaboration with main customer and supplier. Again, the minimum score on these items is 0, the maximum score is 4. The results in table 14 show that both low- and high-tech SMEs score above 2, which indicate an intensive collaboration with their main customer and main supplier, with high-tech SMEs outperforming their counterparts, and there being a significant difference between both groups in supplier collaborations. The results will be further analysed and linked to theory in chapter 7.

		Collaboration with	
		main customer	**main supplier**
LOW-TECH	*Mean*	2.95	2.47
(N=13)	*Std. Dev.*	.67	.88
HIGH-TECH	*Mean*	3.45	3.18
(N=8)	*Std. Dev.*	.36	.43
	Significance	.069	.049

Table 14: collaboration with main customer and supplier

4.3 Concluding remarks

A distinction between low- and high-tech SMEs has been made in paragraph 3.2 based on the percentage of turnover spent on R&D. The results in paragraph 4.1 showed that there were not significant differences between low-tech and high-tech SMEs in innovation performance. In paragraph 4.2 the adoption rate of open innovation at SMEs was measured, and only a few significant differences were found: collaboration with suppliers, the formality of relationships and external idea searching. The statistical power of the analysis was not very strong, but maybe also another explanation can be found for why there were not so many differences.

Low-tech SMEs may possess a lot of practical knowledge that resulted from the increasingly complex relations to other companies and the resulting experiences of cooperation efforts. In such cooperative networks, businesses may gain know-how from their partners without actually conducting R&D (Radauer & Streicher, 2007). This takes up with the statement made in paragraph 3.2.3 that low-tech organizations utilize diffused technologies that sprouted earlier in other, high-tech companies and or universities. The internal organization of innovation is often a derivative of the innovation strategy. With an explicit focus on external idea search, high-tech SMEs suspect to have more dedicated R&D strategies. The general indicators formed a foundation for the adoption rate of open innovation. As high-tech SMEs have a higher need for innovation, they will look more outside the boundaries of their organization then low-tech SMEs do. It is for this reason that this thesis will focus on high-tech SMEs.

5 MULTIPLE CASE STUDY

Four high-tech SMEs, that meet the characteristics as defined in the concluding remarks of paragraph 4.2.3, have been selected for further investigation: Vesper Drive, Adepto, Frendo and Melior Engineering[1]. In this chapter, the cases are described in light of the theory and each case will be analysed in its specific setting. This way it is possible to become intimately familiar with each case as a stand-alone entity (Eisenhardt, 1989). The general characteristics and basic data from the innovation scan will be included to give an overview of the researched cases. From the four cases, two case companies are located in New Zealand with data gathered in autumn 2009, whilst the two other cases were located in the Netherlands (spring 2011). For the New Zealand cases answers of three respondents per company were collected, holding the following positions: Chief Executive Officer, Chief Financial Officer and Chief Technological Officer. In the Dutch cases the data was solely gathered from the Chief Executive Officer. Furthermore, semi-structured interviews were held with the CTOs at the NZ cases and with the CEOs at the Dutch cases. A more detailed description of the inquiry form is recorded in appendix 8.1. The first paragraph is a quick case comparison and on-wards each case is discussed in detail; finally a cross-case analysis is conducted.

[1] These are not the actual names of the companies but fictional Latin names due to confidentiality

5.1 Case overview

In table 15 general figures of the four cases are listed for a quick case overview, a few key figures stand out. The New Zealand-based companies appear to spent more turnover on explorative projects whereas the Dutch case are mirrored and spend more on exploitative projects, the former are OEMs which might explain the difference. Also the New Zealand-based companies are larger in size and turnover. Furthermore, the formality of collaborations appear to differ greatly, this will be further discussed in the following paragraphs.

	VESPER DRIVE	ADEPTO	FRENDO	MELIOR
Company profile				
Country	New Zealand	New Zealand	The Netherlands	The Netherlands
Established	1986	1972	1980	1994
Ownership	Part of a group	Independent	Independent	Independent
Core activity	Manufacture of ventilation, refrigeration and appliances	Manufacture of chemicals and/or plastic products for medical, meat processing markets.	Small to mid-sized batch production of machine parts and hydraulic manifolds	Engineering and design for several industries e.g.: automotive, furniture, plastics, and packaging.
Number of employees / FTE	115 / 115	110 / 100	12 /12	32 /32
Turnover/Financial				
Turnover (2008)	€6.008.897	€ 8.283.563	€ 1.100.000	€ 1.727.323
Percentage of turnover spent on:				
Innov. projects				
- Explorative	70%	90%	30%	20%
- Exploitative	30%	10%	70%	80%
Products/services				
- New	70%	1%	10%	25%
- Improved	10%	10%	20%	25%
- Unaltered	-0%	89%	70%	50%
Customers				
- National	0%	60%	90%	90%
- International	100%	40%	10%	10%
Evolution of the company (last three years)				
- Turnover	Strongly increasing	Stayed the same	Decreasing	Increasing
- Operating profit	Strongly declining	Profitable	Decreasing	Increasing
- Stage of development	Investing / growing	Mature	Mature	Mature
Collaboration with partners				
Formality collaboration				
- Informal	- 20%	- 70%	- 80%	- 25%
- Formal	- 80%	- 30	- 20%	- 75%
Type of collaboration				
- Explore	- 50%	- 100%	- 30%	- 20%
- Exploit	- 50%	- 0%	- 70%	- 80%

Table 15: case overview

5.2 Case A: Vesper Drive

Vesper Drive is one of the world's leading suppliers of energy saving, electronically commutated (ECM) motors and fans. They apply advanced technology and engineering to provide standard and custom design solutions that lower costs, while preserving natural resources. Their products are designed as energy saving replacements of traditional inefficient motors used in refrigeration and ventilation.

5.2.1 Innovation strategy

At Vesper Drive, the product portfolio is relatively balanced. Not only the number of projects and the available resources are balanced, but also the explorative versus the exploitative projects. Vesper Drive is dominantly a technology push organization. The current focus of the R&D department is on developing a new radical motor, making their R&D activities more explorative than exploitative. Projects are ranked on priority, but this is not periodically updated through a systematic process. Furthermore, new product development plans are not heavily influenced by formal planning activities and decisions are not made by standard criteria. Within Vesper Drive the budget and time limit of new product development projects are often exceeded. However, as stated by the CTO in the interview, the number of exploratory projects within Vesper Drive makes it difficult to plan which results in delays.

Vesper Drive prefers to do its exploitative in-house, the motivation behind this is that the employees directly acquire the skills to produce and design the products. The more explorative R&D activities are done outside the company, this way the company tries to balance its explorative and exploitative activities. As the CTO[2] explains: "*We have to have both streams, because on the one hand there's the one that never or hardly ever pays off, but if it does, it pay of big. But on the other hand, you've got to have the one that doesn't pay off very well, but the changes for paying off are pretty high, which is the manufacturing part.*"

The uncertainty of the environment influences decision-making "*us doing project X is much more uncertain than general motors doing exactly the same project*." Vesper Drive has less control over external factors, and fewer resources to anticipate on it.

5.2.2 Inbound innovation

Vesper Drive is well aware of developments in many different sectors and scans the market for potential ideas through on going market studies pursuing a high degree of market orientation. Vesper Drive has a small network and experiences difficulties with building and sustaining external linkages, because of the amount of effort put in a single linkage.

Vesper Drive moved some of its suppliers overseas (Asia) to gain cost advantage. However, this dramatically decreased collaboration, going from informal to a more formal collaboration, and not innovative. Self-managing capabilities of their suppliers are not present compared to their former New-Zealand-based suppliers. They have gained in terms of labour costs, but lost on in terms of all of overhead, engineering and manufacturing. The CTO believes this even digs in on the quality of the product.

Vesper Drive does work reasonably well together with their customers in terms of manufacturing products. This is necessary, as their products are never a drop-in

[2] All quotes in this interview are from the Chief Technological Officer (CTO)

replacement. They have to convert the products and test them on forehand. Vesper Drive made significant investment in testing apparatus for their customers *"as a motor manufacturer, we don't give much about air flow or compressors or any of that stuff. But our customers do, so we've got to help them out there."* However the CTO is not eager to take this to great length, as he recalls how one customer changed its strategy and thereby product line, making all the earlier investments in the collaboration obsolete.

Ten percent of the R&D budget ha been spent on collaboration with universities. Currently, Vesper Drive is working together with a university on a very exploratory project in the biomechanical field. It is something for the long run: "*Ultimately, if you look at the company right now we are a motor company working at ventilation applications using slotless motors. But in the medium term we see ourselves as a motor company without those other constraints. In the long term, we see ourselves as a power conversion company. Anything that involves taking electricity in and motion out is potentially within our area of interest. So for the long term you've got to keep at least a vague idea of all the other technologies that may fit our markets or may fit our skill set or ideally do both."*

There is some possibility that ultimately this technology could be useful for some of the applications that they do: "*There's two possible areas where this could be useful in our market or this could be a way for using our existing skills."* For now, Vesper Drive invests in it.

