Emerging Strategies for Matching Distant Knowledge with Existing Innovation Capabilities

Stern, Alexander

Alexander Brian Stern

Emerging Strategies for Matching Distant Knowledge with Existing Innovation Capabilities

Department of Innovation and Organizational Economics
Copenhagen Business School, Denmark

Table of Contents

I. Acknowledgments

Wisdom begins in wonder. (Socrates)

As the saying goes, every journey begins with the first step. Little did I know, taking my first step toward completion of this PhD, how much perseverance, dedication and enthusiasm would be required to see this project through to the end. I suppose ignorance was bliss, so taking one step at a time seemed like the best way forward, and little by little, the research took shape and the pages filled. A positive outlook certainly helped me along the way. More importantly, I was helped along the way by mentors, colleagues, family and friends. Therefore, I would like to take this opportunity to express my deepest gratitude to everyone who supported me in achieving this goal.

First of all, I would like to thank Sigvald Harryson for encouraging me to undertake such a substantive research endeavor. Sigvald has been instrumental in getting this research off the ground. Together with Jens Frøslev Christensen he made sure that the research did not stray too far from course. Thank you also Jens for taking the time to read early papers and drafts as you put it, "as the devil reads the Bible". Your feedback and continuous support has been most helpful and highly appreciated. Mark Lorenzen and Christoph Hienerth have been formidable opponents in the pre-defense, thank you for your thoughtful and comprehensive feedback. Further, many thanks to all other colleagues at the Department of Innovation and Organizational Economics at the Copenhagen Business School, whom I have had the pleasure to converse with and who took the time to give me the odd nudge and advice. At BMW Group, I would like to thank Martin Ertl, my supervisor at the Innovation and Technology Management unit. Horst Reichl, Head of Innovation and Technology Management BMW Group, has been most supportive in seeing my project through difficult times and has been highly encouraging during the preparation for my stay at the Haas School of Business. Ronny Martin has been a very understanding colleague and very supportive toward the final stages of the project. My deepest thanks further to all other colleagues at BMW, unfortunately too numerous to mention here. Thank you also to all interviewees and contributors who participated in this study.

Henry Chesbrough has been most hospitable during my stay at the Center for Open Innovation at the Haas School of Business at UC Berkeley. Many thanks for all the theoretical insights, the opportunity to contribute to active management education, and the opportunity to spend time at Haas. It has been a great pleasure also to have discussions with David Teece, particularly on the topic of business model innovation. I would also like to thank Anita Stephens for being so accommodating. Sohyeong Kim and Tommi Lampikoski have been the best colleagues – you made my stay at Haas unforgettable.

Marta Harasowska-Luelsdorff and her husband Philipp were extremely kind to proofread the manuscript, thank you very much. My friends have been exceedingly good at feigning interest and pretending to understand my obscure work, thank you for being so supportive and standing by me, even during times where I have been particularly antisocial – I really appreciate your patience with me! Anne-Mette Lilleøre has been a great sparring partner and fellow traveler along the way. Thanks in particular to Charlotte who reminded me that "you can do it"! Finally I would like to thank my mother Irmgard Stern for raising me with the freedom to explore my own interests and for all the incredible support she has given me.

Alexander Stern
Copenhagen, 20 March 2010

II. List of Abbreviations

AG	Aktiengesellschaft (German Acronym for Corporation)
ANE	Automotive News Europe
BMW	Bayerische Motoren Werke (Bavarian Motor Works)
bn.	Billion
CEO	Chief Executive Officer
CIT	California Innovation Triangle
CoPS	Complex Product Sector
CTO	Chief Technology Officer
DEC	Digital Equipment Company
EBIT	Earnings Before Interest and Tax
FIZ	Forschungs- und Innovationszentrum (BMW Central R&D)
FTE	Full Time Employee
GDP	Gross Domestic Product
ICT	Information and Communication Technology
IP	Intellectual Property
IT	Information Technology
JIT	Just In Time Scheduling
M&A	Mergers and Acquisitions
MPT	Multi-Purpose Tailgate
NIH	Not-Invented-Here Syndrome
NPD	New Product Development
OCI	Outstanding Corporate Innovator
OEM	Original Equipment Manufacturer
PATYO	Palo Alto Technology Office
PDMA	Product Development Management Association
PWC	PriceWaterhouseCooper
R&D	Research and Development
TCO	Total Cost of Ownership
TQM	Total Quality Management
VCC	Venture Capital Company
VDA	Verband der Automobilindustrie (German Automotive Association)
VIA	Virtual Innovation Agency
VW	Volkswagen

III. List of Tables

IV. List of Figures

1. Introduction

1.1 Background

For a major part of the 20th century, the industrial business firm has represented the central locus of research, development and innovation. Large industrial research and development (R&D) labs have given rise to blockbuster products which formed the basis for the major industries throughout the world (Teece, 2003). The success of large industrial R&D labs, besides providing capital and other complementary resources required for moving from invention to innovation, can be largely attributed to the task division, specialization and efficient organization of increasingly complex bodies of technical knowledge (Mowery, 2009). The formalized organization of industrial R&D entailed highly routinized, repeatable tasks for the up to then highly uncertain and sometimes chaotic process of R&D (Nelson and Winter, 1982; Hauschildt, 2004). The success of the large industrial R&D lab has therefore hinged on the efficiency of its capabilities, consisting of its processes, procedures, systems and structures.

Scientific and technological progress, however, has had considerable repercussions on the dominant locus of R&D. On the one hand, as knowledge frontiers expand, previously unrelated technology fields are *converging* in single product classes. This has affected most industries, including such diverse fields as pharmaceutical, consumer electronics and the automotive industry (Birkinshaw et al., 2007). In parallel, the specialization required for increasingly complex science and technology has eclipsed the scope of individual firms culminating in complex task division among different economic actors, in a process of technology *divergence*. Thus, as the sheer amount of scientific and technical knowledge required for R&D has eclipsed the scope of individual firms, corporate hierarchy has given way to increasingly market-based forms of organizing R&D. Particularly since the 1970s, this development has gained in momentum. Empirical evidence shows significant growth of outsourcing of previously internally organized research and development tasks (Howells, 2008) since that time. Such outsourcing of non-rival, standardized procedures has more recently become evident in R&D outsourcing and re-location in geographically remote locations, a phenomenon captured in the international R&D literature (Dunning, 1993; Gassmann and von Zedwitz, 1999). Besides parceling out R&D tasks through outsourcing, industrial business firms have started to collaborate with external partners both in order to pool resources, as well as in order to access complementary knowledge through strategic alliances (Contractor and Lorange, 1988; Hagedoorn et al., 2002; Grant and Baden-Fuller, 2004). The general de-coupling of the innovation value chain has been recently summarized in the concept of "open innovation" (Chesbrough, 2003). The open innovation concept represents a turn in innovation research. Rather than treating the disaggregation of R&D

primarily in the context of R&D efficiency, it stresses the opportunities associated with efficient markets for technology as a means to create new avenues for *radical* innovation and growth.

Particularly the implications of R&D disaggregation for the ability of firms to search, transfer and apply knowledge from outside organizational context and the current technology/product/market combination to foster radical innovation growth are of interest to strategy and innovation management scholars. Notably, technology convergence entails the need to integrate increasingly distant technology into existing technology/product/market combinations. Equally, technology divergence exacerbates the risk of discontinuous innovation from outside of one's current niche. Technology-intensive firms are therefore increasingly required to find and apply knowledge distant from their existing organizational and technological context. However, their ability to do so is heavily constrained by the trajectory of their existing routines and processes. These processes and routines which had ensured competitive fitness while R&D was still highly centralized, today present technology-intensive firms with strong constraints on searching and utilizing knowledge from outside their existing context, thereby hampering industrial business firms' ability to adapt in the face of technological or market change (Levitt and March, 1988; Leonard-Barton, 1992; Christensen, 1997).

1.2 Problem Statement

In the light of these developments, this thesis endeavors to explore how technology-intensive, industrial business firms can match knowledge which is outside their current technology/product/market context with their existing capabilities for new innovation and growth. With the increasing dispersion of technological knowledge, sources of innovation are becoming more removed both geographically as well as contextually from the existing knowledge base. In order for organizations to keep abreast of innovation both to further growth and to avoid creative destruction from discontinuous change, they must engage in comprehensive search and transfer of distant knowledge.

Since research on distributed innovation emphasizes the growing opportunities of sourcing innovation from the market, one could be led to surmise that firms have greater capacity for adaptation and change under these conditions. However, prior innovation management literature has also recognized the effects of a firm's current routines and processes in constraining its capacity for change and innovation. As organizations mature, their routines become increasingly rigid, resulting in path-dependence and inertia. Organizations' path dependence and inertia have been extensively researched and documented and are regarded as a major reason for firm failure (Levitt and March, 1988; Leonard-Barton, 1992; Christensen, 1997). Seeing that distant external search for innovation is becoming more commonplace, therefore, a highly critical issue in innovation management is not solely searching and identifying novel sources of knowledge and innovation, but matching them with the firm's existing routines. As Keith Pavitt (1998:433) has pointed out, "firms rarely fail because of an inability to master a new field of technology, but because they do not succeed in matching the firm's systems of coordination and control to the nature of the available technological opportunities". Thus, given on the one hand, a steady disaggregation of R&D, which requires firms to search and transfer knowledge increasingly distant from their existing context, and a stream of literature stressing the opportunities of such open forms of innovation, how are firms able to overcome the constraints imposed on them by their existing routines? Due to the high relevance of this question, several competing research streams have sought to address it. In a sense, the central research question pursued in this study, is located at the intersection of several dynamic research streams which still lack coherence and consistency. However, due to tendencies, on the one hand, to focus on large-scale data sets to explain knowledge transfer, and on the one hand, predominantly conceptual approaches to this question, further empirical research studying the micro-foundations of distant knowledge transfer is necessary.

1.3 Trends and Gaps of Prior Research

The question pursued in this study is central to a number of research traditions within strategic management. An overarching theme is firm survival, adaptation, and sustainable competitive advantage. At the core of this theme, researchers are concerned with how organizations access and utilize new knowledge, thereby changing their routines and processes in response to internal or external stimuli.

In this context, a large body of research has in recent years dealt with mechanisms for accessing new knowledge. For instance, mobility of inventors has been identified as the most effective way of transferring knowledge (Arrow, 1962; Roberts, 2000; Almeida et al., 2003; Singh and Agrawal, 2008). Mobility of scientists and engineers has also been shown to be effective at integrating distant, radical knowledge (Rosenkopf and Almeida, 2003). And, indeed labor mobility has increased due to expansion of higher education and eroding loyalty to one single firm, as highlighted by Chesbrough (2003). However, depending on labor market flexibility, the practice of building up competence in non-related technology areas in large numbers may prove inefficient for incumbent firms, particularly in times of escalating R&D budgets. Further, as Teece (2009) pointed out, new opportunities may be difficult to detect at first and require, before relevant competence can be hired, a prior capability for sensing and reacting to these opportunities. From a methodological point of view, research into inventor mobility frequently utilizes patent data, which makes it difficult to identify how and why inventors integrate their knowledge inside a new organizational context. Therefore, mobility of inventors offers only limited insights into how firms can match highly distant and novel knowledge with their existing capabilities.

Research on strategic alliances has also been discussed prominently as a mechanism for accessing external knowledge (Contractor and Lorange, 1988; Dyer and Singh, 1998; Grant and Baden-Fuller, 2004). The strategic alliances literature has provided detailed insight into the contractual frameworks available for R&D collaboration (Narula and Duysters, 2004). In addition, the motivation for entering into such collaborative agreements has been researched extensively (Hagedoorn et al., 2000). However, the strategic alliances literature has relied on large, firm-level data sets. Therefore, the micro-foundations of how knowledge is exchanged and absorbed by the respective firms, and which functions of the firm are involved has been neglected. Further, it has been found that strategic alliances are generally formed in order to collaborate in areas which lie within the existing organizational and technological context (Rosenkopf and Almeida, 2003). As such, the explanatory power of strategic alliances literature as to how distant knowledge can be matched with existing capabilities is limited.

More research on the sources of innovation deals with lead users, as pioneered by Eric von Hippel (1988; 2005). Furthermore, the presence in geographically concentrated areas of economic activity has been widely discussed (e.g. Marshall, 1920; Saxenian, 1994; Porter, 1998). Recent innovation literature also expands the sources of innovation, including universities, start-ups, venture capital firms, internal venturing and so-called innovation intermediaries (Arora et al., 2002; Howells, 2008; Tidd and Bessant, 2009). Yet, the literature on these innovation sources remains fragmented, and the more pressing issue, of how the knowledge accessed through these sources can be matched with the existing routines in order to create new innovation and growth, is little addressed.

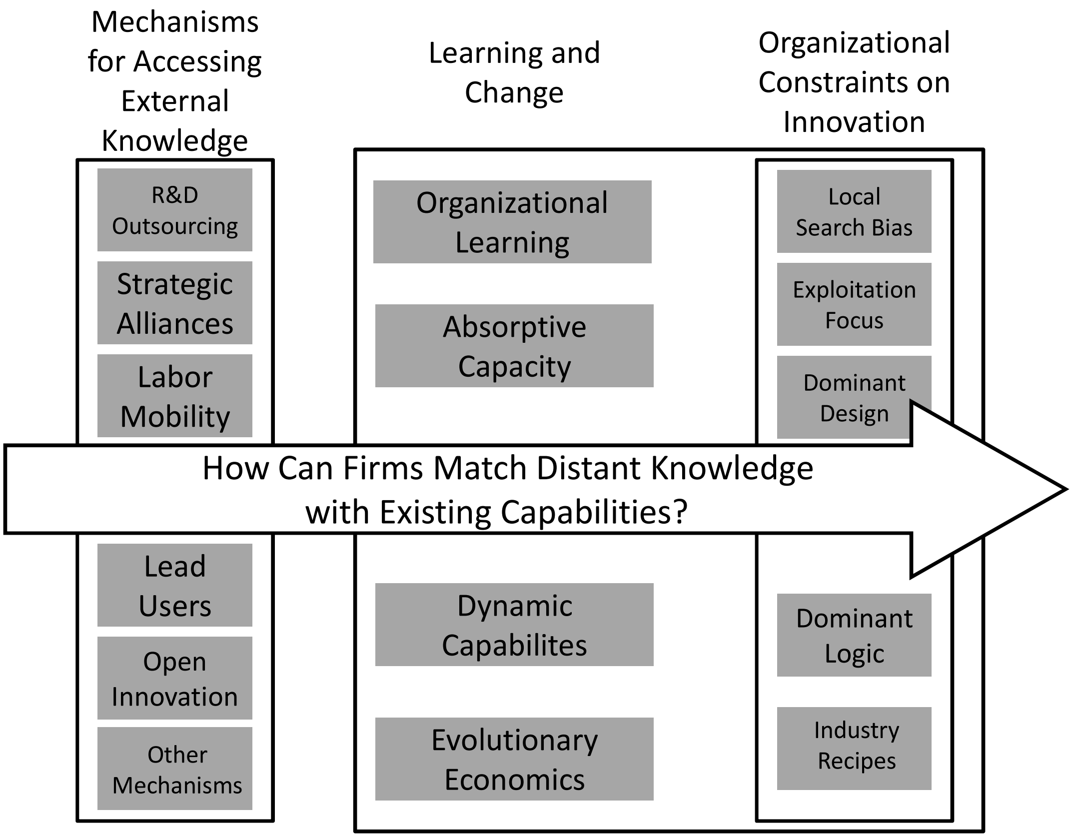
Another major research stream addressing the question of how organizations learn is represented by the organizational learning literature. Whereas all related streams of organizational learning are concerned with questions of acquiring and utilizing knowledge in order for learning to occur, the field distinguishes between organizational learning, learning organization (Senge, 1990), knowledge management and the knowledge-based view. Organizational learning literature is concerned with the question of how *does an organization learn*. Conversely, literature on the learning organization is generally perceived to be more prescriptive, asking *how should an organization learn*. Knowledge management (e.g. Nonaka, 1991), on the other hand, could be described as *managed learning* (Vera and Crossan, 2003:124). The resource-based strategy tradition (Penrose, 1959) in turn regards knowledge as the most central resource providing sustainable competitive advantage. Its outgrowth, the "knowledge-based-view" describes knowledge as the resource most central to competitive advantage (Kogut and Zander, 1992; Grant, 1996). As Vera and Crossan (2003) highlight, all facets of this research stream display considerable incongruence in research tradition, focus, philosophy, method and unit of analysis. As they also point out, organizational learning requires multiple levels of analysis and variables. This requires adequate, rich research methods which are currently underutilized in the literature (Foss et al., 2007; Doz et al., 2009; Knudsen, 2009).