The CTO does not believe networking is always a good thing. When the company started, Vesper Drive entered an existing market with a new product made a deliberate decision not to talk to their competitors, not to learn from their competitors, not to hire engineers that had experience in the industry. "*We thought, if we interact to closely and if we take knowledge from the existing industry we're just going wind up doing something like the exactly same as the industry. Whereas if we go in blind and stupid, we spend a lot of time re-inventing the wheel, but we might actually re-invent the jetliner instead of the wheel." "If you're trying to break the mould, you don't necessarily pay too much attention to what everybody else is doing."*

Being a small company, the CTO believes this thrives innovation as communication lines are short and oversee able. In New Zealand itself, the relationships are very informal with local companies: "*when we need to borrow a bit of equipment, someone just wander down there and people that used to work in a previous company just ring up the guys they've been working with, and say what do you think about x-wise here. And at that level, there's a reasonable amount of networking that is so informal, that it's not even on the radar*". At the other extreme, dealing with off shore customers, suppliers or technology vendors tends to be much more formal as here is no personal relationship and it's hard to build that up.

5.2.3 Outbound innovation

Although being a technology company, Vesper Drive only filed two patents; the administrative burden costs were the main barrier. To get a patent from the start through to approval in a reasonable range of countries costs about a quarter of million New Zealand dollars.

However the company is and was very active in licensing. Historically, trading intellectual property (IP) was a very large part of Wellington's business model. Originally, it was a technology development company licensing-out technology. But this model did not work for them; they found it very difficult to sell IP unless it is proven to be successful.

Out licensing is still a part of the business model, but it is binary thing with the manufacturing model. There are several options the CTO explains: *"We can either supply the customer a motor or we can just sell them a license and they can go do it themselves. Or we can sell them a license, and then contract back from the customer as a consultant in case we actually do the detailed work for the customer and then they manufacture."* That third one, is generally what tends to happen, because the reason customers are going to buy a license of Vesper Drive, is because they do not have the skills to do it themselves anyway, so they're not just going to develop it, but buy a license for that purpose.

Vesper Drive anticipates on this by selling a license to a company and then also sells an engineering program to develop the particular product. This is a joint effort between their own engineering team and the customer's engineering team. The collaboration is usually moderately formalized. During the development process it is very much of a standard consultancy model; the customers pays the company X many thousand dollars to do Y much of engineering which delivers to the customer's milestones and once Vesper Drive delivers the milestone whether that is a set of drawings, tooling or whatever then they get the income. *"It's contract based and the money exchange hands, so it's got to be at last partly formal."*

The company has sold a dozen licenses of their technology over the years, but only one of them has gone as far the customer going actually in production, making a thing and returning royalties to the company. The CTO describes it as a high-risk/high-return strategy: *"nine out of ten times it is going to fail, but the tenth time it's a quite nice revenue generator".* Most of the licensing projects have fallen over, because the customer company had some strategic change, and they just decided to cancel the project, and there is nothing Vesper Drive can do about it. The CTO acknowledges this is typical of what your making as a component of a larger system*: "There's a limit to what you can do, particularly as a small company dealing with a large company. Most large companies treat us as a very small company on the far end of the universe that has one useful thing out the ten million things they are doing at the moment. And to a certain extent, all you can do is gamble that somebody in HQ is saying we're not doing that kind of motors anymore, we're going to put our money in something completely different. There is no way that we have any influence on them."* Vesper Drive experiences this a significant problem, in the industry they work in the customers are inevitably a magnitude larger than they are.

5.3 Case B: Adepto

Adepto is a complete product development and manufacturing company divided in two subsidiary companies, Adepto Meat Industry Products and Adepto Medical. Both companies commercialize a portfolio of proprietary products. Their integrated process includes research, industrial design, engineering, tooling, injection moulding and manufacturing. Adepto Medical offers a range of products to the global healthcare industry. Adepto Meat Industry Products develops and supplies a range of devices to eliminate pathological contamination of meat.

5.3.1 Innovation strategy

The CEO, CFO and CTO of the company have filled in the innovation scan, a follow-up interview has been held with the CTO[3]. All three respondents indicated that exploratory innovation projects are an important objective for Adepto. Introducing new generation of products, opening up new markets and entering new technological domains were all marked as important or very important objectives. The percentage of explorative projects was 70% compared to 30 % of exploitative projects. The company has been founded upon one single successful product 50 years ago, but is now looking at ways to diversify. Adepto is aware of relevant technological developments in its own industry. However, it's less aware of technological developments in related industries or universities. Overall, the company clearly sees innovation and market research as an important part of the strategy.

In the selection process of innovation projects, the company takes balancing the number of projects and available resources in consideration. They also consciously chose projects that improve the existing products and/or projects were the main aim is to create entirely new products. All new product development processes are formally divided into different phases, carried out by employees of multiple departments with a lot of excessive communication between production and R&D.

5.3.2 Inbound innovation

Adepto has a small network and is putting a lot of effort in explorative activities, but their market orientation is just-above average. There is no collaboration with competitors nor suppliers; "*we just buy raw plastic material, there is no innovation there*", quoting the CTO. Although one project emerged:" *We do actually a little bit of work with a company that makes biodegradable plastics that breaks down in water, so we worked with the meat products, the clips they have to be removed from the food chain but they can break down. They are developing new grates and are basically looking for new applications."*

The general motives for Adepto working with other actors are entering new technological domains and potentially opening new markets. This is mainly done by market research and working with universities to explore. A more profound collaboration surfaces while the company is slowly making a shift towards medical appliances. Therefore, the engineering team is working closely together with their customers, hospital suppliers in this case, in focus groups to develop new products. They also include some end-customers, surgeons, in the process for feedback. This is a second tie relationship in their business network. These clinical people in hospitals are the people who understand the unmet need for the medical products that Adepto hopes to develop, so they need to work closely with them to be very clear about what the product needs to do. They also help them validate the concepts and develop a solution that meets their

[3] All quotes in this interview are from the Chief Technological Officer (CTO)

needs. However engaging with clinical people in hospitals is the biggest challenge for Adepto. "*We find many hospitals do not have a framework for this engagement*," the CTO explains. Adepto experiences reluctance talking to commercial companies until they can convince them that they are not just trying to sell something but want to work with them. "*It takes time to build these relationships"*.

With product development often projects do not make it to commercialization. This needs careful management so that the clinical people do not feel they have wasted their time. The employment contract with the hospital often does not consider work with external companies, ownership of IP etc.

Once Adepto is clear about the clinical need, developing technology to meet the need is generally less of a problem for them. Often the products they develop will be in the realm of product design rather than technology development. If they need to develop technology universities and/or other institutes will be sought to do so. Adepto considers ease in collaboration; "*they are well set up for this and keen to work with industry*". There is also a well-defined path for government funding to help Adepto. Ultimately, funding does always become an issue to see a project through to commercialization but at the proof of concept stage this is not a barrier the CTO adds. Another challenge Adepto faces is that medical products have the added overhead of regulatory requirements for each market. Also the question of who pays for the product is complex. Reimbursement is different in each market and there are many stakeholders. Private insurance companies, state health systems, private direct purchase etc.

5.3.3 Outbound innovation

Adepto Medical is based on its capability of plastic injection moulding. The ideal products for them are ones that make the most of this capability or physical products that require high precision moulding. However, when they approach new products from the clinical need, it is not obvious what form the final product will take. This means that often projects that they start are not completed because commercially they do not fit our capability i.e. they may be largely electronic or software based. The CTO acknowledges that there is an opportunity here for Adepto to license out or sell the IP that they have developed to companies that do have the capability. However, the company likes to focus on their core product for now: "*Licensing IP is an opportunity for Adepto but requires a cultural shift. Adepto Medical is an owner-operated company based on in house capability. Negotiating licensing agreements is another set of skills that need to be developed."*

In their core process, the company needs to negotiate about an agreement around ownership of IP can be difficult for Adepto as the CTO explains *"Often we are engaging with people before any IP exists on the understanding that you will develop it together. Who takes the financial risk and whom the financial reward? This needs to be discussed in the process. Inevitably there needs to be a basis of trust and this can take time to develop".* The company applied for one patent in the last three years, but does not have enough financial resources to pursue a patenting strategy: "*Patents are always an issue because to apply them effectively in the international market is very expensive*". Alternatively, to protect their products Adepto relies on speed to market and technical capability. For example, the products contain very precise moulded sub-parts which are hard for competitors to copy and make the product cost effectively.