One key contribution of the organizational learning literature is body of research describing how novelty settles into a dominant design and results in increasingly rigid routines, path-dependence, and inertia (e.g. Prahalad and Bettis, 1986; Levitt and March, 1988; Leonard-Barton, 1992). This aspect of organizational learning stresses that, as organizations mature, the focus of innovation changes from product to process innovation and incremental product improvement (Abernathy and Utterback, 1978). As a dominant design emerges for the "technology/product/market" combination (Gilsing and Nooteboom, 2006:3), managers rely increasingly on heuristics, or a "dominant logic" (Bettis and Prahalad, 1995). Standard heuristics and procedures also diffuse to the entire industry, creating "industry recipes" (Spender, 1989). Industrial competitive forces in mature markets are generally intense, which requires a strong efficiency orientation, where players focus on cost reduction, focus, and differentiation (Porter, 1985). Learning, i.e. the combination of novel knowledge with existing routines leading to a change in routines, is seriously hampered under these circumstances – an organization's routines have become "core rigidities" (Leonard-Barton, 1992). Moreover, the cumulative nature of incremental learning results in path-dependence which prevents organizations from searching for new knowledge from outside of their existing context (Rosenkopf and Nerkar, 2001). Importantly, the tendency to search within the current organizational and technological context is a key characteristic of organizations. This "local search bias" is caused by the cumulative nature of knowledge, which builds on the existing knowledge base (Cohen and Levinthal, 1990) and has become ingrained in the organization's routines, processes, systems and structures. Due to this local search bias, most mechanisms firms use to tap external knowledge sources are also prone to be restricted to closely related knowledge areas, thus pre-empting novel combination by accessing more distant knowledge (Almeida and Rosenkopf, 2003).

Thus, when comparing current innovation and technology management literature with its focus on the "opening up" of the innovation process with one of the central insights of the organizational learning literature, it emerges that the more interesting and pertinent question of "how one gets away from the dominant designs in technology and from prevailing industry recipes regarding organization, for a next round of (radical) innovation" (Gilsing and Nooteboom, 2006:4) is not addressed in the appropriate manner. Some researchers have proposed that organizations need to create separate units designated to develop applications which do not fit with the dominant routines, creating so-called "ambidextrous organizations" (O'Reilly and Tushman, 2004). One much discussed example of such "phasing-out" of new development is Xerox' PARC research center, a de-centralized research center established by Xerox in Palo Alto in 1970, with the aim of developing radical new technologies (Teece, 1992; Chesbrough, 2003; Rogers, 2003). However, as the example of the failure of Xerox to appropriate the new applications developed at PARC vividly illustrates, the core problem does not lie with generating new knowledge, but in how it be reconciled with the existing capabilities and routines of the organization or how these routines can be circumvented.

The more pertinent question, thus, of how knowledge sources distant from the existing technology and context are matched with existing capabilities and new commercial applications developed requires further clarification if we consider the popularity and impact of the Open Innovation argument. In summary, in the context of innovation and learning, prior research provides a good deal of insight into how the dominant locus of conducting knowledge generation and commercialization has changed. Empirical evidence provides strong support for the notion that firms increasingly access external sources of knowledge for their R&D processes (Hagedoorn, 2000; European Commission, 2005a; Teece, 2003) In addition, some literature has investigated in-depth how organizations mature, with their routines becoming increasingly path-dependent, presenting them with considerable constraints on utilizing knowledge distant from their current context. The central research question of this thesis, however, how knowledge distant from current technology/product/market context can be matched with the existing system, procedures and routines, warrants further investigation. Figure 1 provides a graphical illustration of the gap in the literature which this thesis addresses:

Figure - 1 Gap in the Literature Addressed



1.4 Research Questions

Based on this introduction which highlights the relevance of the research problem identified both from a theoretical as well as phenomenological point of view, the guiding research questions can be summarized as follows. Simultaneous technology convergence and divergence dynamics require technology-intensive firms to reach outside of their current technology/product/market context for sources of novel knowledge. Yet, their current routines and processes significantly restrict them in their ability to search and utilize such distant knowledge. The central research question therefore enquires how the disjuncture between external, distant knowledge and existing routines can be reconciled:

Central Research Question:
How do technology-intensive firms match external knowledge distant from their current technology/product/market context with their existing routines and processes?

The literature on organizational learning has highlighted the multi-level nature of learning processes. However, there is little evidence suggestive of which levels of organization are involved in such learning processes, let alone how these are related. A first sub-question in this study thus pertains to:

Sub-Question 1:
Which levels of organization need to be coordinated to ensure successful matching of distant knowledge with existing routines?

Finally, the literature on organizational learning has stressed that learning processes usually occur in response to an internal or external stimulus, or shock (Cyert and March, 1962; Zahra and George, 2002). Therefore the research design also aims to take into account the severity of shock and thus, strategic intent behind the matching strategies investigated:

Sub-Question 2:
How does the extent of internal or external stimulus for change affect the outcome of the matching strategy employed?

1.5 Methodological and Empirical Focus of the Study

Based on prior research and the gap in the theory identified, a case-study-based research design was chosen to investigate the question posed in this study. Previous large scale data such as patent analysis and other forms of data analysis used for the strategic alliances research and inventor mobility have delivered important insights into the occurrence and governance of such forms of accessing external knowledge. In contrast, for the present study, in-depth data is required which uncovers the exact process underlying the matching of external knowledge, particularly, distant knowledge, with existing routines.

Furthermore, the organizational learning literature has highlighted that learning processes entail an involvement of multiple levels of the organization, ranging from firm-level to individual level. More insight is needed, and the correlation between different variables and levels of analysis needs to be disentangled. Therefore, rich-context dependent data is required. Such data can only be collected from a limited number of sources, owing to the complexity of the data. In addition, preserving contextual data necessitated the use of qualitative data. Therefore, this study uses a qualitative, multiple case-study design examining three processes inside organizational functions which have been designated to conduct search and transfer of distant external knowledge. The unit of analysis for the study, thus, consists of the matching processes responsible for searching and transferring knowledge outside the boundary of the firm and distant from the current technology/product/market combination. The population from which this sample was selected consists of the German premium automotive industry. This industry is characterized by a strong focus on process improvement and efficiency. Despite the strong focus on efficiency and stability, which constrains innovation, the sample selected displayed higher innovative capacity than the industry average. This higher innovation capacity was confirmed by consulting surveys, industry awards, and other secondary sources highlighting their respective innovation advantage. Eventually, two cases from the automotive manufacturer BMW, and one case from the supplier Webasto were selected.

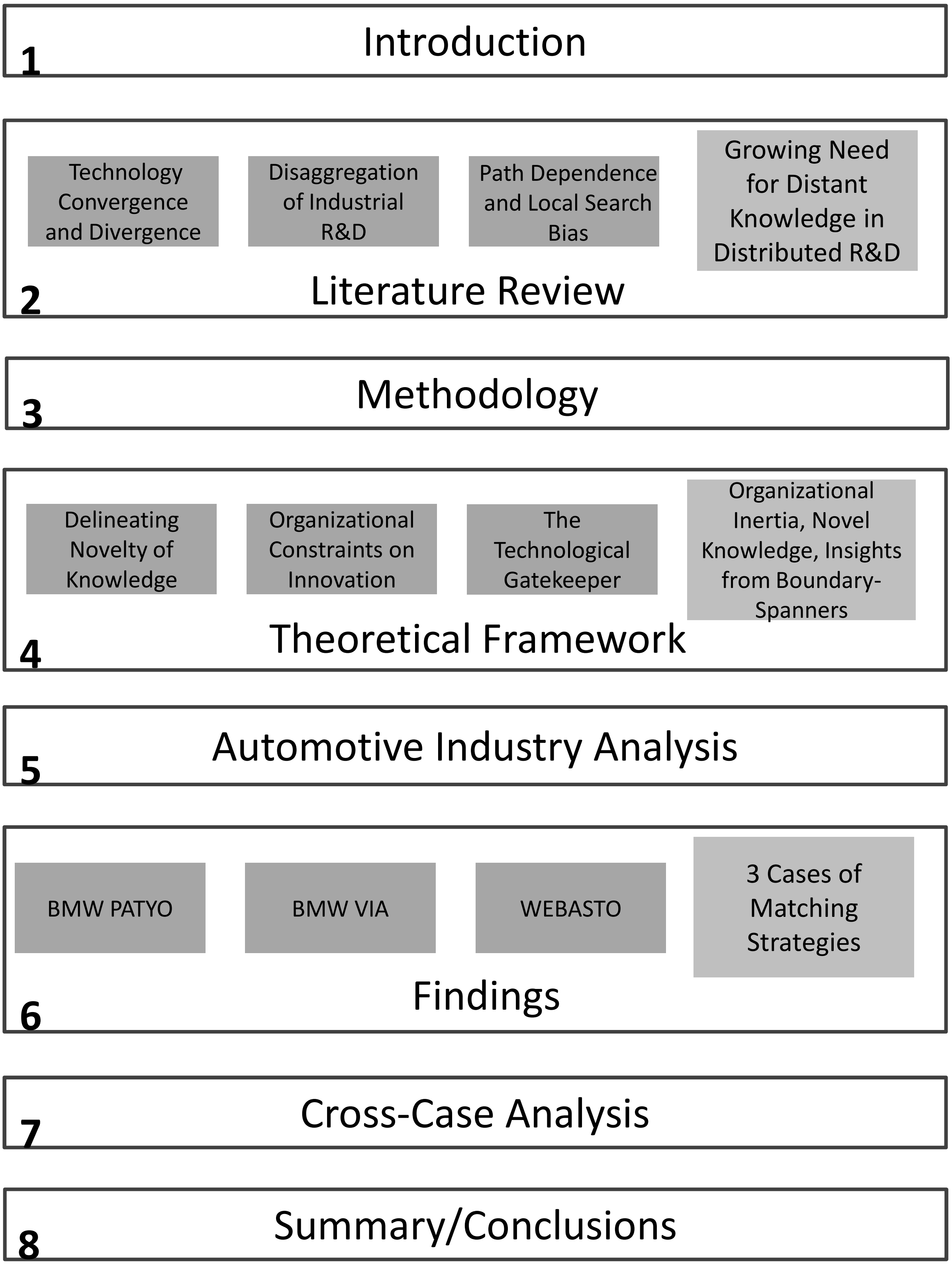
The choice of sample highlights that relevance of this research is consigned to mainly technology-intensive and mature industrial firms. New ventures or start-ups are unlikely to display the same extent of organizational inertia which requires such a dedicated search as proposed in this study. Conversely, this study looks at sources outside of the systems integration context, namely so far unknown and distant providers of knowledge, referred to by Rosenkopf and Nerkar (2001) as external boundary-spanning or radical search.

1.6 Thesis Outline

Chapter 1 provides a summary of the motivation behind this study. It briefly introduces the phenomenological and theoretical context of the central question pursued and highlights the relevance and importance of the problem investigated. *Chapter 2* sharpens the context of the research questions by reviewing some major streams in the literature on the opening up of the innovation process. It presents the main reasons and implications of distributed R&D. In addition, it draws attention to some of the oversights implicit in the theory and clearly justifies the need for further research into how technology-intensive firms can successfully match distant knowledge with existing capabilities. *Chapter 3* presents the scientific method chosen for the empirical data collection and analysis. This thesis uses a multiple-case study design, and the epistemological reasons, based on the research question, is explicated in detail. Further, a detailed account of data collection, analysis, and reporting procedures is provided.
Chapter 4 provides the theoretical structure for the subsequent analysis of the empirical findings. It outlines a theoretical framework which informs data collection and analysis with a detailed structure outlining the two main components involved in matching distant knowledge and organizational capabilities. In so doing, it first delineates distant knowledge into several dimensions. Organizational capabilities, too, are discussed with a view to identify the different aspects of the innovation process which effectively constrain more radical innovation. Finally, the literature on technological gatekeepers is reviewed. Based on the gatekeeper literature, which analyses boundary-spanning individuals which facilitate local search, some main guiding themes are derived which are considered relevant also for distant boundary-spanning.

Chapter 5 provides a brief analysis of the disaggregation of R&D in the global automotive industry. Thereby, the effects of technology convergence and divergence are illustrated with a concrete example. The chapter thus serves as additional context for the subsequent presentation of findings. *Chapter 6* presents three case study write-ups based on the focal cases analyzed. *Chapter 7* follows with a comprehensive cross-case analysis along the dimensions developed in the theoretical framework. Finally, *chapter 8* presents the conclusion and theoretical and managerial implications of the dissertation. Figure 2 give an illustration of the thesis outline:

Figure - 2 Thesis Outline



2. The Effects of Knowledge Expansion on Industrial R&D

2.1 Introduction

This chapter describes the disaggregation of industrial R&D over the last 40 years, highlighting the underlying drivers as well as the implications and challenges organizations face as they increasingly rely on knowledge from outside of their current technology/product/market context. In so doing, this chapter first (1) illustrates the shift in the predominant form of organizing innovation from highly centralized industrial R&D labs to more market-based structures. Second (2), it outlines the principal determinants behind the growing dispersion of R&D, largely consisting of increasing technical convergence and divergence. Third (3), the chapter charts the effects of technology convergence and divergence, namely a steady evolution from R&D outsourcing, strategic alliances, R&D globalization to open innovation. Fourth (4), it addresses the dilemma organizations face as a result of organizational path dependence as they attempt to match distant knowledge with existing routines.

Continuous innovation, by ways of expanding the stock of technological knowledge through organized research and development is paramount to sustained economic growth. Innovation is a catalyst for the shift of geopolitical power and it can help solve long-term problems such as the energy crisis. Notably, technological innovation has had a decisive influence on the outcome of two world wars as well as the space race between the US and the USSR (de Lussanet and Radjou, 2006). On firm level, the ability to create and apply new technological knowledge is a central element in gaining and sustaining competitive advantage (Hauschildt, 2005). Empirical studies demonstrate that innovative firms tend to have higher rates of profits, greater market value, better credit ratings, higher market share and higher probabilities of survival in the market (Banbury and Mitchell, 1995; Czarnitzki and Kraft, 2004)[1].

Schumpeter (1911) stressed that innovation consists both of invention, i.e. a new idea of technical, social or other nature that is new to a given context, *and* its subsequent adoption. In his early treatment of technological progress and innovation, Schumpeter (1911) regarded the individual entrepreneur as the main source of innovation in industrial society. Yet, in his later work (1942), he revised this argument. Instead, he emphasized the imperfect market conditions, evident in lack of complementary resources

---

[1] Aggregate spending on R&D is increasing on all levels worldwide. Between the years 2000 and 2006, overall global R&D expenditure grew from $729 billion to close to $1 trillion (cf. National Science Foundation, 2006:4-40). In Europe, one of the most central goals of the Lisbon treaty has been to raise public R&D spending to 3% of GDP by 2010. Organizations, too, spend a considerable amount of their resources on innovation. A high point was reached by Ford in 2005, investing a total of $8 billion in R&D – 5 % of sales (BCG, 2007).

necessary to move from invention to innovation, which prevent entrepreneurs from commercializing their inventions. Schumpeter therefore underlined the role of large industrial business firms as the central locus of innovation.[2] Large industrial business firms commanded the complementary resources required for the commercialization of invention, consisting of essential know-how, production capacity, capital, marketing and distribution channels, access to input factors, and existing service organizations (Teece, 1986). In addition, large corporations enabled the considerable task division required for increasingly advanced and specialized science and technology (Mowery, 2009). The centralized corporate lab created systematized routines to enable invention, through institutionalized and repeatable R&D processes, which enabled it to benefit from scale and scope effects (Amour and Teece, 1981; Hauschildt, 2004).