5.4 Case C: Frendo

Frendo is equipped to produce small to mid-sized batches of machine parts and hydraulic manifolds. On the shop floor, twelve CNC machines are lined-up to produce those complex products. The company has been founded thirty years ago, and is run by the son of the founder. It is healthy and does not have debt capital. Frendo used to produce in large quantitates and produce on stock, however due to a changing environment there has been an increasing demand for smaller batches and build-to-order production, as is a general trend. Throughout the years, the focus of the company slowly switched from the shop floor production to planning.

5.4.1 Innovation strategy

"Open innovation is also applicable here" the CEO states, "*customers come to us to develop new products for instance*". According to the CEO, the future of the business his company is in will be about automation and collaboration; "*I also have long-standing relationships with my suppliers*", and considers it as a vital part of the company's strategy. R&D expenditure whirls around 15-17%, mainly spent on a higher purpose to turn the machines into data processors.

Before parts can be manufactured, a lot of data needs to be gathered; CNC, CAD/CAM drawings, machinery specifics, setup schemes, maintenance data, etc. All this raw data comes from a handful of systems and is split up in geometric elements. The machines are not directly programmed by employees, but via computers, linked in a network. Tooling setup decisions are made according to standard protocols and the customer-specific drawings and bill of materials. All this is combined in one interface dubbed 'Frendo Portaal' which allows planning the production process to be more efficiently and maximize machine capacity, as less downtime is needed to program the machine. This automation is a pioneering area for Frendo. As Frendo is not an OEM, the majority of the R&D expenditure goes to process innovations, and especially in Frendo Portaal, it is the spearhead of their enterprise.

5.4.2 Inbound innovation

Having split up drawings in geometric data, theoretically, the customers could program the machine themselves if they want too. However, in real life it is not that far yet. A lot of re-engineering has to be done by the Frendo engineers to figure out how the elements are constructed. Therefore, Frendo aspires early customer integration. The company wants to pertain in the customer's engineering and development processes so they both realize cost advantages by eliminating redundant engineering work. However, this is easier said than done and the company is faced with several challenges. By collaborating at the early stage, some customers are afraid of an early lock-in of its supplier, which makes it hard for them to negotiate on prices in a later stadium. The CEO counters "*They [the customer] maybe can get the job done for one euro less per part elsewhere, but what the don't realize is that the engineering process already covered 12.000 euros. Real savings, in my opinion, can be made there.*" To overcome these challenges, the purchasing agent must be surpassed and validation must be sought higher up the organizational tree. But even on an operational level the company sometimes faces problems, "*when a Frendo engineer starts working together with a customer's engineer, the latter sometimes feels threatened, saying; 'this is my area of expertise, what are you doing here?'*" A change in attitude is happing the CEO notes. Frendo more and more profiles itself as an open organization towards its environment. "*This took a while though, we also had to think about what questions we need to ask to our customers/suppliers.*"

Frendo works with research institutes like Synthens, TNO and VMO; "*if the knowledge is there, why should we develop it ourselves?*" the CEO motives the collaboration. In the past the company did some research themselves, but realized it is cheaper to invest in external organizations and let them identify possible problems. The company also has a project at the University of Groningen, where it invests in lean manufacturing plans. "*The majority of our investments are in process innovations*".

Some of Frendo's customers are located in Germany, but they do no experience any differences compared to Dutch customers; "For *both it takes a lot of time to establish a good working relationship, in general 1.5 to 2 years for each customer"*. When working with large companies as customers, the CEO does experience some differences, "*large companies have more bargaining power and try to drive costs our way"*. Also, a large customer who the company has been working with over twenty years, and developed some solutions for, decided to move to Italy overnight. "*It hurts, but we cannot do much about it, we could send a lawyer but that doesn't change the situation*". The advantage of Frendo Portaal also shows itself at the negotiating table, the CEO has direct access to the system and can quickly outline costs and see the production schedule *"this gives us great internal flexibility*".

5.4.3 Outbound innovation

Frendo did not apply for any licenses or patents nor is holding any. Their customers mainly do engineering and Frendo is executing. The company is not thinking about patenting its software system yet, as it is still in its early stages. At this time, the Frendo Portaal system is only used for their own production process, the CEO is thinking of commercializing the system; "*There are a lot of manufacturing companies here in the Twente area whom ran out of work, sometimes I customer comes to me and I don't have the right machine, but the neighbour does. I want to grab the data and do the work there, that is my dream*". The CEO conveys a wider vision 'Frendo turns information into products'. However, the company first has to work on the system, fill it with more information, link ERP to the CAD/CAM systems, subdivided more information in smaller parts and standardize ways of operation between customers.

After a sale is made, customer contact primarily goes via the planner but often engineers from both sides get involved to narrow down details which presents a challenge on its own; "*sometimes the engineers get so caught up in the problem that it takes too much time, the question then is who is paying the bill*".

The CEO highlights a culture change in the company itself "from a traditional production company, we now more and more become a sales organization". This moves the thoughts from internal thinking towards external thinking and faces the company with new challenges they never thought about before like delivery, packaging, price and quality agreements; "*we have to formalize more processes.*"

Other challenges the company stumbles upon are: understanding the customer and/or supplier; "*are we talking about the same thing?",* valuing the customer/supplier, with some you can collaborate more and deeper than others; go beyond price negotiations and convince a customer of more structural savings by innovating together; dealing with creative people who can or cannot bend a design problem into an engineering problem, translating vague comments in hard figures. These challenges are founded in communication, as the CEO acknowledges.

5.5 Case D: Melior Engineering

Melior Engineering is a mechanical engineering office with a team of 32 employees that focuses primarily on creating designs for custom-made machines. The markets for which they design machines include: automotive industry, office furniture industry, concrete industry, plastics industry and packaging industry. The engineers work in their office, as well as on site at their clients. Melior Engineering provides the concept, basic and detail engineering drawings of these machines. They do this by integrating processing techniques and propulsion techniques into machines or production lines, meeting the wishes and requirements of the customer. The trained staff maintains an engineering degree at bachelor and/or master level.

5.5.1 Innovation strategy

The CEO[4] of the company has been interviewed in this case study. Melior does a lot of collaboration with other actors in its networks; "'*being open to each other', that for me is open innovation. Discussing matters back and forth in the design process with our customers, it justifies the existence of our company*". 90% of the work Melior comes from one customer, this creates an interesting situation. One could say that their main customer completely outsourced their R&D function. Their customer is a thoroughbred machine builder and wants to stick to their core business, as Melior wants too, the two companies maintain a good understanding. One downside Melior experiences are that its engineers lose touch with real products they engineered, they hardly see the final products at work, the CEO comments "*they should forge the iron themselves, meaning engineers should consult with the actual builders*". To overcome this, Melior is planning to physically move to the same building as its main customer, both parties think the quality will improve by this move.

With delivering no physical products to its customer, knowledge is the main asset for Melior. Knowledge, for a big part, is tacit and intangible and maintaining knowledge in the company is a challenge. A lot of knowledge and experience rests at the employees of Melior, as at most companies, this is documented in working instructions. However, since 2011 Melior developed a new system with its main customer, which can be compared to Wikipedia, the online encyclopaedia. Each employee can add bits of information to the system on a particular subject, also the name of the contributor is added, so if the information is unclear, he or she can be contacted. It is a far going collaboration with its customer, but as the CEO notes: "*the system will be made or break by the people who maintain it, that is crucial*" he also acknowledges that he needs people for it that like to work on such systems.

The company develops the mechanical part of the machines, whereas the software design happens at the customer. To speed up the development process, there is an early customer integration in the design process to enables a parallel development of the mechanical part and the software side.

The CEO predicts that in ten years time, the less sophisticated engineering projects will move to low-labour countries as well, as the manufacturing did earlier. Therefore besides moving to the same building as its main customer, in the near future the company wants to focus more on development in addition to its 'standard' machine building. The company doesn't want to grow much further: "*we like to stay a small company to preserve synergy in the team*"

[4] All quotes in this interview are from the Chief Executive Officer (CEO)

5.5.2 Inbound innovation

Networking and being part of trade organization is an important channel to gain customers. Melior sometimes goes outside its treaded markets and takes on a new non-standard job. The main reason for this is to satisfy its employees by challenging them and offer some variety in their work; an employee satisfaction survey discovered this. The company hardly looks at his competitors; *"they don't reveal a thing, and besides that we believe in our strength"*. However, they do use video-websites like YouTube to get ideas for possible solutions. Also a lot of knowledge just comes in from the customer itself; "*we have to adjust ourselves to their needs*"

Contact with the customer first happens with the salesmen, but during the development all parts of the company are involved with the customer at some point. When working together, challenges do arise, such as: clashing cultures, can the customer carry the matter enough to make it happen, unclear arrangements and diverging priorities: "*it can happen that one party did not explored the agreement good enough, which creates a dispute at the end of the deal".*

The majority of the customers are located in the Netherlands some are in Germany. The CEO doesn't see a difference in working with its international customers; distance is overcome by using an online video conferencing tool.