Long before Schumpeter's early work, the R&D labs of German chemical giants such as BASF, founded in 1865, provided an early blueprint for the effective organization of corporate R&D labs. Based on these archetypes, in North America, DuPont created its first R&D lab in 1902, AT&T set up Bell Labs in 1907.[3] Between 1921 and 1940, the number of US scientists and engineers employed in corporate R&D rose from 2,775 to almost 30,000 (Teece, 2003:339). Mowery (1983) noted that, for the first part of the 20th century, individual entrepreneurs, small technology providers and corporate R&D were not at all mutually exclusive. Corporate R&D labs, at that time also fulfilled therefore a scanning function, searching for external scientific and technical developments. The Cold War tensions in the period of 1945 to 1980 resulted in high public spending in corporate R&D consolidating the belief that technical progress was key to survival of the political system (Saxenian, 1994). In addition, at least in North America, institutional changes, primarily anti-trust laws, increased competition and led to an industrial R&D system which emphasized protection and proprietary technology over market transaction (Mowery, 2009). In Europe, too, automotive, aerospace and transportation industries expanded, depending on large R&D investment for their growth and competitive advantage.

However, from the 1970s onwards, the large industrial R&D lab began to display considerable anomalies. Many industries had entered maturity, emphasizing incremental improvement over new blockbuster products. For instance, in the early 1970s, the "big three" auto manufacturers General Motors, Ford and Chrysler, failed to react to the shift in consumer preferences resulting from the oil shocks, enabling cheap and more fuel-efficient Asian and European imports to enter the market. As leading industries entered maturity, the routines and processes which had made corporate R&D superior in the past, proved to be powerful constraints in reacting to exogenous change. Moreover, technological innovations generated in R&D labs were increasingly difficult to appropriate, since the operations of the current business were too narrow to utilize truly novel technological improvements. Xerox, for instance, failed to appropriate a large

[2] The two theories are also referred to as Mark I (entrepreneurial model) and Mark II (corporate model).
[3] Thomas Edison set up his "Invention Factory" in 1876.

part of the breakthrough innovations generated in its Xerox PARC research center, for the benefit of companies such as Apple (Chesbrough, 2003; Rogers, 2003). Thus, corporate R&D was increasingly inflicted by constraints caused by the inertia of its technological and organizational trajectory. In addition, advances in technology and science had significantly pushed the scope required for conducting R&D. This was exacerbated by the convergence of different technologies in single product categories. This development impacted diverse industries, pharmaceutical companies as much as consumer electronics or heavy industry (Birkinshaw et al., 2007). In parallel, information and communication technologies (ICT) proliferated, culminating in the dot-com boom at the end of the 1990s. The scope and efficiency of ICT significantly lowered transaction costs, enabling looser forms of organizing the innovation value chain. Further, as Teece (2003) highlighted, from the 1970s onwards, the private venture capital industry played a significant part in making high-risk capital available for technology companies, first primarily in information technology (IT) and biotechnology.[4] All of the above factors contributed to the erosion of entry barriers in many markets. In broad terms, these factors can be regarded as the central catalysts of the considerable "de-verticalization" (Langlois, 2003) of corporate R&D since the 1970s. Section 2.2 discusses these catalysts briefly.

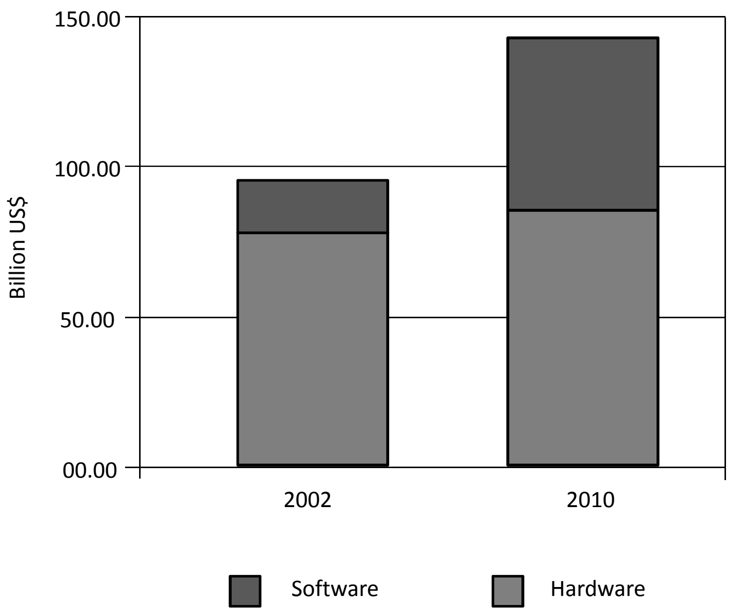
2.2 Technology Convergence and Divergence Dynamics

2.2.1 Technology Convergence and Product Commoditization

The division of labor required by increasingly specialized scientific and technical knowledge has been a major reason for the emergence of the large industrial R&D lab (Langlois, 2003). Yet, further specialization resulting from the advances in most technology fields has largely eclipsed the scope of the centralized R&D lab of large industrial firms today (Pavitt, 1998). At the same time, for many high-tech products the technologies required for standard products have converged (Kodama, 1992). As Birkinshaw et al. (2007) pointed out, incumbents encounter competitors which previously had little to do with their industry or products. Pharmaceutical companies need to equally worry about GSK, Merck, Pfizer, or Novartis, as they need to keep abreast of new compounds from biotech companies. Also, whereas technology in the automotive industry used to be dominated by mechanical engineering, electronically controlled systems are fast extending their share in a product, a fusion of technology dubbed "mechatronics" (Kodama, 1986). Maxton and Wormald (2004) predicted, for instance, that the value of electronic systems in cars was due to continue to rise until 2010:

[4] Between 1987 and 1998, total venture capital disbursement in the US rose from just under $5 billion to nearly $17 billion (Teece, 2003:340).

Figure - 3 Value of Electronically Controlled Systems in Cars 2002 and 2010



Source: Maxton and Wormald, 2004:139

The simultaneous widening and deepening of technological knowledge inputs required for increasingly complex products may lead to decreasing returns to R&D. While technology convergence impacts on R&D costs, many technology-intensive industries have entered maturity. Accordingly, product commoditization and competitive forces are eroding margins. Yet, in a quest for differentiation, industry actors continue to add incremental product improvement, usually aimed at the top end of the market (Christensen, 1997).

2.2.2 Technology Divergence and the Threat of New Entrants

Scientific and technological advances have created the need for further specialization, dividing labor among new, smaller players. In semiconductors, for example, "fabless" or "chipless" companies have been proliferating. These firms sell their designs to other companies which in turn design and manufacture the complex chip on which individual modules are embedded (Arora et al., 2002:119). Due to the focus of large companies on exploitation, with a narrow focus on specialized knowledge around a core set of technologies associated with incremental innovation, smaller firms increasingly conduct exploitation, thus creating new technology-based innovations (Christensen, 2006; Lichtenthaler, 2008). Between 1981 and 2001, small firms (<1,000 employees) increased their contribution to US industrial R&D spending from 4.4 % to 24.7 %, while large firms' (>25,000 employees) share of aggregate R&D spending dropped from 70.7 % to 39.4 % (Chesbrough, 2006:16).

Technology divergence and new entrants are supported by important advances in communication. Building on the invention of the microprocessor by Intel in 1971, information and communication technology (ICT) has tremendously shaped the speed with which the creation, transfer and absorption of knowledge is accelerating over the course of the past thirty years. Particularly the IT revolution in the 1990s fundamentally changed the nature of work through significantly reducing communication costs, while at the same time enabling unprecedented "richness" of information. These developments in ICT have a direct impact on the scope available to firms in working across different geographical and organizational boundaries. "ICTs facilitate the rapid collection, collation, storage, and dissemination of data, thereby assisting the knowledge creation and diffusion process" (Roberts, 2000:429). Thus, advances in technology have significantly lowered the barriers to entry in many industries, as the means of production in R&D have become more affordable. The opening up of financial markets and the emergence of high-risk venture capital have furthered lowered barriers to competitive entry (Rybczynski, 1993).

Broadly speaking, therefore, technological progress has had a two-fold effect on the firm-level organization of innovation activities. On the one hand, the sheer breadth and depth of technological knowledge required for increasingly complex products cannot be accumulated in one single proprietary industrial R&D lab anymore. On the other hand, technological improvements, particularly in communication technology, have greatly facilitated distant communication and information exchange, thus considerably lowering transaction costs associated with search and coordination of market actors, and also, by opening up markets for geographic regions with lower labor costs. The effects of the simultaneous improvements in efficiency of ICT as well as convergence and divergence of technology has been extensively studied and measured. Five major aspects shall briefly be addressed here. First (1), the growth of R&D outsourcing, second (2), proliferation of strategic alliances , third (3), globalization of R&D, fourth (4), the emergence of new R&D actors, and fifth (5), literature falling under the rubric of open innovation.

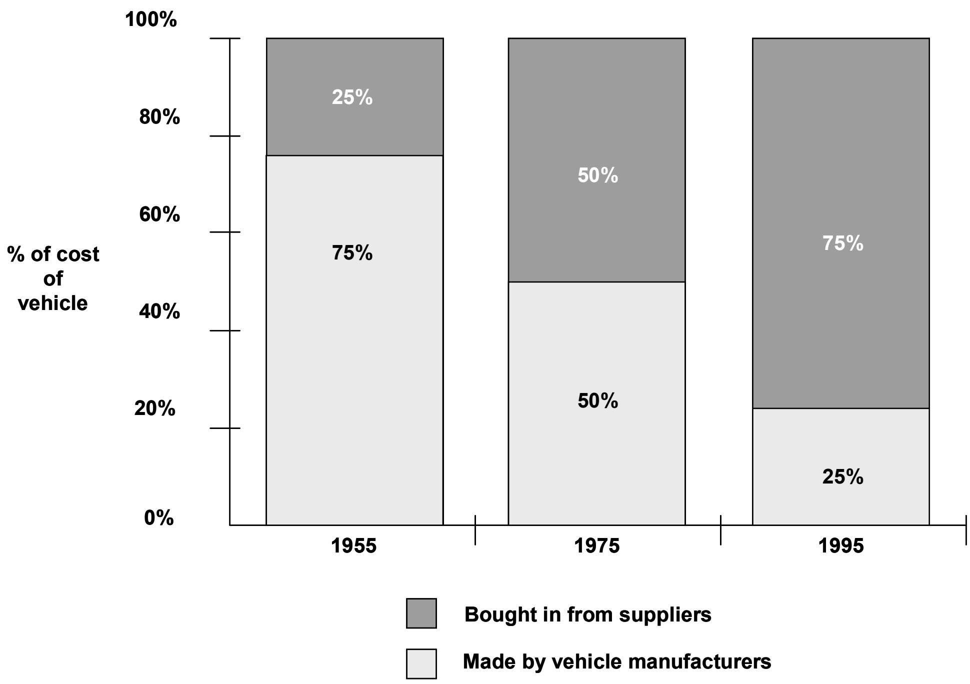
2.3 The Disaggregation of Industrial R&D

2.3.1 Outsourcing of R&D

The outsourcing wave initially affected back-end functions of the business which were not considered core to the business. However, the outsourcing trend hasn't stopped short of R&D. As indicated above, cost saving and access to complementary expertise, in addition to speeding up time to market (Howells, 2008) are the main factors influencing R&D outsourcing decisions. Outsourced or external R&D expenditures are defined as capital expenditures of the cost of R&D contracted to outside organizations. In the US, the share of external R&D expenditures almost tripled from between 1991 and 2001 – from

2.8% to 7.4%. In Germany, it nearly doubled from 8.6% to 15.3% between 1987 and 1999 (Gaso, 2005). Automotive manufacturers, for instance, have outsourced 75% of their value chain to a complex web of first, second, and third-tier suppliers between 1975 and 2005 (Anonymous, 2004). Mercer Management Consulting (Anonymous, 2004) has estimated that vertical integration in the automotive industry is likely to be as low as 23 per cent by 2015. The outsourcing trend is supported by a growing market in suppliers of technology-related products and services.

Figure - 4 Outsourcing in the Automotive Industry (1955-1995)



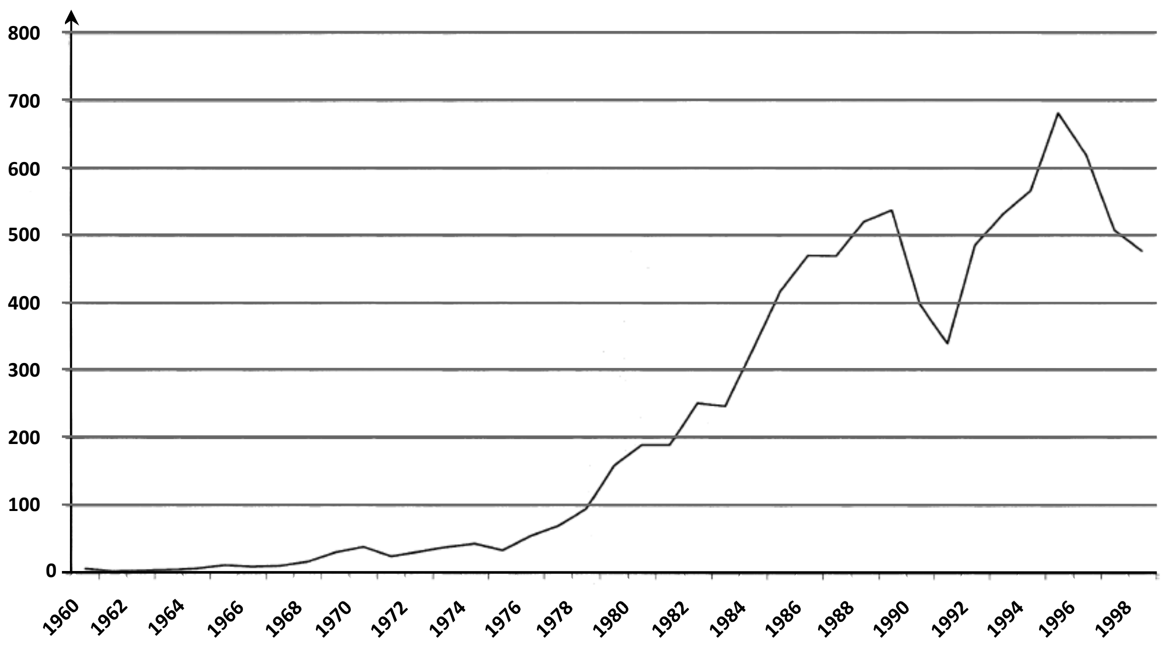
Source: Maxton and Wormald, 2004:152

Traditionally, industrial firms have tended to outsource fairly standardized, routine, imitable tasks, primarily for cost advantages in the form of spot-market transactions. Increasingly though, more complex bundles of R&D tasks are outsourced, to the point where some industries risk making the firm obsolete and being taken over by its suppliers (Engardio and Einhorn, 2005). However, when knowledge is more tacit, and it cannot readily be codified and transmitted, industrial firms have tended to enter into alliances with some degree of systematic interdependence with one or more partners to pool resources and access complementary knowledge (Narula, 2001).

2.3.2 Strategic Alliances

Strategic alliances are collaborative arrangements which fall between market and hierarchy, ranging from loose collaboration agreements to joint ventures (Grant and Baden-Fuller, 2004; Narula and Duysters, 2004). Such collaborative R&D arrangements are entered when the desired outcome is more strategic, i.e. more central to the competitive fitness of the firm. They allow for more intensive collaboration and therefore have often been studied in the context of accessing complementary knowledge. The increase in R&D partnerships started to become considerable in the 1980s (Hagedoorn, 2002). Inter-firm R&D partnerships have been most common in industrial sectors characterized by high-technology (Eisenhardt and Schoonhoven, 1996). Hagedoorn et al.'s (2000) review of several literature streams outlines the major reasons for entering strategic alliances as mainly related to cost-reduction through the pooling of resources. Strategy scholars, particularly the knowledge-based view and the dynamic capabilities school, however, regard partnerships as a vehicle to access complementary knowledge, as a dynamic capability to re-configure existing resources (Grant, 1996; Teece et al., 1997). Figure 5 shows the growth of strategic alliances from 1960 to 1998:

Figure - 5 Growth of Strategic Alliances 1960-1998

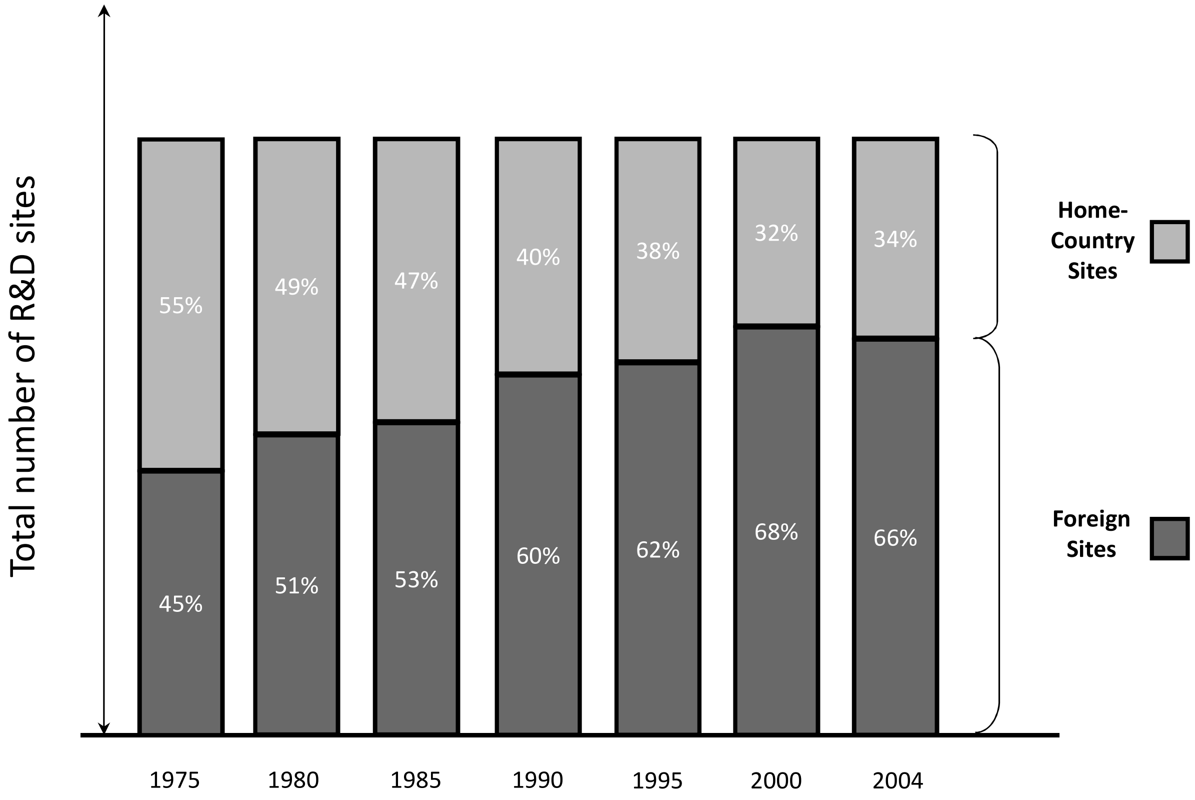


Source: Hagedoorn, 2002:480

2.3.3 Globalization of R&D

Both proprietary R&D activities and R&D collaboration are no longer restricted by geographic proximity. The dispersion of R&D activities today displays an increasingly international dimension. Coinciding with the aspects described so far, globalization of R&D activities has become steadily more common in the last 30 years. Globalization of R&D started with "offshoring" of standardized R&D tasks, either through external contractors or by establishing wholly owned subsidiaries, primarily as a means to exploit cost advantages through labor arbitrage. Increasingly, though, global R&D is conducted for adaptation to local market needs as a result of the increasing buying power. For instance, local market needs and improving local competence of the BRIC countries (Brazil, Russia, India, China) has led to a wave of R&D internationalization, particularly in China. R&D internationalization was observed as early as the 1970s, and it became a widespread phenomenon from the in the late 1980s onwards (Cantwell, 1995:161). Despite some international R&D activity by smaller multinationals, R&D internationalization remains by and large a reserve of large multinationals (Dunning, 1993; Gassmann and von Zedwitz, 1999). Further, the majority of total R&D carried out worldwide has been restricted to OECD member countries – thus mostly consisting of large multinationals moving their R&D from one advanced economy to another (Howells, 1990). Currently, however, a 'widening and deepening' of international R&D activities can be observed (Howells, 2008: 244). The results of a study conducted by Booz Allen Hamilton in 2005, based on a survey among 186 companies from 19 countries and 17 sectors and a combined R&D expenditure of $76 billion finds support for the suggested R&D internationalization trend:

Figure - 6 Growth in Foreign Research and Development Sites 1975-2004



Source: Booz Allen Hamilton (2005:2)

2.3.4 Open Innovation

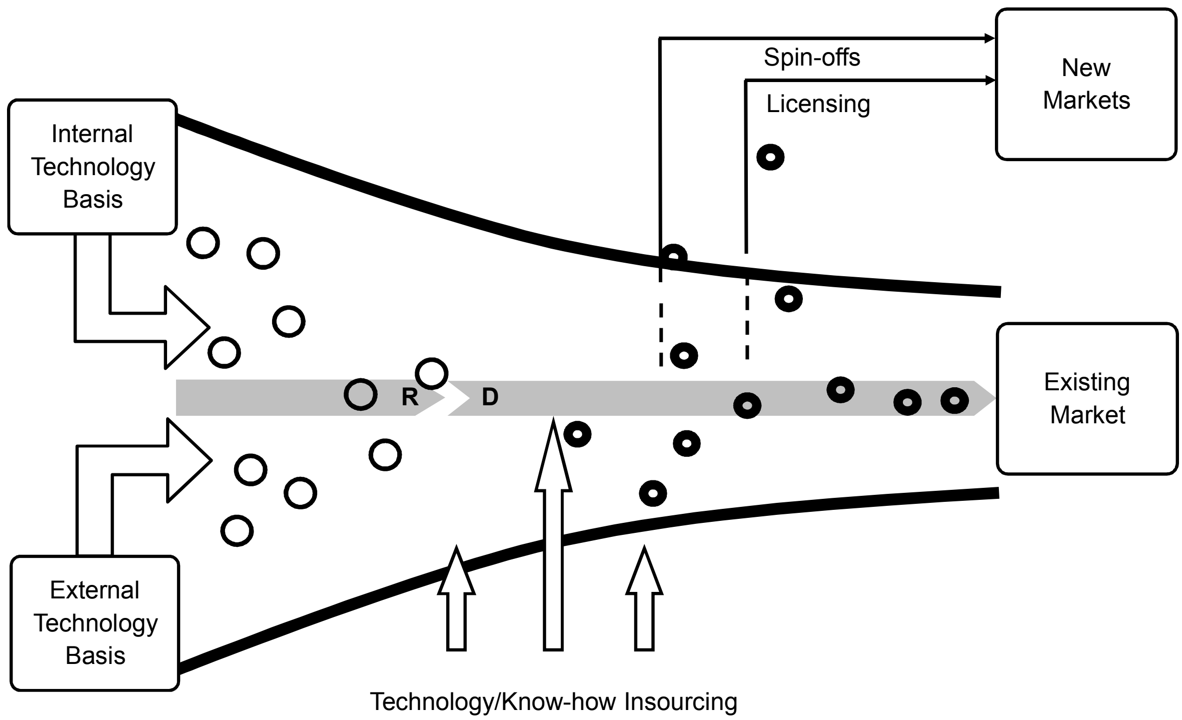
With his book "Open Innovation", published in 2003, Henry Chesbrough has created an evocative label and umbrella concept for all strands of research dealing with the increasingly dispersed nature of R&D (Christensen et al., 2005). His book and his subsequent work has been singularly influential in terms of its popularity with practitioners, and increasingly, with researchers[5]. In addition to being widely used as an umbrella label for the disaggregation of R&D, open innovation marks a shift in emphasis regarding the opportunities inherent in this development. Previous discourse and managerial action had treated the increasing efficiency of technology markets primarily from a transaction cost point of view. Managers took advantage of more cost effective transaction for technology in the market. The academic discourse mirrored this, stressing cost advantages from R&D outsourcing, collaboration, and globalization. Open innovation, on the other hand, offers some prescription of how firms have taken advantage of the markets for technology in order to radically change their business model and create new avenues of innovation and

[5] In support of this claim I conducted a simple literature meta-analysis. An EBSCO meta-search of 19 key strategy and innovation journals using keywords pertaining to open innovation revealed that the number of related publications has risen from 8 in 1999 to 61 in 2007, reaching a peak of 71 in 2006. From 1999 to 2006, therefore, open innovation related publication activity increased nine-fold.

growth. The concept is therefore rooted less in industrial economical but in the resource-based tradition (Penrose, 1959).

Open innovation treats a firm's R&D function as an open system, with a semi-permeable boundary through which both internal and external sources of innovation are appropriated while internal innovations which could otherwise not be commercialized take alternative ways to market (Chesbrough, 2003, 2006). While the insight that R&D depends and benefits from external knowledge is certainly not new, the notion that alternative ways to market can be utilized for internal spillovers is fairly novel. Rather than regarding spillovers resulting from R&D activities as waste products, they are regarded as an opportunity to generate additional value – not through the company's existing channels, but through alternative channels such as licenses or external spin-offs. Intellectual property (IP), traditionally reserved for safeguarding design freedom and protecting internally generated innovation, is considered a valuable asset with a much wider commercial application. Open innovation claims that firms can and should actively find buyers for their unused IP otherwise 'sitting on a shelf' (Chesbrough, 2003; Kline 2003). The central aspects of the open innovation framework are illustrated in figure 7:

Figure - 7 Open Innovation Process



Source: Adapted from Chesbrough, 2006

The popularity of the label open innovation in the field precedes, to some extent, scholarly activity. Concerns could be raised as to the external validity of the concept, since the largely anecdotal evidence presented in the open innovation literature has a strong North American bias (Chesbrough and Crowther, 2006; Lichtenthaler, 2008). Generalization may also be limited to few select industry contexts (Christensen et al., 2005), particularly with regard to the efficient tradability of IP. Moreover, it underplays the role of organizational constraints to innovation, and, in particular constraints to matching external distant from the current knowledge base with existing capabilities.

2.4 The Implications of Distributed R&D on Firm-Level Innovation and Change

> *"Episodes of "competence-destroying" technological change, which suddenly make existing capabilities obsolete, are often characterized by a shift in the locus of technical expertise from industry incumbents to newly formed ventures and firms from other industries. Competition from these new entrants and their eventual triumph is what Schumpeter had in mind when he referred to the process of "creative destruction" (Pisano, 1990:155).*

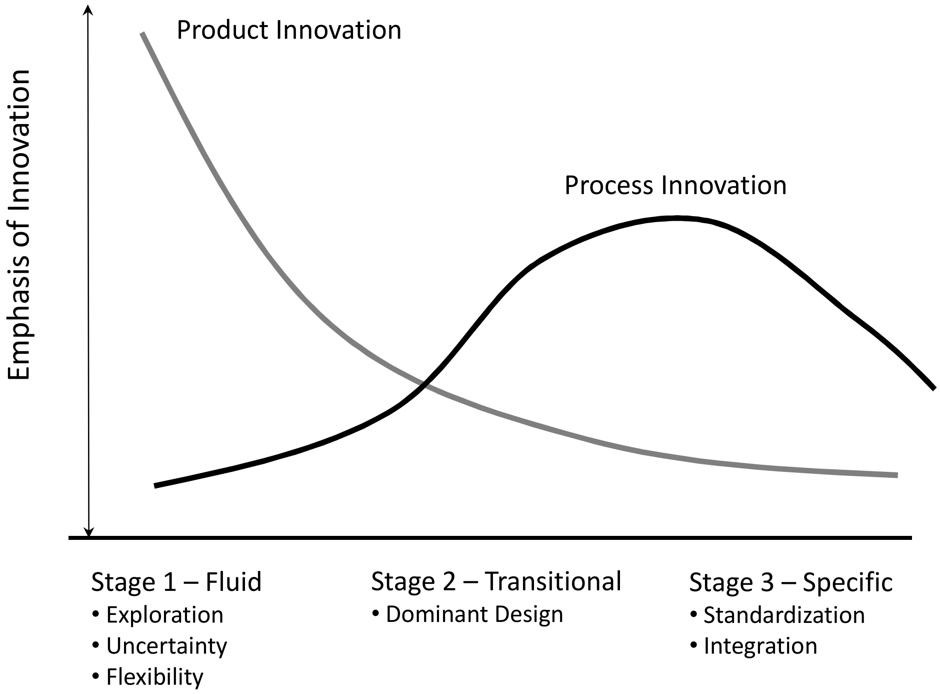
The previous sections highlight the general advancement of scientific and technological knowledge and the ensuing technology convergence and divergence dynamics as the catalysts for increasingly market-based forms for organizing innovation. This section argues that the reaction of technology-based firms to these developments was mainly targeted at economizing on the associated escalation of R&D costs. In this respect scholarly discourse, too, has centered on the discussion of the "opening up" of innovation on issues of sourcing cheaper resources for lower-order R&D externally, entering strategic alliances to pool R&D resources, and of exploiting labor arbitrage by locating R&D in low labor cost locations. As a result, markets of technology have become increasingly efficient. Low entry barriers have resulted in a multitude of new entrants, even in previously prohibitively resource-intensive industries, such as pharmaceuticals or automotive. This aspect is captured in the literature on open innovation, which treats these markets not only in terms of make-or-buy decisions, but also as opportunities in the form of latent external demand for R&D spillovers not used by the focal firm. All these aspects are discussed under the label of innovation. However, it has been frequently stressed in technology and innovation management research, that especially mature, technology-intensive firms mostly fail to innovate, due to the path-dependent nature of their existing routines and processes. Even knowledge spanning organizational boundaries will lie within the existing technological and organizational trajectory (Cohen and Levinthal, 1990; Rosenkopf and Nerkar, 2001).

However, as, on the one hand, technology-intensive firms increasingly rely on external distant knowledge for increasingly complex products, and on the other hand, the threat of discontinuous change from outside one's familiar niche increases, the more pertinent question is how under the conditions of open innovation, fims can utilize distant knowledge for innovation and adaptation. Given the emerging innovation ecology, therefore, a highly relevant and pressing question is how firms can match and reconfigure their existing capabilities in accordance with distant knowledge, to identify new areas of growth and adapt in the event of change.