The suppliers that add the most value to the company are software makers. Solid Works provides the drawing software, with which Melior has developed some specific options like a print tool; "*We developed a piece of software together and took a little bit of the risk involved, in the end we had to pay less for the solution, and Solid Works could take it to the market*". Another company supplies a PDMA-system (Product Development), Melior is motivated to save on the number of mouse clicks; "*this may sound silly, but if you can eliminate five mouse clicks, per minute, per employee it does add up.*"

Melior once collaborated with TNO, a Dutch research institute, but generally doesn't work together with universities or other research institutes. "*It takes too long to get an answer from these organizations, the turnaround time for our project is too high for that, we cannot wait for it*"

5.5.3 Outbound innovation

Melior develops a lot of innovative machine that have never been built before. But the company does not feel like spinning out knowledge to develop separate companies; *"we don't have that ambition"*, the CEO explains, *"I'm a born engineer and not a tradesman. I want to engineer, develop. We've been doing this for seventeen years, business is good, so why should I?"* continuing on the subject, even if they were start-up their own machine company, it will be a though market to compete in, millions of euros go around which involves a risk that a small company cannot bear.

Melior is active in different markets, which allows them to use the knowledge developed in one market, to be used in another market. Together with their customers they find solutions to their problems. After the project, the customer becomes the owner of the intellectual property. Melior never chooses to share the development risk "*the customer just pays for our knowledge*". Another motivation not to apply for patents is stay independent. "We don't want to limit our options". Melior' customers sometimes do apply for patents on the technology developed by Melior, but the company does not share in royalties.

5.6 Cross-case analysis

For the cross-case analysis, the technique of selecting dimensions and to look for within-group similarities coupled with intergroup differences has been used (Eisenhardt, 1989), allowing unique patterns to emerge to accelerate the cross-case analysis. This analysis should result in knowledge on what motives and challenges the cases face in engaging open innovation.

5.6.1 General figures

First similarities and differences are sought between the case companies on a general level. Looking at the general characteristics, the New Zealand based companies – Vesper Drive and Adepto - are roughly the same size (number of employees) and substantially larger then their Dutch counterparts, Frendo and Melior Engineering. Perhaps the company size reflects itself in their R&D expenditure behaviour as Vesper Drive and Adepto are mainly focussing on explorative innovation projects, where the emphasis is on fundamental research, experimenting with new technologies and building first prototypes. Conversely, Frendo and Melior Engineering focus more on exploitative innovation projects such as standardisation, optimization, fine-tuning and scaling. Furthermore, Vesper Drive and Adepto are OEMs, whereas Frendo semi-manufactures products. Melior Engineering does not have physical production but their main customer (90%) does, the company could be regarded as a completely outsourced R&D department. Looking at the collaboration with partners (formality and type of collaboration), no trend can be found in the actual figures, but great differences are seen in the formality of collaborations. It looks like each company employs its own strategy; this will be further investigated in the following paragraphs.

5.6.2 Innovation strategy

The differences between the case companies arguably influence their individual innovation strategies. Traditionally, SMEs are characterized by a chronic lack of resources, i.e. in funds. Vesper Drive has overcome this problem by attracting a group of investors and is distinct to grow. Their main target is shortening time to market, the company is making a loss; so the sooner they start selling products, the better. Adepto on the other hand, is a mature company with a steady income from one product (OEM) and is now slowly making a transition towards new markets with new products to diversify; therefore the company's focus is mainly on explorative innovation projects.

Frendo is not an OEM but produces semi-manufactured for their customers, their innovation efforts are therefore mainly pointed towards process innovations. Frendo hopes to transform itself into a service company on the long term, turning the machines into data processors. The company pictures a future of increasing automation and collaboration and is developing a shop floor planning system - Frendo Portaal - to take advantage of these developments. Melior can be regarded as an outsider and presents itself as a completely outsourced R&D department, with 90% of their orders coming from one customer.

5.6.2.1 Motives

From the four cases, Vesper Drive is the company leaning most towards a full open innovation strategy. The CTO balances its explorative and exploitative R&D activities thereby using internal and external resources. The company prefers to keep exploitative innovation projects in-house, so that employees directly acquire the skills to design and produce the products. Conversely, exploratory innovation projects are first done outside

the company, to keep the scope of the company wider. An analogy is made with a game of poker, were at each round the player needs to chip in to *'stay in the game'*, it is more of a gamble as the probability of the investments becoming profitable are lower. For exploitative projects this probability is higher, taking these considerations into account, the portfolio balance is composed. Adepto executes a similar but trimmed down strategy as it uses external resources to feed their focus on explorative R&D activities. They have split up the company in two divisions; one focussing on their exploitative products whilst the other is focussing on their exploratory products and select innovations projects accordingly. Their main motive is get less reliant on their existing product line and prepare for the future by entering new markets. Innovating with external actors is in Frendo's and Melior's blood and they both consider it essential for survival, this mainly involves customer collaboration. Frendo tries to adapt to the future, Melior pursues early customer integration to speed up their product delivery, by enabling parallel mechanical and software development.

5.6.2.2 Challenges

Large companies can dedicate more resources to its innovation strategies, as the costs can be spread over a larger range. Vesper Drive mentions that the uncertainty of the environment is influencing their decision-making process because of this matter, only so many risks can be run and this number is lower at high-tech SMEs. Adepto also determines their selection process on the number of projects already running and resources available. As small companies, they have less control over external factors and fewer resources at hand to anticipate on sudden changes in their environment. Internally, Vesper Drive experiences a challenge with planning explorative innovation projects, the company finds it hard to predict how the trajectory will develop and to estimate proper time and budget. Melior finds a challenge in engineers loosing touch with real products and plans to move in with their main customer to shorten the product feedback loop. As a service company, keeping knowledge between their walls is another challenge; a Wikipedia-type of project is recently started to safeguard knowledge.

5.6.3 Inbound innovation

All four companies actively use their network to explore new markets and industries. The main collaborations are with customers and suppliers. The companies have small networks, consisting of only a handful of actors. Vesper Drive invests in testing apparatus to work out custom-made design for its customers. Frendo wants to bring customer collaboration to higher level by enabling an early integration and presents itself as an open company.

In the early days of Vesper Drive, the company explicitly didn't look at their competitors, as they suspected it would lead to imitation instead of innovation. Melior also hardly looks at its competitors, it believes in its own strength, however this points more towards the earlier mentioned NIH-syndrome.

5.6.3.1 Motives

Inbound innovation is mainly used for market orientation, entering new technological domains and potentially opening new markets. Melior also works with new partners to motivate its employees. Vesper Drive probes into the future with working together with universities. The CTO defined it as playing poker; they paid a fair amount to stay in the game of an emerging technology. Although the technology isn't applicable to the company in this stage, it might be in the long run; this is a highly explorative activity.

Adepto also had some growing collaborations with universities to explore new technologies and same goes for Frendo, that also found out it is cheaper to get technologies from research institutes then develop themselves. Frendo also believes in realizing cost advantages in engineering from both sides by focusing on early customer integration, however the companies also face some challenges.

5.6.3.2 Challenges

Building and sustaining external linkages is a challenge for all four companies, as a lot of effort is put in already one linkage. Vesper Drive attracted new suppliers from low-labour cost countries in Asia, while they had an innovative relationship with their previous suppliers in New Zealand, this new collaboration made the innovativeness obsolete. The distance made the relationships more formal and the company could not iterate on product design as fast as it was used too. The proximity of suppliers and customers is important for the New Zealand based companies, sprouting informal collaboration and innovativeness. Foreign collaborations with suppliers and customers more formalized in the NZ cases.

Vesper Drive has had bad experiences with collaborating with larger customers, as the relationships usually don't balance out in terms of power. When the large company decides to do something else, Vesper Drive ends up empty-handed. Frendo is experiencing a similar problem. Adepto is also experiencing problem with building relationships; some customers are suspicious that the proposed collaboration is only about innovation, and also acknowledges it takes time to build relationships. Adepto tries to develop a new product with the customer of its customer (a second tie relationship) but finds a challenge in that actor not having a framework to do such work. Another challenge experienced in this relationship is that the fail-rate of R&D is relatively high and not all developments turn into products, it is hard for Adepto to keep its customer convinced that they did not waste their time. Vesper Drive also says you almost need a finished product before you can innovate with your customer. Frendo aspires early customer integration, but the customer's are reluctant because they feel they are locked-in and cannot negotiate on price in a later stadium. Another challenge for Frendo is when its engineer starts working with the engineer of the customer, where the latter feels himself threatened in his field, unintentionally. Melior has to deal with clashing cultures and unclear arrangements. The company also hardly works together with research institutes, as it takes too long for them to develop a new technology.