2.4.1 Path-Dependence and Local Search Bias

Teece et al. (1997) defined organizational capabilities as the combination of routines, processes, systems and structures. Organizational capabilities, in essence, are therefore bundles of aspects of a complex organization, which are unified by a purpose and the goal of achieving a particular objective (McEvily and Marcus, 2005). In commercial organizations, an overriding goal is likely to consist of profit maximization, which naturally explains the strong tendency of firms to efficiently exploit current assets and protect short-term revenue streams. With growing maturity, industrial business firms focus their operations on exploitation of their existing knowledge base, leaving little scope for search and integration of novel knowledge distant from their current context. If we treat the innovation lifecycle model as a spectrum, the entrepreneurial start-up constitutes one extreme, whereas the mature or declining incumbents constitute the opposite extreme. Start-ups are fast at identifying market opportunities and acting on them. This is due to their closeness to market developments and their organizational agility. Start-ups feature flat hierarchies and as such are highly "organismic" (Burns and Stalker, 1961). As opposed to larger, mature organizations, they can be sustained by an initially small market, an option often not considered viable for larger firms (Christensen, 1997). Mature firms, on the other hand, have moved from an experimental, fluid phase, and have arrived at a dominant design or dominant logic (Prahalad and Bettis, 1986) and their focus has switched from exploration of new knowledge combinations to full exploitation of existing assets (March, 1991). Abernathy and Utterback (1978) showed how industries develop in three distinct stages. From a fluid (1) stage, characterized by exploration, uncertainty and flexibility, they move to a transitional (2) stage, where a dominant design emerges, to a specific (3) stage, characterized by standardization and integration, as illustrated by figure 8:

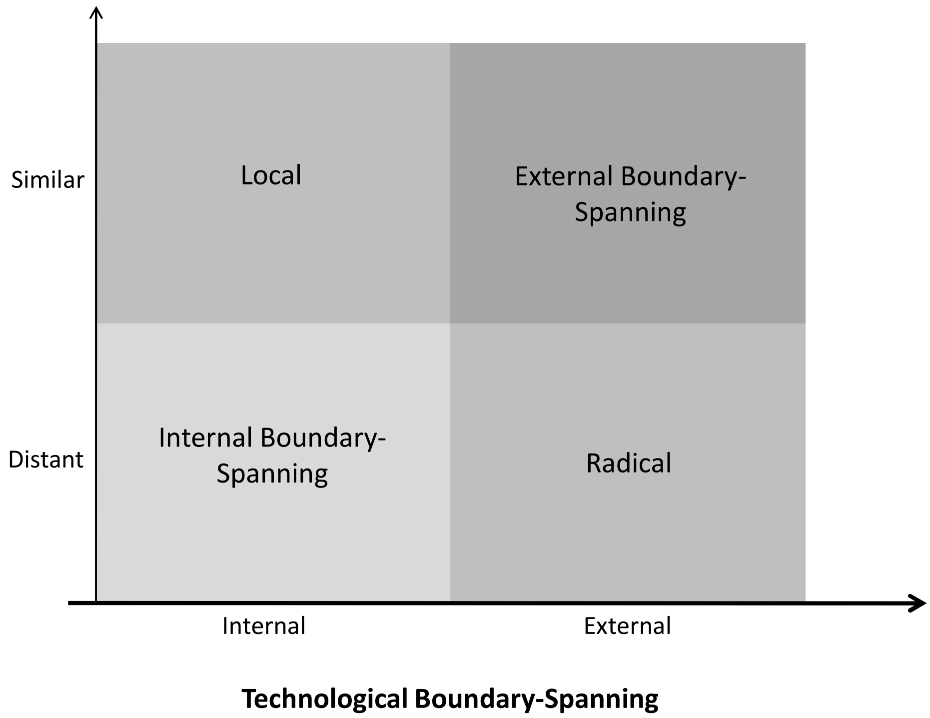
Figure - 8 The Innovation Lifecycle



Source: cf. Tidd and Bessant (2009:40)

A later book by Utterback (1994) extended the lifecycle concept to a variety of industries. It detailed the technological history of various industries, including typewriters, airplanes, light bulbs, glass, ice, and photography. Utterback regarded the final stage of the innovation lifecycle as a "last gasp" of productivity increase. A preoccupation with incremental innovation in the last stage typically entangles incumbent firms and prevents them from recognizing the potential of novel and more radical knowledge. The application of the innovation lifecycle model and the consequences of firm maturity were also verified by Christensen (1997), who found evidence of the failure of highly successful, yet mature industries to react to changes in technology or the market place. Thus, as organizations mature, their innovation focuses on incremental improvement and operational stability. As conceded by many innovation management scholars, this narrows their search activity for novel knowledge to knowledge close to current organizational and technological trajectories (Cohen and Levinthal, 1990; Stuart and Podolny, 1996). Rosenkopf and Nerkar (2001) created a typology of innovation search, ranging from search within the organization to looking for technologically distant knowledge outside:

Figure - 9 A Typology of Innovation Search



Source: Rosenkopf and Nerkar (2001:289)

Local search denotes the search of development units for similar technological knowledge from within the firm. Internal boundary spanning also refers to intra-firm search, however, for technologically distant knowledge. Conversely, external boundary-spanning search entails looking for related technical knowledge outside the firm, usually from closely aligned actors in the immediate environment of the firm, e.g. suppliers, universities or buyers (Cohen and Levinthal, 1994). Radical search refers to search for technologically distant knowledge from outside of the organization. The quadrants external boundary spanning/similar and especially radical/distant, are the search areas which yield the greatest scope for truly novel combinations of knowledge and thus carry the greatest potential for innovation (Henderson and Cockburn, 1994; von Hippel, 1994). Knowledge from different domains is essential for the serendipity required for innovation since it "enables the individual to make novel associations and linkages" (Cohen and Levinthal, 1990:131). Especially industry boundary-spanning knowledge drives innovation of the more radical kind, rather than 'me-too' or follower innovations conceived within industry-boundaries.

Yet, as previously stressed, mature firms are constrained in their search behavior since they focus their search activity on incremental improvements from within their technological trajectory. This chapter has argued, however, that technology-intensive, mature firms need to rely on knowledge considered radical in order to create new growth as well as for firm survival. Thus, with little description and prescription offered by theory and practice, this study endeavors to explore how the opposing effects of firm maturity and increasing knowledge distance can be reconciled. As the quote from Keith Pavitt (1998) highlighted, the critical question in sustaining innovation and hedging against creative destruction is to identify ways to match distant knowledge with the existing routines and capabilities of the firm. To this end, the next chapter will lay out the scientific method adopted to achieve this aim, before describing a theoretical framework intended to guide empirical analysis and subsequent theoretical generalization.

3. Methodology

3.1 Introduction

Chapter 1 introduces the central research question of this study. It suggests that both from a theoretical and phenomenological point of view, further research is required to explain how technology-intensive organizations can effectively match knowledge distant from their existing technological and organizational trajectory with their current system of routines. It further suggests that although previous research has addressed this question, especially in the organizational learning field, more insight is needed. This is, amongst other things, due to the limited explanatory power offered by empirical research methods relying mostly on large data sets such as patent data which provide limited insights with regard to the micro-foundations involved in matching distant knowledge with current capabilities. Chapter 2 provides an overview of the disaggregation of industrial R&D, and presents the challenges inherent for managers and academics with regard to identifying ways of matching distant knowledge with existing capabilities. This chapter explains the rationale behind the choice of a multiple-case-study in more detail. It then describes the research design, which outlines the logic from formulating the initial research question, to data collection and analysis as well as the process for subsequent generalization to theory.

3.2 Research Methodology

> *Predictive theories and universals cannot be found in the study of human affairs. Concrete, context-dependent knowledge is, therefore, more valuable than the vain search for predictive theories and universals. (Flyvbjerg, 2006:224)*

This study pursues an interpretive research methodology, employing multiple case-studies as a research tool. The choice of methodology reflects considerable phenomenological and theoretical ambiguity of the subject matter. In contrast, logical positivism assumes one immutable reality whereby the researcher shares a common rationality and common understanding with the research subject (Spender, 1989). Due to this common understanding, positivist research measures causal relations among variables following the well-known hypothetico-deductive model of explanation. In so doing, positivist research achieves methodological rigor, control and accuracy, and enables deriving generalizable theory based on the observation of phenomena. Generalizable theory depends on statistically representative, large samples of data to robustly measure effects. Interpretive research, on the other hand, emphasizes processes and meanings that occur naturally. It studies objects in their natural environments and investigates how social experience is created and given meaning. It makes these processes visible and enables depictions of complex realities that are problematic to capture through reductionist treatment of few variables (Gephart, 2004). As Popper (cf.1969:115) expressed, positivist research effectively makes "guesses" through hypotheses which are then checked. Interpretive research however, attempts to make discoveries during research. Among the tools available to interpretive researchers, case studies are particularly appropriate when phenomena are difficult to isolate from their context, thus case studies rely on rich data of events in their *real-life* context (Yin, 2003). Case study research follows induction logic, building and expanding theory rather than merely testing it. Due to its predilection for theory building, case study research is often regarded as a precursor for deductive, quantitative studies, and thus often relegated to sharpening hypotheses which can then be tested through quantitative modeling (Flybjerg, 2006). Indeed, inductive theory building and consequent deductive testing can be regarded as two complementary elements of one research cycle. In addition to being used for exploratory purposes, however, the case study is a method in its own right and can be used to create theoretical constructs and mid-range theory (Eisenhardt and Graeben, 2007). Case studies, for instance are equally suited to perform an explanatory function, in research setting which pursue "why" or "how" questions (Yin, 2003).[6]

When justifying a choice of scientific method, it is mandatory for the researcher to ensure that it is best suited to the question posed. In this instance, the choice of method is strongly predicated both by phenomenological and theoretical ambiguity. The central research question asks how technology-intensive firms can match external knowledge distant from their current technology/product/market context with their existing routines and processes. From a *phenomenological* point of view, this question is warranted due to the increasing risk of firm failure associated with technology convergence and divergence dynamics. Incumbent firms are under growing risk of creative destruction from new entrants from outside the industry. In addition, they are under pressure to find new areas of growth as existing markets stagnate. Therefore, technology-intensive firms need to constantly monitor not only related, but also, distant technology developments. While managers are able to utilize a number of different mechanisms to access such distant knowledge, the critical task remains how such distant and more radical knowledge can be reconciled with the existing routines (Pavitt, 1998; Rosenkopf and Nerkar, 2001) in order for timely adaption or to create new areas for growth. From a phenomenological point of view, therefore, dependence on distant knowledge is continually growing, with little prescription how such distant knowledge can effectively be matched with existing routines and capabilities.

---

[6] It is important to note that there is some degree of confusion when it comes to the distinction between interpretive methods and qualitative research. Qualitative research is sometimes used synonymously with interpretive research. Gebhart (2004) for instance therefore equates qualitative research with interpretive research characterized by strong social constructionist tendencies. While this study uses qualitative data in the form of interviews, it doesn't aspire to be explicitly social constructionist. In general, the purpose of this methodology chapter is to convey the "rigor, creativity, and open-mindedness of the research processes while sidestepping confusion and philosophical pitfalls" (Eisenhardt and Graeben, 2007:30).

From a theoretical perspective, research has addressed various issues pertaining to the disaggregation of R&D. Historical studies (Chandler, 1977; Mowery, 1983; Langlois, 2003; Teece, 2003) have charted the changing dynamics of industrial organization. As highlighted in the introduction, a large body of research has in recent years dealt with mechanisms for accessing new knowledge, for instance, in the form of mobile inventors (Arrow, 1962; Almeida et al., 2003; Singh and Agrawal, 2008). As a further mechanism for accessing external knowledge, research on strategic alliances has featured prominently (Contractor and Lorange, 1988; Dyer and Singh, 1998; Hagedoorn et al., 2002; Rosenkopf and Almeida, 2003; Grant and Baden-Fuller, 2004). More research on the sources of innovation deals with lead users, as pioneered by Eric von Hippel (1988; 2006). Furthermore, the presence in geographically concentrated areas of economic activity has been widely discussed (e.g. Marshall, 1920; Porter, 1998 Saxenian, 1994). Recent innovation literature further addresses the new sources of innovation as a result of the growing efficiency in the market for technology, such as start-ups, venture capital firms, internal venturing and so-called innovation intermediaries (Arora, 2002; Chesbrough, 2002; 2006; Harryson, 2007, Tidd and Bessant, 2009). In terms of providing insights to the central research question of this thesis, the above theory has largely ignored the problem. Moreover, the majority of research has relied on large datasets such as patent data or industry level data in empirical analyses. Even some studies which have addressed the present problem (e.g. Rosenkopf and Almeida, 2003) do not provide more detailed insights into the micro-foundations of how firms are able to match distant knowledge with existing capabilities (Knudsen, 2009; Teece, 2009).

As also outlined in the introductory chapter, another major research stream addressing the question of how organizations learn is represented by the organizational learning literature. This literature stream, however, is highly fragmented. As Vera and Crossan (2003) highlight, all facets of this research field display considerable incongruence in research tradition, focus, philosophy, method and unit of analysis. As they also point out, organizational learning requires the analysis of multiple levels of analysis, thus requiring appropriate research methods, which, so far, have not been used sufficiently (Foss et al., 2007; Doz et al., 2008).

A key contribution of the organizational learning literature, though, concerns the question of how novelty settles into a dominant design and results in increasingly rigid routines, path-dependence, and inertia (e.g. Prahalad and Bettis, 1986; Levitt and March, 1988; Leonard-Barton, 1992). This aspect of organizational learning stresses that, as organizations mature, the focus of innovation changes from product to process innovation and incremental product improvement (Abernathy and Utterback, 1978). As a dominant design emerges for the "technology/product/market" combination (Gilsing and Nooteboom, 2006:3), managers rely increasingly on heuristics, or a "dominant logic" (Bettis and Prahalad, 1995). Learning, i.e. the combination of novel knowledge with existing routines leading to a change in routines, is seriously hampered under these circumstances – an organization's routines have become "core rigidities" (Leonard-Barton, 1992). Moreover, the cumulative nature of incremental learning results in path-dependence which prevents organizations from searching for new knowledge from outside of their existing context (Cohen and Levinthal, 1990; Rosenkopf and Nerkar, 2001). This "local search bias" also extends to the mechanisms for accessing distant knowledge discussed earlier (Rosenkopf and Almeida, 2003). In this respect, the notion of path-dependence and organizational inertia presents a rival theory to the empirically observed "opening up" of innovation processes. The effects of organizational inertia militate against accessing and utilizing external knowledge which is distant from the current technology/product/market context. A central theoretical conundrum therefore, consists of the questions whether, and how this inertia can be overcome. Finding answers to this question could provide an explanation of the limits to choosing markets over hierarchies for organizing innovation. It would also shed more insights into the limits of certain mechanisms to instill learning and change.

The choice of the case study method, thus is predicated both on phenomenological as well as theoretical challenges. Technology-intensive organizations are increasingly forced to find and apply knowledge which lies outside of the scope of their current operations. Moreover, many managerial publications currently advocate the use of external sources of technological input for R&D. Yet, the challenges associated with matching such distant knowledge with the existing system and routines are largely ignored. Managers have been attempting to source outside sources of innovation and impulses with little concern for their organizational idiosyncrasies, creating R&D outposts or web-based innovation platforms. Often, such strategies have little impact. At the same time, organizations time and time again fail to react in a timely manner to discontinuous changes, often resulting in creative destruction. There is, thus, imminent need for inductive research to provide in-depth answers whether and most important how organizations can manage such matching. There is compelling evidence that organizations are becoming increasingly dependent on knowledge distant from their existing technological and organizational trajectory. Attempts by firms to integrate such distant knowledge are less informed by theory, but seem to be based on trial and error. The costs both for companies but also for the economy at large could be substantial, given the high risk of firm failure as well as the wrong-guided investment decisions undertaken my managers. As widely discussed in evolutionary perspectives on strategy, most firm failure has at its root the inability to react to changes exogenous of the immediate organizational and technological context consisting of new knowledge. Detailed accounts of such episodes of "creative destruction" are legion. Yet, theory addressing the fundamental challenge of how organizations can not only identify but match new pieces of knowledge with their existing capabilities is scant. Practitioners, therefore, have at best heuristics and trial-and error learning to guide their decision making.

3.3 Case Study Research

Definitions of what constitutes a case study are diverse, compounding the difficulties of conducting rigorous case study research. For instance, Miles and Huberman (1994:25) define it as a description of a phenomenon occurring in a bounded context. Broadly speaking, case studies rely on multiple, difficult to entangle sources of evidence and are therefore appropriate when the researcher, rather than isolating particular variables in a more controlled manner, intends to study phenomena within their natural context (Yin, 2003). Within the scope of this research project, for instance, prior isolation of contextual factors would do little to expand on existing research. Particularly since the research question posed is aimed at disentangling the several units of analysis and variables which may be of high relevance to the causal relationships explored. The case study method, moreover, can be defined as a holistic research strategy, which covers "logic of design, data collection techniques and specific approaches to data analysis (Yin, 2003:14).

Case studies offer two main approaches – single or multiple-case study designs. Single case studies are useful when examining phenomena with extreme characteristics. Extreme characteristics can mean cases which deviate significantly from the average in a relevant dimension, thus revealing a particularly rich set of variables (Eisenhardt, 1989). Multiple-case studies, on the other hand, are considered to deliver more robust results. They are suited to exploring a phenomenon under varying conditions across several cases. Multiple-case studies therefore share similarities with experiments. Instead of a sampling logic, therefore, a multiple-case study methodology can follow replication logic, similar to the replication of experimentation used in controlled environment experiments. However, the case study method presents the researcher with several problems. Single case studies focus on single, isolated phenomena and their external validity is invariably weak. Although the results derived from multiple-case studies are more robust, neither single- or multiple-case studies are suited for generalization.

3.4 Research Design

Case study research comprises a comprehensive logic encompassing data collection, analysis, reporting, and the process of generalizing the results back to theory (Yin, 2003). This section outlines the design structuring the research conducted, consisting of the development of a theoretical framework, data collection, analysis, and reporting. Thereby this section ensures that the research satisfies academic rigor and quality, primarily by improving validity and reliability. As the previous section has demonstrated, case study research offers two main approaches – single or multiple case studies. Multiple-case studies are generally considered more robust since they strengthen theory building through wider and more diverse empirical evidence (Eisenhardt and Graeben, 2007). Moreover, similarly to experimentation, multiple-case studies allow for *replication* across the different cases. Replication may entail observing the same phenomenon under the exact same conditions across different cases. Equally, researchers may use replication by looking for some extent of deviation between the cases (Yin, 2003) – in the extreme consisting of contrary or "polar type" – cases contrasting polar extremes of a particular variable (Eisenhardt and Graeben, 2007:27). This research pursues a multiple-case study design in order to improve reliability and external validity. Further, it aims to study the significance of a particular variable on the outcome of the different cases. The variation in the cases is intended to reflect a potentially highly significant independent variable moderating the success of learning processes. Organizational learning research acknowledges that the re-organization of existing routines and processes only occurs in response to external or internal shocks (Cyert and March, 1963). In their re-conceptualization of the absorptive capacity construct, Zahra and George (2002) suggest that what they refer to as "activation triggers" instill a sense of crisis in the organization, thus resulting in learning stimuli.

> *"The source of a trigger is likely to influence the locus of technological search (Doz, Oik, & Ring, 2000). Radical technological shifts encourage a firm to invest resources in acquiring specific information relevant to the new technology, thereby determining the locus of its search and the content of information sought (Rosenkopf & Nerkar, 2001). The intensity of the trigger will influence a firm's investments in developing the capabilities to acquire and assimilate this knowledge, with the intention of exploiting it to improve firm performance or avoiding a technological lockout (Tegarden, Hatfield, & Echols, 1999)". (Zahra and George, 2002:194)*

Therefore, the cases have been chosen to represent different levels of "shock" and, accordingly, strategic focus of the search and matching effort. According to this notion the seriousness of strategic intent behind the creation of the search and transfer function is likely to be reflected in (1) the search locus, and therefore, knowledge distance, and (2) the specific search mechanism. Thus the research design reflects the desire to disentangle both the extent of the moderating influence of strategic focus, and the measures taken for the innovation search effort:

Table - 1 Cross-Case Variation

Dimension	PATYO	VIA	Webasto
Strategic Focus	**High**	**Low**	**Medium**
Knowledge Distance	Medium	High	Low
Search Mechanism	R&D Listening Post	Web-Platform	Lead-User Integration

While the multiple-case studies are aimed at disentangling how these contextual factors affect the ability to match distant knowledge with existing capabilities, other factors commonly associated with innovativeness are being held constant across the cases:

Table - 2 Factors Traditionally Associated with Innovation Capability

Case	Org. Size	Org. Age	R&D ratio	Location	Industry	Competition Intensity	Products
PATYO/VIA	Large	96 years	5.2%	Bavaria	Automotive	High	CoPS[7]
Webasto	Medium	108 years	8.3%	Bavaria	Automotive	High	CoPS

The above criteria are commonly associated with the innovativeness of a firm. By holding these factors constant, they can be ruled out as factors influencing differential outcomes in the findings. As an initial step in this research project, relevant theory was reviewed and a theoretical framework created, which allowed for focused data collection and analysis.

3.4.1 Theoretical Framework

As Yin (2003) stressed, multiple-case studies which follow a replication logic require a rich theoretical framework which provides the basis for identifying relevant dimensions varying between the cases. In addition, a rich theoretical framework is essential for subsequent theoretical generalization. During the first stage of this research project, literature pertaining to R&D collaboration was reviewed. Initial insights revealed a gap in the theory both with theoretical and phenomenological relevance. On this basis, an initial

[7] Complex Product Sector.

research question was formulated which enquired how technology-intensive organizations could successfully transfer external knowledge to their internal R&D organization. As a second step, preliminary, loosely-structured interviews were conducted with several individuals at the case companies. The first round of interviews helped to sharpen the initial question and propositions of the study. Subsequently, the theoretical framework evolved further, in an iterative process. Dubois and Gadde (2002) describe such an approach as systematic combining. By this they mean continuous matching of theory and empirical data by going back from preliminary data to existing theory. As Spender (1989) points out, such an iterative process helps create a common understanding between subject matter and the theory. The data and the cases were thus used as a focusing device for research proposition and theoretical framework. Based on this framework, I spent an extended amount of time in the field, gathering data and building a common frame of reference with the managers studied. This research was thus conducted with the researcher spending more than a third of the total project time inside one of the case companies which amounted to roughly one and a half years. Having a common frame of understanding helped to improve the reliability of the data. The insights gathered in the field were then analyzed based on relevant theoretical frameworks. The final theoretical framework which guided the semi-structured interviews also served for creating coherent and comparable narratives. In addition, it provided the basis for the subsequent theoretical generalization. The iterative process of alternating between data gathering and theory construction provided a major advantage but, at the same time, resulted in a major drawback when it came to the subsequent theoretical generalization. Particularly in the early stages of data gathering data seemed to be inconclusive, superficial, and prone to confirmation bias. By going back to theory and identifying potential critical issue which secondary sources and respondents omitted, it was possible to identify areas in the processes studied which had essentially failed. By scoping the theoretical framework tightly, thus, it was possible to extract the high level of detail evident in the findings and the case write-ups. The drawback of the highly structured framework and write-up is evident in reduced scope for allowing categories to arise through open/axial coding of interview data. Nevertheless, in addition to confirming some aspects of incumbent theory in strategy and innovation management, the results provided meaningful new theoretical propositions, as well as further sharpening of insights to existing theory. A full description of the theoretical framework can be found in chapter 4.

3.4.2 Unit of Analysis

The early, idea-generating phase is the most dependent on external information, whereas subsequent stages required closer coordination with internal stakeholders, such as production and marketing (Tushman, 1977). The early phase of innovation is also referred to as the "fuzzy front end" of innovation.

> *"The fuzzy front end is defined as the period between when an opportunity for a new product is first considered, and when the project idea is judged ready to enter 'formal' development. Hence, the fuzzy front end starts with a firm*

having an idea for a new product, and ends with the firm deciding to launch a formal development project, or alternatively, decides not to launch such a project" (Frishammer and Floren, 2008:1).

At later stages of the development process, important decisions regarding the pursuit of a project are already taken. These decisions are likely to conform to the current business model of the firm, and thus conform to the current technology/product/market trajectory. The fuzzy front end is therefore the stage of the innovation process which formulates the subsequent direction of development. Due to this, it is the ideal focus of this study. Early on in the research process, it emerged that some organizations have created dedicated organizational units to the task of searching and transferring knowledge from outside the current context to the R&D organization. However, it was not clear whether these functions operated largely independent of other organizational functions thus being exclusively focused on creativity and innovation. This is reflected in the first research sub-question which addresses the extent to which such matching functions interact with other levels of organization. In order to disentangle the interaction with different organizational levels involved in the search and matching of distant knowledge, the entire process of searching, matching and transferring was chosen as the unit of analysis.

3.4.3 Sample Selection

The sample for this study was selected from a population of German premium automotive companies. The choice of population is not based on the assumption that the findings can be generalized to other industries. Rather, it is influenced by the sheer complexity of the industry. In an industry which relies on a multi-tiered web of suppliers, complex production, a product containing around 8,000 individual parts (Maxton and Wormald, 2004) offering hundreds of individual combinations of options, complexity is evident at every part of the value chain. Therefore, processes and practices in the industry can be expected to reflect this complexity. This enables researchers to uncover a rich set of variables which may be less explicit in other, less complex settings. The automotive industry may not be extreme in these dimensions, however, due to their expected rich information content, the cases could certainly be considered prototypical.

With regard to emerging strategies to overcome path-dependence, particularly the Japanese and German car industries stand out. Thus, the German premium automotive industry was selected, in part also due to superior access. Initially, three companies were chosen, two manufacturers and one supplier. Sample selection was based on the proven track record of innovation compared to competitors. For instance, the Business Week (Anonymous, 2005; 2006) "World's Most Innovative Company" list, jointly aggregated with the Boston Consulting Group, provides a measure for a firm's innovation performance[8]. Among the German automotive companies, particularly the BMW Group stood out, ranking 20 and 16 in 2005 and 2006, respectively. Known less for its innovation capability but more for its operational excellence, Porsche was chosen as a second case. During the preliminary research conducted for this study, a highly innovative supplier was also identified and included in the sample, the Bavaria-based Webasto AG. Unfortunately, after several rounds of interviews with Porsche, it was found that the replication logic conditions could not be met, since the company provided little scope for comparability along the dimensions outlined in the research design. It was therefore decided to include a second case from within BMW in the overall case study design. The unit of analysis in all three cases is the process dedicated to searching for novel knowledge and transferring it back into the mainstream R&D activity. At BMW, this was the web-based innovation platform "VIA", and the technology outpost in Palo Alto, "PATYO". At Webasto, this consisted of the marketing department being responsible for lead user integration activities.

3.4.4 Data Collection

Data collection was aimed at carefully triangulating overlapping pieces of primary and secondary data. Particularly due to the unique nature of this research project, data collection greatly benefitted from close access to the primary field site. The researcher spent a total of roughly 40 per cent of his time at the main case company, amounting to around one and a half years of full time work. This access enabled good approachability of key interviewees related to the cases. In the initial stages of the research project, commencing in October 2006, in parallel to the initial literature review, exploratory interviews were conducted at the main site as well as at Porsche. During the entire time, insights and pieces of information were recorded in a field diary. Secondary data from presentations, internet documents, newspaper and journal articles and academic books complemented interviews and participatory observation. Following the initial formulation of research questions and propositions, as well as the initial data collection, the researcher participated in workshops with BMW and Porsche. One workshop specifically addressed the initial insights developed and discussed them critically with relevant managers. Particularly the understanding created through the intense period of participatory observation mitigated a great deal of misunderstanding and ambiguity inherent in the rich and complex data. In addition, informant biases could be more easily identified by having some understanding of the underlying motivations and context of informants. Conversely, potential researcher biases through the long periods of observation were mitigated by still basing the majority of data on interviews and secondary data.

During early and mid-2008, structured interviews were conducted at BMW pertaining to the Virtual Innovation Agency. Since the preliminary data gathered from Porsche proved to be inconclusive and

[8] Without elaborating on the usefulness of these rankings any further, it is worthwhile pointing out Garcia-Osma's (2009) critique of the methodologies used to aggregate these lists, which often use obscure expert panels or surveys, and seem to reflect size, brand image and financial performance more than actual innovativeness.

unsuitable for more in-depth analysis, the Porsche case was dropped, and a second BMW case identified, the Palo Alto Technology Office. Structured interviews were thus conducted with members of the Palo Alto Technology Office in Munich. During the first part of 2008, interviews were also conducted for the third case, Webasto. A detailed interview guideline was used and the interviews were usually tape recorded and transcribed. If interviewees were not willing to be recorded, interviews were recorded manually during interviews.[9] The interview guideline was drafted based on the theoretical framework developed up to then, as well as critical additional questions which had arisen during the preliminary interviews. As opposed to VIA and PATYO, no participatory observation took place at Webasto. Further, the interview sample from Webasto was much smaller, consisting initially of one main informant. This was due to the fact that the function to be analyzed consisted of only few people, only one of which had relevant insight into the subject matter investigated. The problem of reliance on initially one interview source was remedied with a more comprehensive incorporation of secondary information, of which more was available than for the other two cases. In addition, corroborating interview data from other interviewees was provided by an outside researcher who shared a similar research interest and had conducted interviews pertaining to the same subject at Webasto[10]. At the beginning of 2009, further interviews were conducted with project members of the Palo Alto Technology Office in Silicon Valley. In addition, individuals from other companies employed in similar functions were interviewed during that time, as well as representatives from academia. It should be noted that in addition to data sources triangulation, some interview data was enhanced by using "dissenting voices". In both the BMW PATYO and VIA cases these dissenting voices consisted of former members of the different functions investigated who had since left the company. In the case of Webasto, dissenting voices came from a researcher who also had intimate knowledge of the case investigated. These dissenting voices sometimes delivered interesting insights which may have been omitted by other sources due to interviewee reflectivity and desirability biases. Table 3 summarizes the data sources, and table 4 summarizes the interview sample:

Table - 3 Data Sources

Case	Interviews	Workshops	Field Notes	Secondary Sources	Participant Observation	Presentations
PATYO	X	-	X	X	-	-
VIA	X	X	X	X	X	X
Webasto	X	X	-	X	-	X

[9] See Appendix 10.1 for the full interview guideline.
[10] Please also see Appendix 10.1.

Figure - 10 Distribution of Data Sources

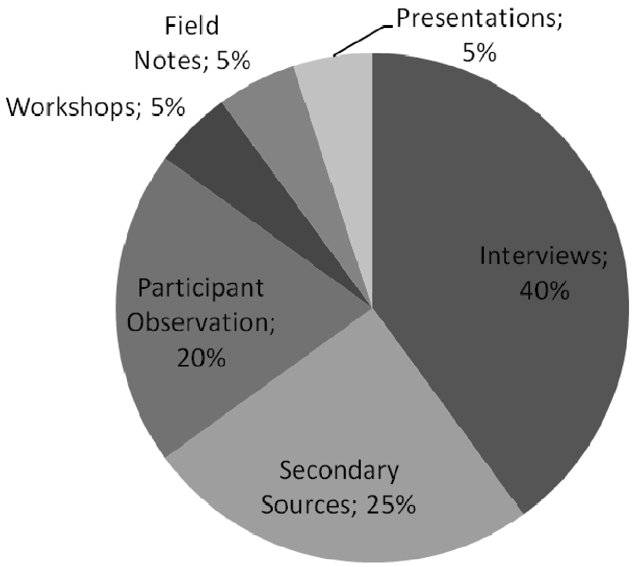


Table - 4 Interview Sample

	Industry	Interviews*	Companies/ Institutions	Structured/ Unstructured
	Automotive	38	6	21/17
	OEMs	(31)	(5)	(16)/(15)
	Suppliers	(7)	(1)	(5)/(2)
	Higher Education	6	4	1/5
	Technology Intermediation	4	2	1/3
	IT	2	2	2/0
	Pharmaceutical	1	1	1/0
	Multi-Technology	1	1	1/0
Total	**6**	**52**	**16**	**27/25**

* Please refer to section 10.2 of the appendix for a full list of interviewees, companies and dates.