5.6.4 Outbound innovation

Whereas there is a lot going on the part of inbound innovation, less outbound innovation can be found at the cases. The companies indicate that an active patenting strategy is very hard to execute.

5.6.4.1 Motives

The companies all have their motives to or not to out-license. While Adepto is retaining an out licensing strategy because it wants to stick to its core business, Vesper Drive is actively pursuing one, it is a part of their business strategy but acknowledges it is a high-risk/high-return strategy. Melior also does not feel the need to start licensing, as their business is already good, most of their IP goes to the customer as they pay for it. Another motive for Melior not apply for patents is to stay independent.

5.6.4.2 Challenges

For every country a new patent application needs to be requested, bringing a financial and administrative burden, the companies don't have to resources for that. Vesper Drive also found it very hard to sell IP unless it was proven to be successful. And again, the company faces the challenges of dealing with larger companies' if they change their mind Vesper Drive is left hanging.

5.6.5 Motives and challenges overview

To give clear insight in the found motives and challenges, table 16 is constructed summarizing the results from the analysis.

		Motives	*Challenges*
INBOUND		Exploratory innovation activities (mainly with universities)	Face uncertainty of environment
		Opening up new markets	Proximity of partners
		Entering new technological domains	Building and sustaining linkages
		Market research	Backseat in the business network
		Cost cutting by early customer integration	Early customer integration creates lock-in
			Distribution of risk and reward with partner
		De-motives	Limited resources = limited strategy
		Prevent imitation	Partner doesn't have fitting innovation network
OUTBOUND		First sell a license, second sell additional services	Patenting strategy is very costly to pursue
		Leverage turnover by selling IP	Hard to sell/license IP if not proven successful
			High-risk / high-return strategy
		De-motives	Cultural shift needed for owner operated firms
		Own business is already successful	
		Stay independent	

Table 16: motives and challenges overview

6 DISCUSSION

Before heading to the conclusion, the discussion chapter will be used to reflect on the conducted research and the meaning of open innovation at high-tech SMEs. Since the introduction of the open innovation paradigm by Chesbrough (2003), the idea evolved and nowadays exists in different forms in the business world. The most vivid models are so-called innovation intermediaries, where companies propose a challenge to a (online) crowd and gets dozens or hundreds of solutions. Some won't work. But all they need is one solution that does work for them. There are companies that make a living of running such platforms (e.g. Innocentive, IdeaConnection, NineSigma). For large companies it is worth the effort to setup their own open innovation programs to externalize their innovation processes (e.g. Lego, Proctor & Gamble, BMW). However, the behaviour of open innovation at high-tech SMEs has been underexposed and has been researched in this thesis.

Over the last years, more research has been conducted on how high-tech SMEs can adopt the paradigm and become smarter through open innovation. While conducting this research, the question arose if open innovation is applicable on SMEs. A rebellious opinion is easily found; SMEs are most often based on one product, service, technology or platform; they are bound to find partners around this in order to prosper let alone survive, but is this open innovation? Their innovation strategy is mainly focused on their main activity, and SMEs don't need to innovate across several types of innovation and business functions. A third argument is that SMEs are not large enough; they just do not have the organizational infrastructure to engage in open innovation.

This study reveals when SMEs do have a role to play in open innovation ecosystems, they get the backseat. The larger companies take the driver's seat, as was shown in the case studies. In open innovation, companies either control the projects or they contribute to them. Large companies prefer projects where they are in control whereas smaller companies do not even get a choice unless they have something unique that allows them to run an open innovation ecosystem.

The companies in the case studies seem to grow in an open innovation-like way without knowing or paying special attention to this. They also grow like this because today they can no longer hide in an ivory tower until their development is done and then try to sell their products or services. They need to work with partners from day one, but again is this open innovation? Or is open innovation more of a deliberate process based on a selection of choices on how to innovate and survive in the business environment? In this case, it seems that the high-tech SME does not have a real choice than to cooperate with others in order to bring about innovations.

Although the term open innovation was just recently coined and most of the time is associated with innovate business models that include crowdsourcing and ecosystems executed by large companies, the actual openness of innovation dates as long as companies exists, as argued in paragraph 2.2.2. In such views, large companies where considered as atoms or hubs controlling the business environment and allowing others to embark on their innovative ideas. Due to the rise of information technology and accompanying globalization, time and distance became less relevant in today's business world, which resulted in an easier flow of knowledge over the world that companies are eager to make use of, which again increased the rate of new technologies and products that are developed.

Open innovation is argued to be a mind-set, not a tool. But do high-tech SMEs define innovation down into the different types? They would respond to opportunities in more open ways but do they structure this as open innovation, more they would 'feel' this is just natural innovation. This also means it requires quite an internal structure to make it happen properly – and yet even companies with the resources to back fail miserably, as was the case with Vesper Drive and Frendo, who were left out in the dark when their partner changed strategy. Large companies need some level of internal structure to make open innovation happen on a sustaining level but many high-tech SMEs do not have a formalized process for innovation or for development let alone going that one granular level down to open innovation. Lastly, open innovation, as it is known today, is still in its infancy. To start drawing conclusions as to where it should be applied and how is premature at best. The new questions for developing open innovation programs are how to mine/capture ideas and how to evaluate them for further work. In that case there is no differentiation in size of company.

7 CONCLUSION

In this final chapter, the practical findings will be linked to the theoretical insights, and with the discussion from chapter 6 in mind conclusions will be drawn and added to the open innovation science. Subsequently, the theoretical and managerial implications and consequences will be highlighted. The chapter will be concluded with the limitations of this paper and provide suggestions for future research.

7.1 Adoption rate

In this research the innovation scan was used to measure the adoption rate of open innovation at low- and high-tech SMEs. Firstly, the general innovation performance was measured, based on the stability of the environment, R&D strategy and R&D expenditure, no significant differences were found. Secondly, the adoption of open innovation was measured based on collaboration with partners. The questionnaire did measure for inbound innovation, but as mentioned before patenting and licensing - a substantial part of outbound innovation - were not measured. On most areas, low- and high-tech SMEs did not differ significantly, only on the formality of relationships, collaboration with suppliers and external idea searching differences could be found. The results showed that low-tech SMEs are missing chances on discovering new product ideas. Conversely, high-tech SME are actively searching the external environment for new ideas. Based on these indicators, it was suspected that high-tech SMEs have a higher need for innovation, and will therefore look more outside the boundaries of their organization then low-tech SMEs do. Consequently, the focus hereupon was on high-tech SMEs.

Looking at SMEs in general, it must be noted that SMEs appear to have rather small business networks consisting of only 1-5 partners; this is in line with the research findings of Pullen et al. (2010). Viewed from a network perspective, SMES are a small node in a business network, and its actors are not connected to each other (Pullen et al., 2010). Delving deeper into the partners that are collaborated with it appears that there is hardly any collaboration with competitors and low collaboration with universities, other research institutes and companies from other industries. The collaborations seem to be naturally limited to suppliers and customers and in a lesser sense to consultancy firms. These supplier/customers collaborations, however, indicated to be very intensive, meaning they holster a lot of innovation.

7.2 Motives and challenges

While the previous conclusions were drawn from data analysis, the following paragraphs are the result of a multiple case study on four high-tech SMEs. Van de Vrande et al. (2010) conducted research on open innovation at SMEs in the Netherlands, but no particular research on open innovation has been done in New Zealand before. This thesis allowed doing a multiple case study in both the Netherlands and New Zealand and adds to the existing literature.

Unsurprisingly, the limitations that SMEs have compared to large companies are also found when engaging open innovation. Some SMEs can overcome their 'liability of smallness' by opening up their innovation process (Keupp & Gassmann, 2007; van de Vrande et al., 2010). The protection of intellectual property is a hard task at hand for SMEs, as they do not have the financial resources for pursuing an active patenting strategy and the participating companies did not feel the need, as they were doing well already. The companies did not appear to have a well-defined and standardized

approach managing open innovation projects. However, they did not necessarily see this as a problem. Most believe that the approach should be customized according to the type of project, the partners and the respective objectives of the parties involved. The view was that these factors would also dictate the necessary skills and investments. In table 16 an overview was given of the found motives and challenges. A few key themes emerged and will be discussed in the following paragraphs.