Table - 5 Workshops

Workshops/Presentations	Attended	Organized
BMW	3	2
Webasto	1	-
Porsche	1	1

The bibliography contains a list of all sources of secondary data used. A full list of interview partners is provided in the appendix.

3.4.5 Data Analysis

The data and the case reports were then analyzed along the dimensions defined in the theoretical framework. Within-case analysis was achieved by iterations with the organizations involved, having them check the accuracy of facts presented. Within the cases, careful attention was also paid to the presentation of the mainly qualitative data in tables and figures, in order to ease cross-case comparison and enable convenient access to the data embedded in the case narrative. As part of data analysis, a pilot case study of the Webasto case was adapted for use in an MBA course at the Haas School of Business. This teaching case was discussed with students in order to provide fresh view points on the issues highlighted in the narrative. During the final stages of analysis and write-up, a sub-sample of the qualitative interview data was coded using the qualitative analysis software program NVivo. The sample comprised 10 transcripts, 3 from VIA, 3 from Webasto, and 4 from PATYO. Although comprehensive analysis based on quantification derived from the coding has not been conducted, some tentative insights from the coding helped to sharpen the conclusions derived. For instance, coding helped to clarify the hierarchy of knowledge transfer barriers experienced by the individuals interviewed. In order to improve the reliability of data analysis, the cross-case analysis closely adhered to the conceptual constructs derived from the theoretical framework. As discussed in the section on the theoretical framework, the tightly scoped theoretical framework helped to guide data collection in a meaningful way, yet it somewhat restricted the scope for analysis to narrowly pre-defined categories. There was therefore a trade-off between level of detail and scope for new theoretical categories to emerge. However, due to the generally strong confirmation bias and lack of transparency inherent in innovation studies it seemed more advantageous to reveal failure and the reason to failure than be content with more superficial data and a better ability to draw implications for theory based on it.

Particular attention was paid to visualizing the data, thereby making it more suitable to accurate comparison of similarities and difference between the cases. The goal of this approach was to achieve pattern-matching between the variables proposed in prior theoretical conceptualization and the data. The pattern-matching helped to explain the significance of the predicted variables. In particular, it supported the strong significance of the variable which varied across the different cases.

4. Theoretical Framework

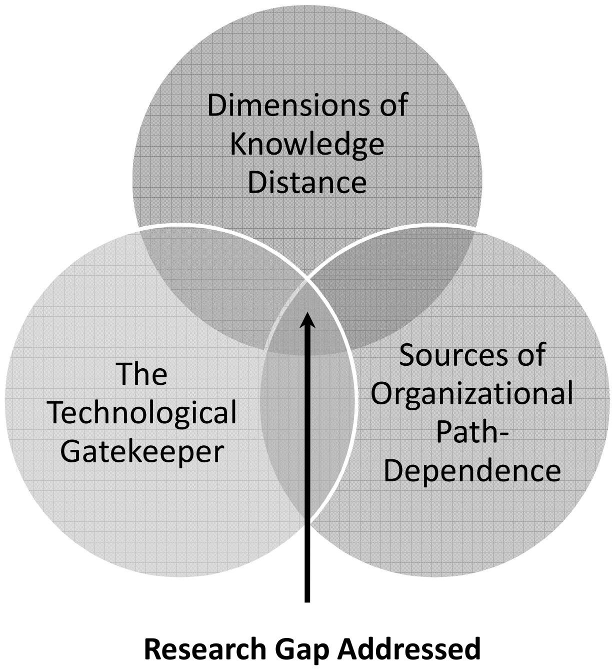
4.1 Introduction

Firms rarely fail because of an inability to master a new field of technology, but because they do not succeed in matching the firm's systems of coordination and control to the nature of the available technological opportunities. (Pavitt, 1998:433)

Chapter 2 highlights how the simultaneous dynamics of convergence and divergence of technology has led to the disaggregation of industrial R&D. It also introduces a serious dilemma industrial business firms are facing as a result of these dynamics. They increasingly need to search and apply knowledge from outside of current organizational and technological boundaries. Yet, their existing routines and processes present them with considerable constraints on utilizing knowledge outside of their existing context. The central question therefore is how existing routines and knowledge outside of the current context can be matched so that industrial business firms can create the basis for new innovation.

Chapter 3 introduces the research methodology used in this study. It further highlights that the case study method, and particularly multiple-case study designs, depend on a rich theoretical framework in order to guide data collection, analysis, and to form the basis for subsequent generalization to theory. Thus, in order to guide the empirical analysis, the present chapter reviews the state-of-the-art in strategy literature. It focuses on literature closely related to the research question. Two of the most relevant topics have already been mentioned. On the one hand, a clearer insight is needed with regard to what exactly constitutes “distant” knowledge. The innovation management literature has so far mainly distinguished between incremental and radical knowledge. However, since the degree of radicalness is relative to the status quo, this chapter aims to arrive at a more differentiated conceptualization of distance and novelty. Further, the nature of organizational routines which crowd out novel or distant knowledge needs to be disentangled. Thus, this chapter aims to provide a more holistic view on the constraints on integrating novel knowledge along the main innovation process steps. In order to do so, the chapter first (1) delineates the notion of relative novelty of external and distant knowledge. Second (2), the nature of organizational routines and processes at the mature business firms causing path dependence is scrutinized. Third (3), the technological gatekeeper literature is reviewed. Technological Gatekeepers are a mechanism for mediating external knowledge across organizational boundaries. Yet, the literature has so far only examined instances of path-dependent boundary-spanning by gatekeepers. However, the results of empirical studies on gatekeepers are expected to provide a framework on which to base the subsequent empirical analysis of how *distant* knowledge can be mediated across organizational and technological boundaries. Based on the three theoretical perspectives reviewed, a framework is presented which guides the empirical analysis and findings. Figure 11 illustrates this theoretical framework:

Figure - 11 Overview of Theoretical Perspectives Reviewed



4.2 Delineating Knowledge Distance

Knowledge is 'localized' in tacit learning processes that are embedded into the background and experience of each innovator and hence highly idiosyncratic. It is thus largely excludable and its use is partly rivalrous. In particular, technological knowledge tends to be localized in well-defined technical, institutional, regional and industrial situations: it is specific to each industry, region, firm and individual or team of individuals and consequently costly to use elsewhere (Antonelli, 1999:44-45).

A detailed debate around the concept of "knowledge" is entirely beyond the scope of this dissertation. It should here suffice to say that, in academic traditions, it is discussed and analyzed across a wide range of disciplines. Theories of knowledge are applied in philosophy, management, organization theory, learning, accounting, marketing, and IT, thereby ranging from highly theoretical to more normative and hands-on disciplines. In the present study, knowledge, and particularly knowledge novel relative to an existing organizational knowledge base, is regarded as one component of innovation, the other being its consequent integration and commercialization. The main intention of this section is to provide a more refined concept of what constitutes relative "distance" of knowledge. Classic microeconomic theory treats knowledge as objective and codifiable information, which can be transmitted without friction, generally applied and easily reused and reproduced (Arrow, 1962). However, more recent scholarly treatment of knowledge, especially from the knowledge-based view (Grant, 1996) and organizational learning traditions (Argyris and Schon, 1978; Nonaka and Takeuchi, 1995; Easterby-Smith and Lyles, 2003), has treated knowledge in a more differentiated manner. Accordingly, this study adopts the view that knowledge is, to varying degree, idiosyncratic, contextualized, tacit, rivalrous, and correspondingly costly to transfer and apply. Given that the knowledge necessary for innovation is different by degrees from the extant stock of knowledge in a particular context, it should follow that novel, highly distant knowledge contains highly tacit components in accordance with the relative distance between sender and receiver which is also evident in the degree of uncertainty with regard to the outcome of its application. Further, it will have a divergent context from the current technology/product/market context. This chapter argues that this divergence is manifest mainly in technological, cognitive, institutional and geographic distance.

4.2.1 High Uncertainty

Galbraith (1977:36-37) described uncertainty as "the difference between the amount of information required and the amount of information possessed by the organization". Naturally, acquiring and applying knowledge in the innovation process always involves a considerable degree of uncertainty. This uncertainty translates to the degree of risk associated with investment decisions in innovation. Profit-maximizing organizations manage and fight this uncertainty as part of their general pursuit of efficiency. Risk associated with knowledge building on previously acquired stocks of knowledge can be extrapolated and diversified away, recently practiced through innovation portfolios and other financial risk assessment tools such as value at risk or net present value. However, whereas this degree of uncertainty pertains to what Dosi (1988:1134 [italics added]) described as "imperfect information about the occurrence of a known list of events", in the extreme, organizations deal with "*strong uncertainty,* whereby the list of possible events is unknown and one does not know either the consequences of particular actions for any given event". The high uncertainty associated with novel, distant knowledge may be associated with various aspects of the current knowledge base of the firm. Since the knowledge base is mostly defined by the current technology/product/market combination, these dimensions will be more closely discussed. In the interest of parsimony, technology and product will be treated jointly, whereas in addition to market uncertainty, the business model inherent in novel knowledge will be treated in addition

Technology

The early stages of a new technology are marked by little certainty of the viability and feasibility of a particular approach or solution. Subject to entry barriers, market attractiveness and imitability, new ideas rapidly attract innovators pursuing alternative paths to solving identical problems (Abernathy and Clark, 1984). Serendipity and luck play a significant role in determining which technology will ultimately establish the dominant design. Superior technology need not necessarily play a decisive role in the outcome of the initial standard wars. For instance, complementary products and services may significantly affect the diffusion and adoption of new technology. The classic VHS vs. Betamax story is a case in point. VHS' technical inferiority to Betamax was evident from the start. Despite this technical advantage, Matsushita, backing the VHS standard, succeeded in establishing the standard due to its encouragement of adoption through licensing of the VHS system to Sharp, Philips, GE, RCA, and other competitors (Grant, 2005). Further, Matsushita ensured appropriate supply of the most important complementary product, films, early on. Besides the influence of complementarities, technological uncertainty is compounded as technology, product, and services converge further. For instance, Apple's iPod and iPhone business model relies heavily on network effects from complementary products and two-sided markets. The iPod is coupled with Apple's iTunes store, which in turn depended on the willingness of the music industry to open this form of outlet. The iPhone, in a similar vein, benefits from the numerous applications which are created by a vast community of independent developers. iPhone applications in turn are augmented in their value the more users use the respective application. Accurately assessing such network effects is essential in order to determine the viability of novel technology, particularly considering that often technically suboptimal solutions become the de facto standard.

Market

Many breakthrough innovations such as the internet, laser technology, and computers started their lives as solutions looking for a problem (Taleb, 2007). The more removed from current economical and social practice new knowledge is, the harder it is to anticipate its potential commercial application. Thus, determining size and growth rates of potential markets for a new technology, and furthermore, establishing the speed of diffusion is inherently difficult. The more radical innovations satisfy a need which may be highly opaque for mainstream customers or managers[11]. Eric von Hippel (1988) ascribed the myopia of customers with regard to radical innovation to their "functional fixedness", i.e. a focus on the usage and utility of a current product or service. His well-known remedy for this condition is to involve visionary customers, so-called "lead users", who anticipate entirely latent demands long before the mainstream. Regardless of market growth potential, initial market size may be small. Large incumbents therefore, find themselves unable to justify and sustain investment in technology which does not provide the size of revenue streams required by their current operations. Often, therefore, new technology is pioneered by smaller players who target niche markets (Christensen, 1997).

[11] Ken Olson, then CEO of DEC famously said in 1977: "I can think of no conceivable reason why an individual should wish to have a computer in his own home".

Business Model

A concept temporarily popular during the days of the dot-com boom and bust of the 1990s, the business model underlying new ideas is likely to also be highly uncertain. More recently, innovation management scholars have once again begun to highlight the importance of business models in not only ensuring technological viability, widespread diffusion and adoption, but to capture value. As Chesbrough (2009:1) stressed, "technology by itself has no objective value". Its value is determined by a business model, which, in essence, "defines the manner by which the business enterprise delivers value to customers, entices customers to pay for value, and converts those payments to profit" (Teece, 2009a:2). A business model defines the value proposition of a firm, product or service, the target market segment, the structure of the value chain, explicates the value stream and profit potential, describes the position of the firm in the value network, and formulates the competitive strategy of the firm (Chesbrough and Rosenbloom, 2002). Even if the market is sizable and the technology is rapidly adopted, the business model and the underlying revenue structure may be weak. Particularly internet-based ventures have displayed high uncertainty with regard to their business model, for instance during the first dot-com boom. For most of the dot-com boom, many new ventures only had a vague idea of how they could charge for their services despite rapid adoption and technological dominance [12] (The Economist, 21 March 2009). A similar phenomenon could be observed during the Web 2.0 boom following Google's success. Therefore, an important aspect of the uncertainty inherent in distant/novel knowledge consists of the opaqueness of the underlying business model.

4.2.2 Tacitness

In addition to high uncertainty, a central aspect of novel knowledge consists of high tacitness. Tacitness is mostly understood as the extent of codifiability, however, as Teece (2009b) tacitness also pertains to the strength of the appropriability regime of a new idea or technology.

Codifiability

Polanyi (1967) first introduced the distinction between tacit and explicit knowledge. Tacit and explicit knowledge could be described as two extreme poles of a spectrum constituted by the degree to which knowledge can be codified and articulated in universally intelligible form. Highly tacit knowledge cannot be codified, but may only be communicated or demonstrated in direct interaction. For instance, this entails hands-on participation by the intended recipient or co-worker, corrected in mutual adjustment between each other, in "communities of practice" (Brown and Duguid, 1991; 2000; Nonaka and Takeuchi, 1995). The notion of codifiability was later used by von Hippel (1994), who proposed the concept of stickiness of information. This is defined in the sense that "the information used in technical problem

[12] A common term in Silicon Valley for this (lack of) business model is the acronym URL – ubiquity now, revenue later.

solving is costly to acquire, transfer, and use in a new location" (1994:429). Szulanski used the stickiness concept to explain why best practice was not transferred within organizations and found that recipient's lack of absorptive capacity, causal ambiguity and the arduousness of the relationship between the sender and receiver were at the root of information stickiness. The implications of the extent of tacitness of knowledge are that the more idiosyncratic the knowledge, the richer the communication channels required for transmission. Nonaka and Takeuchi (1995) have captured this implication in their SECI model, which suggests intensive socialization between sender and recipient of knowledge in extreme cases of tacitness. A lack of codifiability associated with novel knowledge is one of the main reasons for the effectiveness of individuals in the transfer of knowledge.

Appropriability

Another aspect of the tacitness of knowledge is appropriability. Teece (1986) defined a regime of appropriability as the environmental conditions determining the share of profit generated by an innovation. As long as novel knowledge is non-codifiable and tacit, it may not be fully protectable under intellectual property rights (Teece, 2009b). Thus, fully disclosing knowledge in a transaction may make the basis for an exchange redundant. However, a seeker must be able to assess whether and in how far the knowledge is relevant and a relevant subject of exchange. This dilemma militates against formal contracts and calls for mutual advantage and trust-based relationships (Nootebom, 2000). The problem of low appropriability of novel knowledge has given more impetus to the development of an intermediary market for technology, pioneered by companies such as NineSigma and Innocentive.