7.2.1 Exploratory innovation activities via universities

The concepts of incremental and radical innovations were introduced in paragraph 2.2.2. Due to the smallness of SMEs, it is harder for them to split both ends as they have limited resources. The main challenge for SMEs is to balance exploitative and explorative innovation projects. The analysed high-tech SMEs tried to cover this challenge by doing a lot of exploratory research externally, mainly at universities, underpinning Rosenberg's (1990) argument about conducting R&D as a 'ticket of admission' to potential partners.

7.2.2 Proximity of partners

SMEs are known to be flexible because of short communication lines and the proximity of suppliers and customers seemed to influence the innovation strength of collaborations. Vesper Drive, and other New Zealand companies are largely exporters. For them it is much harder to have informal collaborations with customers and/or suppliers, because of geographical reasons. Vesper Drive experienced a dramatic decrease in supplier collaboration when sourcing from Asia. Conversely, the company has held advanced relationships with actors that were 'around the corner'; although this is so informal that it is not even on the radar. Melior Engineering, on the other hand, wants to enhance the innovativeness by physically moving in with its largest customer. For cooperating companies it is useful to be located in close proximity to each other, in order to overcome the barriers of mistrust and benefit fully from different corporate cultures (Lorenzen, 2002 as cited in Hirsch-Kreinsen, Jacobsen, Laestadius, & Smith, 2005) this has been confirmed in the cases in New Zealand, where moving suppliers overseas had a paralyzing effect on the innovativeness of the relationship. Informal relationships are very much built around personal relationships, for a remote country as New Zealand this is certainly the case.

7.2.3 More inbound than outbound innovation

Absorptive capability is associated with inbound innovation that centres on the outside-in approach; knowledge and idea creation outside of the company that wants to flow inside the company by advanced customer and supplier integration. Feedback from the research confirmed that gaining access to a range of insights, ideas, capabilities and partners from different sectors is seen as essential in the current competitive environment but also a complex time-consuming task requiring significant resources. Outbound innovation revolves around the inside-out approach, where the commercialization of own ideas and technologies outside the company is the key part. Patenting, licensing and cross-industry innovation are some of its characteristics and a multiplicative capability is needed to do so. However, the cases gave a lack of financial resources as the main barrier to engage in licensing and patenting strategies. Concluding, high-tech SMEs appear to engage more in inbound than outbound innovation.

7.2.4 Back seat/driver seat

A profound challenge for SMEs engaging in open innovation is that they get the backseat. The large companies take the driver's seat. In open innovation, companies either control the projects or they contribute to them. Large companies prefer projects where they are in control whereas SMEs do not even get a choice unless they have something unique that allows them to the market. Vesper Drive experienced this as a problem, having no control on the large companies. Such linkages should be handled with care but this doesn't mean SMEs cannot benefit from open innovation. Open innovation can give SMEs the opportunity to compete in previously unattainable markets, which was also mentioned as the most significant motive. SMEs can even be more nimble. Contributing to or owning seems to be a more accurate question in differentiating large companies from SMEs. A larger company perhaps more frequently owns the open innovation process, but SMEs are not excluded from the equation, as a larger is company is not always needed to use external ideas or paths to market. Process ownership and participation are two different things and both can be beneficial regardless of organization size.

7.2.5 Risk

All companies experienced problems with some sort of risk. As high-tech SMEs have a small innovation portfolio they have problems spreading risk in an uncertain environment, whereas larger companies can strike this out over greater length. To describe the relation between success and failure in innovation, a popular quote from scientist Thomas Edison comes in place: "*I have not failed 700 times. I have not failed once. I have succeeded in proving that those 700 ways will not work. When I have eliminated the ways that will not work, I will find the way that will work.*" Many researchers use this quote because it 'validates' the iterative development innovation process, which is the cornerstone of most R&D departments. They have convinced themselves that they learn as much from their failures as they do from their successes.

This viewpoint counters the concept of open innovation. When some R&D people look at open innovation, they see it as linear rather than iterative process; work together and get a solution. This seems inconsistent with their belief in learning from failures. With internal iterative development, the company pays for the successes and the failures in time and money. But when moving the innovation process outwards so does the risk. In an ideal world, open innovation is a massively parallel process where failures and successes happen at the same time. The question arises if companies really learn enough from their failures to justify the extra cost and time involved, and how this burden will be shared. In my cases studies, each of the four companies experienced risk and approached this problem differently.

7.2.6 Concluding remarks

Open innovation becomes more seeming and if large companies execute it well, they can harvest knowledge from multiple external actors and push knowledge into the system. SMEs, however, are much more constrained and have less weight then their big brothers. To a certain extent SMEs are following larger companies when adopting open innovation, but their adoption might come with some advantages. It will be faster and deeper. The reasons for this seem obvious on the surface: SMEs are less tied down by historical investments in infrastructure, massive data files, and organizational obstacles to adoption. Conventional wisdom has it that the lack of access to capital and resources is driving these companies toward open innovation. For them to engage in open innovation a different set of thinking needs to be applied as they cannot rely on large amounts of

resources. One concern was that high-tech SMEs take the backseat in the open innovation style landscape. If looked at this topic from a network perspective, the case studies showed that SMEs have small networks and conversely large companies are bigger nodes in the network, thus having more connections. Since open innovation is all about external networking it is not a surprise that a bigger node appears to do better in open innovation, the results will always be skewed when compared. This does not clarify the "bully effect" of larger companies as described earlier. Just because SMEs are not often in a position to control it, doesn't mean they cannot be an integral part.

7.3 Consequences and managerial implications

Open Innovation has been an increasingly hot topic since the publication of Henry Chesbrough's book, Open Innovation (2003). Here we are eight years later, a top-of-mind question for innovation managers that are on this road is, "What does my company have to show for our innovation investment?" This thesis described where open innovation has been valuable for high-tech SMEs, what motives they have and what challenges they faced. There is still a lot to discover, but hopefully this thesis created some new insights.

A first step is to see open innovation as a mind-set. Open innovation is not a tool, but a paradigm. The company's leaders should recognize that the smartest people don't work for them and considerable knowledge can be found outside the company. A challenge was found in building and sustaining linkages a strong innovation culture requires a strong networking culture. Thus, it is advisable to have networking strategy and give employees time to develop relationships. On the communication side, it is important to speak the same "language" as those you are trying to build a relationship with. People often forget that they see things differently leading them to have different views and even a different vocabulary on many things.

Time is, of course, a key concern, but perhaps it can be thought of as learning by doing and as an alternative to participating in a conference or a training programme. Joining with peers who are tackling a challenge means the company is learning not just about open innovation but also about dealing with issues of diversity. Being able to deal with diversity is a key skill that employees need to build before venturing in the world of open innovation but often it is not something they have much of a chance to tackle in their daily work lives. In addition, the exposure to different styles of thinking can also be something that such engagement offers that isn't always readily available within a small organization.

Open innovation should never be seen as some kind of strategic silver bullet, rather a series of agile behaviours that are much more productive in a networked world. The risk involved depends mainly on who makes the investments, who is responsible if a project fails, and who will take the rewards if it succeeds. These factors should be taken into account when engaging in an open innovation effort. Lastly, high-tech SMEs often take a smaller spot in the innovation landscape, and should be aware not to become a victim of trying to control the effort, but possibly act more as a contributor.

Also, the case organizations provided some arguments on not to engage in open innovation. Firstly, two companies noted they were already doing well with their current innovation efforts, and didn't feel the need to engage in more open innovation efforts, this was mainly outbound innovation. Secondly, one case explicitly did not collaborate with its partners to prevent imitation. They were trying to enter an existing market with

an innovative product, and believed that looking at the actors in that market would result in imitating what was already common. Also, Pullen et al. (2010) show that a more business-like approach to open innovation at SMEs is more effective than completely opening up its innovation processes.

There are also benefits in using open innovation in high-tech SMEs, especially if they move away from only thinking of using it for new products/services. The engagement should be based on a definition of where the high-tech SME is positioned in the network. In many cases, the high-tech SME is part of a network containing suppliers, external consultants, distributors, resellers, agents etc. Along with their direct customers – and off course their employees. So the company should think in topics like; How to engage your suppliers in order to create increased demand for your products? How to bridge knowledge from your direct customers to your distributors to enhance your services? How to create a forum for capturing ideas from your resellers that could help them increase your product positioning? Concluding, if the company concentrates on topics/efforts where at least one part of the network will benefit – the company will benefit automatically.

7.4 Limitations and future research

This study has some limitations that suggest a number of directions for further research. In the quantitative analysis, the first limitation is the sample size. The data set has been provided by the University of Twente and originally consisted of 65 responses in the VMO Benchmark research. 35 responses were valid for this research, but the sample appeared to be skewed towards low-tech SMEs (<5%), based on the percentage of turnover spent on R&D. Therefore medium-tech (5-10%) and high-tech SMEs (>10%) were merged to get a better offset. Subsequently, only few significant differences were found. If this research would repeat with a larger sample and better distribution, significant differences might appear. The innovation scan is not included in the appendix, as it has been labelled classified by the NIKOS department. Parts of the scan could be re-used, however the scan mainly measured for inbound innovation, and should be re-edited to include outbound innovation. Another suggestion for further research is to conduct a cross-industry study in multiple sectors for generalizability of the research findings. The participating companies were manufacture based, but differences might be found in other industries regarding the adoption of open innovation. Lastly, only one person has been interviewed per case organization, the point of view has not been angled.

Despite these limitations, this study has provided valuable insights in the field of open innovation. Hopefully, the conclusions and managerial implications trigger both academics and managers to dive deeper into the concept of open innovation at high-tech SMEs. The participating companies actively used their network, but more research can be conducted on how these sources are actually found. Companies have to know which new and established models and tools exist to tap into external knowledge for innovation in a flexible way. They have to gain knowledge how to operate these approaches and learn about their success factors. Secondly, companies have to identify and reach the external partners that can help them in their open innovation process. They require an overview of methods and possible partners who are specialized in applying these methods, future research might focus on the particular skills needed for SMEs to engage in open innovation. Lastly, more researched can be started around my concluding remarks of the place of high-tech SMEs in an open innovation network and the importance of proximity and the innovativeness of a relationship.

8 REFERENCES

Acs, Z.J., & Audretsch D.B. (1990). Innovation and Small Firms (Cambridge, MA: MIT Press, 1990). Innovation in Large and Small Firms: An Empirical Analysis. *American Economic Review.* (78), 678-690.

Ahuja, G. (2000). Collaboration networks, structural holes, and innovation: a longitudinal Study. *Administrative Science Quarterly*, (45), 425–455.

Arrow, K. (1962). Economic welfare and the allocation of resources of invention. In: Nelson, R. (Ed.), The Rate and Direction of Inventive Activity: Economic and Social Factors. National Bureau of Economic Research. *Princeton University Press,* 609–625.

Babbie, E. (2008). *The practice of social research*. Thomson Wadsworth.

Boschma, R.A. (2005). Proximity and innovation: a critical assessment. *Regional Studies 39* (1), 61–74.

Brusoni, S., Prencipe, A., Pavitt K. (2001). Knowledge specialization and the boundaries of the firm: why do firms know more than they make? *Administrative Science Quarterly,* 46 (4), 597–621.

Buckley, P. J., Casson, M. (1996). Joint ventures in Firms, Organizations and Contracts: A Reader in Industrial Organization. *Oxford University Press: New York*, 410-428.

Burgelman, R.A., Christensen, C.M. & Wheelwright, S.C. (2004). *Strategic Management of Technology and Innovation*. McGraw- Hill.

Casson, M. (1998). Information and Organization: A New Perspective on the Theory of the Firm. *Oxford University Press: New York*.

Chang, Y. C. (2003). Benefits of co-operation on innovative performance: evidence from integrated circuits and biotechnology firms in the UK and Taiwan. *R&D Management,* 33 (4), 425-437.

Chesbrough, H. (2003)a. *Open Innovation*. Harvard University Press: Cambridge, MA.

Chesbrough, H. (2003)b. The era of open innovation*. Sloan Management Review* Summer, 35–41.

Chesbrough, H. & Crowther, A. K. (2006). Beyond high tech: early adopters of open innovation in other industries. *R & D Management*, 36 (3), 229-236.

Chesbrough, H. (2006). *Open business models: how to thrive in a new innovation landscape*. Boston, MA: Harvard Business School Press.

Chesbrough, H., Rosenbloom, R.S., (2002). The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies*. Industrial and Corporate Change,* 11 (3), 529–555.

Christensen, J.F., Oleson, M.H., Kjær, J.S., (2005). The industrial dynamics of open innovation—evidence from the transformation of consumer electronics. *Research Policy* 34, 1533–1549.

Cohen, W.M., Levinthal, D.A. (1989). Innovation and learning: the two faces of R&D*. Economic Journal,* 99 (September), 569–596.

Cohen, W.M., Levinthal, D.A. (1990). Absorptive capacity: a new perspective of learning and innovation. *Administrative Science Quarterly,* 35, 128–152.

Cooper, D.R. & Schindler, P.S., (1998), *Business Research Methods*, New York, McGraw-Hill Education.

Dahlander, L., Gann, D.M. (2010. How open is innovation? *Research Policy*, 39, 699-709.

Dyer, J.H., Singh, H. (1998). The relational view: cooperative strategy and sources of interorganizational competitive advantage. *Academy of Management Review*, 23, 660-679.

EIRMA, (2003). *Innovation through spinning in and out*. Working Group Report WG60. Eirma, Paris.

Eisenhardt, K.M. (1989). Building theories from case study research. *Academy of Management Review*, 14 (4), 532–550.

European Commission. (2003). SME Definition. *Enterprise policy*, retrieved from http://europa.eu.int/comm/enterprise/enterprise_policy/sme_definition/index_en .htm on 29.7.2011
Fagerberg, D., Mowery, J. & Nelson, R. (2005). *The Oxford Handbook of Innovation*. Oxford University Press.
Fosfuri, A. (2006). The licensing dilemma: understanding the determinants of the rate of technology licensing. *Strategic Management Journal*, 27 (12), 1141–1158.
Freel, M. (2000). Barriers to product innovation in Small Manufacturing Firms, *International Small Business Journal*, 18(2), 60-79.
Freeman, C. (1974). *The Economics of Industrial Innovation,* Harmondsworth: Penguin Books
Freiling. J. (2004). A Competence-based Theory of the Firm, management revue. *The International Review of Management Studies*, 15 (1), 27-52.
Gambardella, A., Giuri, P. & Luzzi, A. (2007). The market for patents in Europe. *Research Policy*, 36 (8), 1163–1183.
Garcia, R., Calantone, R. (2002). A critical look at technological innovation typology and innovativeness terminology: a literature review. *Journal of Product Innovation Management*, 19, 110–132.
Gassmann, O. (2006). Opening up the innovation process: towards an agenda. *R&D Management*, 36 (3), 223–228.
Gassmann, O. & Enkel, E., (2006). Towards a theory of open innovation: three coreprocess archetypes. *R&D Management Conference*.
Gassmann, O. & Keupp, M. (2007)a. The Competitive Advantage of Early and Rapidly Internationalising SMEs in the Biotechnical Industry: A Knowledge-Based View. *Journal of World Business, Special Issue "The Early and Rapid Internationalisation of the Firm"*.
Granstrand, O., Patel, P., Pavitt, K. (1997). Multi-technology corporations: why they have distributed rather than distinctive core competencies. *California Management Review* 39 (4), 8–25.
Hanna, V., & Walsh, K. (2002). Small firm networks: a successful approach to innovation? *R&D Management*, 32(3), 201-207.
Hargadon, A. B. (2003). *How Breakthroughs Happen: The Surprising Truth About How Companies Innovate*. Harvard Business School Press.
Henderson, R., Cockburn, I., (1994). Measuring competence? Exploring firm effects in pharmaceutical research. *Strategic Management Journal*, Winter Special Issue 15, 63–84.
Henkel, J. (2006). Selective revealing in open innovation processes: the case of embedded Linux. *Research Policy* 35, 953–969.
Hirsch-Kreinsen, H. (2008). 'Low-tech' Innovation, *Industry & Innovation*, Vol. 15 (1), 19-43.
Hirsch-Kreinsen, H., Jacobsen, D., Laestadius, S., & Smith, K. (2005). Low and medium technology industries in the knowledge economy: The analytical issue, *Low-Tech innovation in the knowledge economy,* 11–30.
Howells, J., James, A. D. & Malik, K. (2004). Sourcing external technological knowledge: a decision support framework for firms*. International Journal of Technology Management*, 27 (2-3), 143-154.
Huston, L & Sakkab, N. (2006). Connect and Develop: Inside Procter & Gamble's New Model for Innovation, *Harvard Business Review*, Vol. 84 (3).
Katz, T. & Allen, R. (1982). Investigating the Not Invented Here (NIH) Syndrome: a look at performance, tenure and communication patterns of 50 R&D project groups. *R&D Management*, 12, 7-19
Kaufmann, A. & Tödtling, F. (2002). How effective is innovation support for SMEs? An analysis of the region of upper Austria. *Technovation*, 22 (3), 147-159.

Kay, N.M. (1997). *Patterns in Corporate Evolution*. Oxford University Press: New York.
Kleinknecht, A. (1989), Firm Size and Innovation: Observations in Dutch Manufacturing Industry, *Small Business Economics* 1 (3), 215-222.
Kleinknecht, A. (1987). The Measuring R & D in Small Firms: How Much are we Missing? *Journal of Industrial Economics*, 36, (2), 253-256.
Kotabe, M. (1992) *Global Sourcing Strategy*. Quorum, New York.
Kotler, P., Adam, S., Brown, L. & Armstrong, G. (2006). *Principles of marketing*, 3rd ed., Prentice Hall, French Forest, NSW.
Lado, A. & Wilson M. (1994) Human Resource Systems and Sustained Competitive Advantage: A Competency-Based Perspective. *Academy of Management Review*, 19 (4), 699-727
Laursen, K., Salter, A. (2006)a. Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. *Strategic Management Journal* 27, 131–150.
Lecocq, X., Demil, B. (2006). Strategizing industry structure: the case of open systems in low-tech industry, *Strategic Management Journal*, 27, 891–898.
Legler, H., Frietsch, R. (2007). Neuabgrenzung der Wissenswirtschaft - forschungsintensive Industrien und wissensintensive Dienstleistungen, *Studien zum deutschen Innovationssystem*, 22
Lichtenthaler, U., Ernst, H. (2007). External technology commercialization in large firms: results of a quantitative benchmarking study. *R&D Management* 37 (5), 383–397.
Lindlof, T.R. & Taylor, B. C. (2002). *Qualitative Communication Research Methods*. Second Edition. Sage.
Mariti, P., Smiley, R.H. (1996). Co-operative agreements and the organization of industry. *Firms, Organizations and Contracts: A Reader in Industrial Organization*, Oxford University Press: New York, 276-292.
Menon, T., Pfeffer, J. (2003). Valuing internal vs. external knowledge: explaining the preference for outsiders*. Management Science* 49 (4), 497–513.
Mowery, D., Oxley, J. & Silverman, B. (1996). Strategic alliances and interfirm knowledge transfer. *Strategic Management Journal,* 17, 77–91.
Mowery, D.C. (1983). Industrial Research and Firm Size, Survival, and Growth in American Manufacturing, 1921-1946: An Assessment. *The Journal of Economic History*,43 (4), 953-980
Nalebuff, B.J. & Brandenburger, A.M. (1996). *Co-opetition*. London: HarperCollins.
Nerkar, A., (2007). The folly of rewarding patents and expecting FDA approved drugs: Experience and innovation in the pharmaceutical industry..Kenan-Flagler Business School, University of North Carolina at Chapel Hill.
Nicholls-Nixon, C. L. & Woo, C. U. (2003). Technology sourcing and output of established firms in a regime of encompassing technological change. *Strategic Management Journal*, 24, 651- 666.
Noori H. (1990). *Managing the Dynamics of New Technology: Issues in Manufacturing Management*. Prentice-Hall, Englewood Cliffs, NJ
Nooteboom, B. (1993). Innovation and Diffusion in Small Firms: Theory and Evidence, *Small Business Economics* 6, 327-347.
O'Reilly, C.A. & Tushman, M.L. (2004). The Ambidextrous Organization. *Harvard Business Review* 82 (4), 74–82.
OECD (2002). *SMEs in Focus*, retrieved from http://www.oecd.org/dataoecd/37/47/34026603.pdf on 29.7.2011.
Pentland, B.T. (1999). Building process theory with narrative: From description to explanation*, Academy of Management Review*, 24, 711-724.

Pfeffer, J, Nowak, P. (1996). Joint ventures and interorganizational interdependence, *Firms, Organizations and Contracts: A Reader in Industrial Organization*. Oxford University Press: New York; 385-409.
Porter, M. E. (1985). *Competitive Advantage*, New York: Free Press.
Powell,W., White, D., Koput, K. & Owen-Smith, J. (2005). Network dynamics and field evolution: the growth of inter-organizational collaboration in the life sciences. *American Journal of Sociology* 110 (4), 1132–1205.
Pullen, A. J. J., De Weerd-Nederhof, P. C., Groen, A. J. & Fisscher, O.A.M. (2010). Open Innovation in practice: closed NPD networks leading to high innovation performance *for SMEs School of Management and Governance, Institute for Governance Studies*, University of Twente, the Netherlands.
Pun, K.F. (2004). A conceptual synergy model of strategy formulation for manufacturing. International, *Journal of operations & production management*, 24 (9), 903-928.
Radauer, A., Streicher, J. & Ohler, F. (2007). Benchmarking National and Regional Support Services for SMEs in the Field of Intellectual and Industrial Property: Final Benchmarking Report. *The Austrian Institute for SME Research* (KMU Forschung Austria)
Ritter, T. & Gemünden, H. G. (2003). Network competence: its impact on innovation success and its antecedents, *Journal of Business Research*, 56, 745-755.
Ritter, T. & Gemünden, H. G. (2004). The impact of a company's business strategy on its technological competence, network competence and innovation success. *Journal of Business Research*, 57, 548-556.
Rivette, K., Kline, D. (2000). *Rembrandts in the Attic: Unlocking the Hidden Value of Patents.* Harvard Business School Press, Boston, MA.
Rosenberg, N. (1990). Why Do Firms Do Basic Research (with Their Own Money)? *Research Policy*, 19(2), 165-174.
Rothwell, R. (1991). External networking and innovation in small and medium-sized manufacturing firms in Europe. *Technovation*, 11(2), 93-112.
Salman, N. & Saives, A. L. (2005). Indirect networks: an intangible resource for biotechnology innovation. *R&D Management*, 35(2), 203-215.
Schutt, R.K. (2006). *Investigating the social world: The process of practice of research*, 5th ed., Pine Forge Press, Thousand Oaks, CA.
St. John, C.H., Cannon, A.R. & Pouder R.W. (2001). Change drivers in the new millennium: implications for manufacturing strategy research, *Journal of Operations Management*, 19 (2), 143-160
Tunzelmann, von, N., Acha, V. (2005). Innovation in „Low-Tech" Industries. In: Fagerberg, J.; Mowery, D.C.; Nelson, R.R. (eds.), The Oxford Handbook of Innovation, Oxford, 407-432
Van de Vrande, V., De Jong, J. P. J., Vanhaverbeke, W. & De Rochemont, M. (2009). Open innovation in SMEs: Trends, motives and management challenges. *Technovation*, 29, 423- 437.
Vossen, R.W. (1998). Relative strengths and weaknesses of small firms in innovation. *International Small Business Journal* ,16 (3), 88–94.
Yin, R.K. (1987). *Case study research: Design and methods*, Sage publications, Thousand Oaks, London, New Delhi.
Weick, K. E. (1995). *Sensemaking in organizations*. Thousand Oaks, CA: Sage.
Williamson, O.E. (1975). *Markets and Hierarchies: Analysis and Antitrust Implications*. The Free Press, New York.

9 APPENDIX: INTERVIEW QUESTIONS

1. What are you motives to engage in open innovation?

2. What challenge do you face?

3. Is looking outside for technology that can be leveraged everyone's job–or is there a distinct group dedicated to doing this? What types of people fulfil this role?

4. What specific goals or objectives do you have regarding bringing in technology? What incentives are tied to these goals?

5. Where do you typically look for outside ideas and technology: e.g.: universities, start-ups, competitors, conferences, or companies in peripheral industries?

6. How would you characterize your efforts to bring in technology?
    a. Would you say that typically when you bring-in or jointly develop an outside technology, it is to address an incremental product improvement or a breakthrough product?
    b. Do you typically work with 'proven' technologies used in other applications, or are you trying to develop something entirely new?
    c. Do you typically bring in technology that leverages core R&D capabilities, or does it feel more like outsourcing non-core needs?

7. How has bringing in outside technology helped your company? Has the impact been significant? What has the impact been?

8. How would you characterize your efforts to take out technology?
    a. When something is developed internally that doesn't fit with your business model, do you have a practice of taking the IP or technology assets out to the marketplace?
    b. When something that was initially developed internally is deemed 'dead,' are efforts made to find companies or partners that might be interested in it? Is this done opportunistically or is there a formal mechanism to do this?

9. Are there specific goals around when a technology asset can be taken out to the marketplace? Who or what group has responsibility for doing this? How are they motivated?

10. What impact has taking IP or technologies you have chosen not to commercialize out to the market had on the company?

11. Do you have 'knowledge spill overs', and what do you do with it?

12. How do you manage the conflicts between the goals of the internal business unit and the external partners?

13. Is open innovation more relevant for explorative technology projects compared to exploitative ones?
14. To what level of satisfaction are your technology needs met by your internal R&D? Explain.

15. How can you better bridge internal and external resources to solve your challenges and solutions?