4.2.3 Distance Effects

In addition to high uncertainty and tacitness, it is particularly the notion of distance which requires a more accurate definition. Rosenkopf and Nerkar (2001) define radical knowledge as knowledge spanning both organizational and technological boundaries. This seems a somewhat limited notion of boundaries encountered when searching and transferring novel knowledge. When discussing processes for matching distant knowledge with existing routines, therefore, a finer definition is required. Since Rosenkopf and Nerkar's (2001) seminal paper, literature from the innovation-oriented economic geographical school have advanced the understanding of distance away from mere "spatial distance" to a multi-facet concept (Hartig, 2009). This school argues that purely referring to spatial, geographic distance does not do justice to the actual, underlying sources of distance which are evoked by spatial distance, namely cognitive, organizational, social and institutional distances (Boschma, 2005). While the literature, and, in particular, Boschma's contribution analyzes distance in terms of the four aforementioned dimensions, in addition to purely geographical, this study also introduces technological distance, while social distance and organizational distance are omitted. This is done for several analytical purposes. First, by adding technological distance, it introduces a variable of high relevance for the present study, which, due to the highly technical nature of the firms studied, requires careful consideration when establishing knowledge distance. Second, social distance refers to "socially embedded relations between actors at the micro-level" (Boschma, 2005:66). Since the focus of this study is on knowledge where no prior social relations are supposed to be present, it is not included in the analysis of knowledge distance. Nevertheless, a possible outcome of this study may well be that social proximity needs to be created in order to enable trust-based, rich communication and exchanges, a notion widely accepted and researched in the organizational learning/knowledge management literature (e.g. Nonaka, 1991). Third, organizational distance is omitted since it is to some extent redundant in the context of this study. Although organizational proximity is treated broadly and defined in terms of common knowledge base, cognitive distance, and discrepancy in size, Boschma (2005:65) defines it as "the extent to which relations are shared within an organizational arrangement, either within or between organizations", and more specifically, "the rate of autonomy and the degree of control that can be exerted in organizational arrangements". To the same extent as issues of social distance, organizational distance is assumed to be high in the context of this study, and social and organizational proximity would contradict the notion of novel or distant knowledge applied in this study, therefore rendering both variables redundant. Thus, the following section distinguishes between technological, cognitive, institutional and geographic distance.

Technological Distance

Technological distance determines in how far knowledge is compatible with the existing technological trajectory. Technology close to the existing knowledge base builds on existing capabilities and provides incremental improvement. Since investment in technological knowledge is cumulative, organizations are inclined to search and invest in technological knowledge close to their existing knowledge base (Cohen and Levinthal, 1990; Rosenkopf and Almeida, 2003). Conversely, technologically distant knowledge fundamentally changes an organization's technological trajectory and may have profound implications for the entire business model (Benner and Tushman, 2003). Distance can also be modeled along the dimension of systemic or autonomous innovation. Autonomous or modular innovation can be integrated without any repercussions for the overall product architecture. Systemic or architectural innovation involves changes in how modules are linked together (Henderson and Clark, 1990; Iansiti and Clark, 1994; Chesbrough and Teece, 1996). The closer to the existing technological architecture novel knowledge is, the easier to identify and utilize. However, the more removed from the existing knowledge base, and the more influential on technological architecture, the more competence-destroying and conflicting knowledge is likely to be.

Cognitive Distance

"Cognition denotes a broad range of mental activity, including proprioception, perception, sense making, categorization, inference, value judgments, emotions, and feelings, which all build on each other" (Nooteboom et al., 2007:1017). Cognitive proximity between actors makes knowledge sharing more efficient, especially inside an organization. This is captured in the concept of dominant logic proposed by Prahalad and Bettis (1986). In the interest of efficiency, managers inside the organization rely on heuristics which guide their decisions. Such cognitive schemas are also present on industry level, a phenomenon labeled "industry recipe" by Spender (1989). Large cognitive distance has the merit of novelty but may encounter misunderstanding and incomprehension (Nooteboom, 2000). The more rigid in their capabilities and cognition actors are, the higher the costs to bridge cognitive distance (Perez and Soete, 1988). Rigid cognitive structures and low cognitive distance between actors are also likely to increase competency traps (Levitt and March, 1988). Cognitive distance, conversely, may provide complementary knowledge, triggering creativity and fostering serendipity (Boschma, 2005).

Institutional Distance

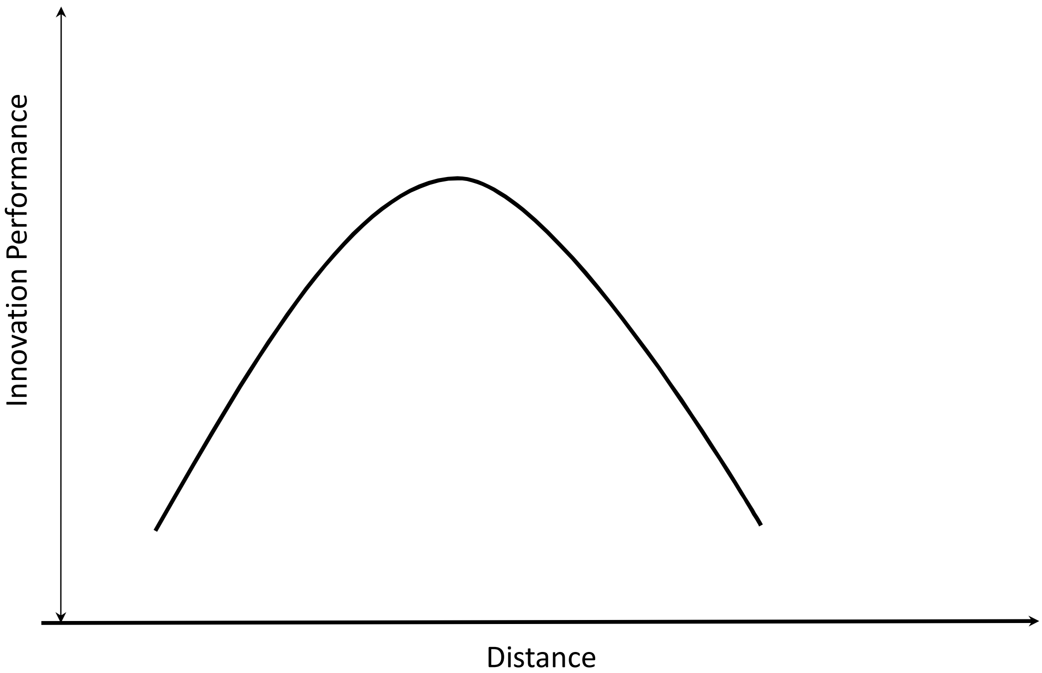
Institutions consist of a formal component, embedded in laws and rules, as well as an informal one, such as cultural norms and values (North, 1990). Together, they are contained in "sets of common habits, routines, established practices, rules, or laws that regulate the relations and interactions between individuals and groups" (cf. Edquist and Johnson, 1997:46). Close institutional proximity between actors decreases the costs of transactions by providing a framework for effective contracting. In addition, shared institutional bases instill understanding and trust, complementing formal forms of transaction. As with other distance effects, close institutional proximity may lead to lock-in and inertia, and leave little room for novel knowledge and associated change. Conversely, high institutional distance may make transactions difficult.

Geographical Distance

Geographical distance can be understood as the "spatial or physical distance between economic actors" (Boschma, 2005:69). Research in the Marshallian industrial district tradition stresses the importance of geographically proximate interaction with regard to innovation, due to the ability of actors for frequent face-to-face interaction, strong social networks and high localized labor mobility (Saxenian, 1994; Storper and Venables, 2004). Advances in ICT have raised doubts as to the continued relevance of geographic proximity, as increasing richness in communication is expected to replace the need for geographical proximity (Friedman, 2007). However, although the distance of novel knowledge and an organization's formal and informal structure should not be used in the geographical sense, geographical proximity is nevertheless a factor in the mitigation of the effects of other aspects of distance, such as technological or institutional distance (Phene et al., 2006; Tallman and Phene, 2007). Geographical proximity facilitates frequent and cost effective rich forms of communication, such as face-to-face. Face-to-face enables the close socialization necessary to transfer tacit knowledge, which couldn't otherwise be codified. At the same time, it fosters trust and mutual understanding and helps to solve incentive problems, an important element of transactions which may not be possible under formalized contracts and under conditions of incomplete information (Roberts, 2000; Storper and Venables, 2002). Since clusters tend to geographically center on a core set of technology, novel knowledge can therefore be expected to originate from geographically distant sources. Since, as Roberts (2000) pointed out, the scope for distant knowledge transfer is still severely limited and may be restricted to highly codified and universally understood knowledge, firms must devise appropriate means of establishing rich communication channels. Ideally, of course such channels consist of human carriers (Allen, 1977; Rosenkopf and Almeida, 2003; Singh and Agrawal, 2008). However, as discussed in chapter 2, the costs of hiring human resources in all relevant fields are prohibitive.

As Boschma (2005) highlights, there is a tradeoff between distance and the firm's ability to integrate and utilize novel knowledge. Therefore, organizations must strike the right balance between knowledge distance, on the one hand, and their ability to utilize distant knowledge, on the other hand. The curvilinear relationship between knowledge distance and innovative performance is captured in figure 12. Table 6 provides an author summary for the theory discussed thus far in this chapter:

Figure - 12 Relationship Between Knowledge Distance and Innovative Performance[13]



[13] Laursen and Salter (2004) found the same curvilinear relationship between searching widely and deeply and innovative performance in a large-scale sample of industrial firms.

Table - 6 Author Summary

Dimension	Explanation	Supporting Authors
High Uncertainty	Technology may lose to other entrants in becoming dominant design. Market size and growth difficult to predict: Even if technology becomes standardized and market is sizable, business model may be ineffective.	*Dosi, 1988; Teece, 1996; ; Chesbrough and Rosenbloom, 2002; Grant, 2005; Teece, 2009; Tidd and Bessant, 2009*
Tacitness	At the early stages of a new technology development, knowledge will be difficult to codify and to transfer. This also creates difficulties in appropriability.	*Polanyi, 1967; Teece, 1986; Nonaka and Takeuchi, 1994; von Hippel, 1994; Brown and Duguid, 1996; Szulanski, 1996; Brown and Duguid, 2000; Nooteboom, 2000*
Technological Distance	Technologically distant knowledge is less compatible with existing technology trajectory but has more innovative potential.	*Henderson and Clark, 1990; Iansiti and Clark, 1994; Chesbrough and Teece, 1996; Benner and Tushman, 2003*
Cognitive Distance	Cognitive distance between actors makes communication more difficult but promotes creativity.	*Perez and Soete, 1988; Nooteboom, 2000; Boschma, 2005; Nooteboom, 2007*
Institutional Distance	Institutional distance, manifest in differences in formal and informal norms and rules, creates scope for creativity. Too much distance, however, makes communication impossible.	*Nooteboom, 2000; Taylor and Osland, 2003; Boschma, 2005*
Geographical Distance	Geographical distance per se no barrier in knowledge transfer. However, geographical proximity can facilitate rich communication and trust to buffer other distance effects.	*Roberts, 2000; Storper and Venables, 2002; Boschma, 2005, Phene et al., 2006; Tallman and Phene, 2007*

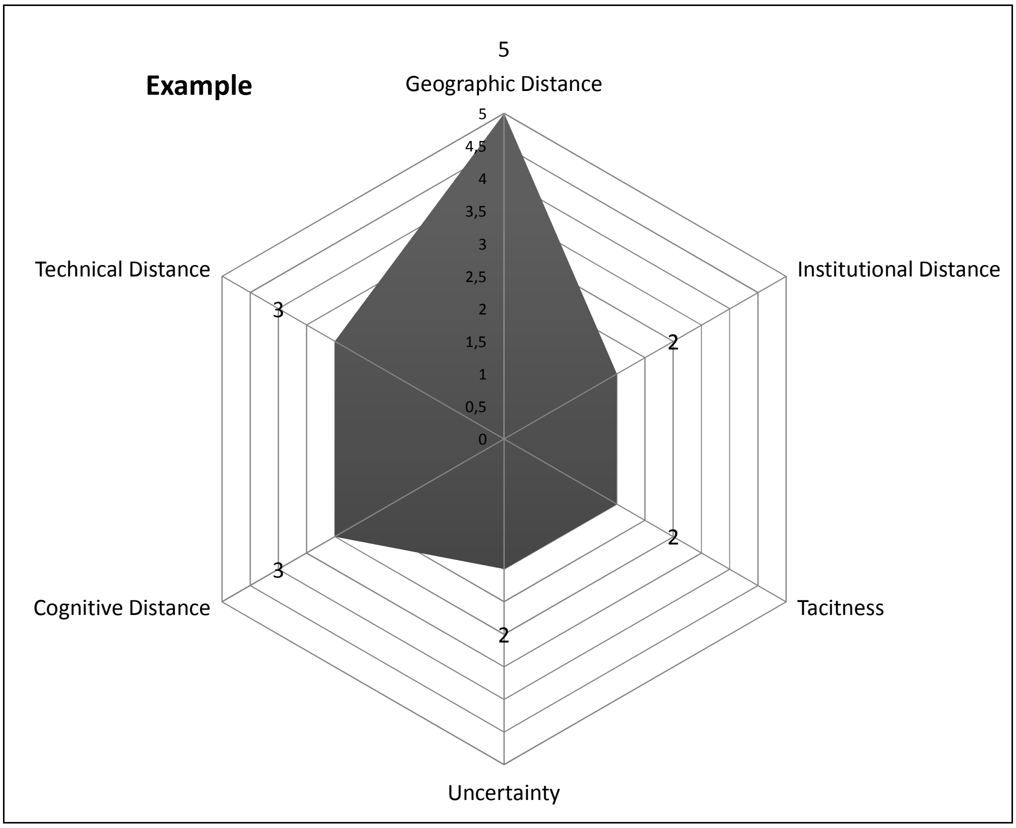
Rosenkopf and Nerkar (2001:289) stress that "technological similarity actually implies a continuum, where some technologies are quite similar, others are somewhat similar, and still others are less similar". They also highlight that "these distinctions are, to a large extent, socially constructed; furthermore, any such boundary between technologies is fuzzy and can evolve with time". For the purpose of data collection and subsequent analysis, this study adopts both the notion that technological similarity, and thus, equally, distance, is not an absolute value in itself, but always relative. For the subsequent empirical analysis, in an effort to enable more thorough within-case and cross-case analysis, this notion is operationalized by attributing a subjective value to the degree of distance between a focal firm and the source of novel knowledge. This is expressed in a scale of one to five. Table 7 summarizes the logic applied to the scale:

Table - 7 Degree of Knowledge Distance/Novelty

Dimension	Scale Logic (1 = Very Low/ 5 = Very High)
High Uncertainty	• Uncertainty of Dominant Design • Opaqueness of Target Market • Opaqueness of Business Model
Tacitness	• Ambiguity/Idiosyncrasy • Language Difference • Richness of Communication Channel Required • Weakness of Appropriability Regime
Technological Distance	• Competence Discrepancy in Underlying Scientific Discipline • Discrepancy in Product Technology • Non-Compatibility with Existing Production Facilities
Cognitive Distance	• Discrepancy in Mental Models and Thought Patterns • Discrepancy in Problem Solving Approaches
Institutional Distance	• Discrepancy in Regulatory Framework • Discrepancy in Informal Rules, Habits and Values
Geographical Distance	• Spatial Distance • Time Difference • Travel Time

For the later analysis, the distance of knowledge to be integrated can be visualized using a radar chart. Figure 13 shows an example in which particularly geographic, cognitive and technological distance are moderate to high:

Figure - 13 Radar Chart of Dimensions of Knowledge Distance



4.3 Organizational Constraints on Innovation

With the rise of the modern corporation, the emergence of the organization required by modern technology and planning and the divorce of the owner of capital from control of the enterprise, the entrepreneur no longer exists as an individual person in the mature industrial enterprise. (cf. Galbraith, 1968)

4.3.1 The Innovation Process in Mature Organizations

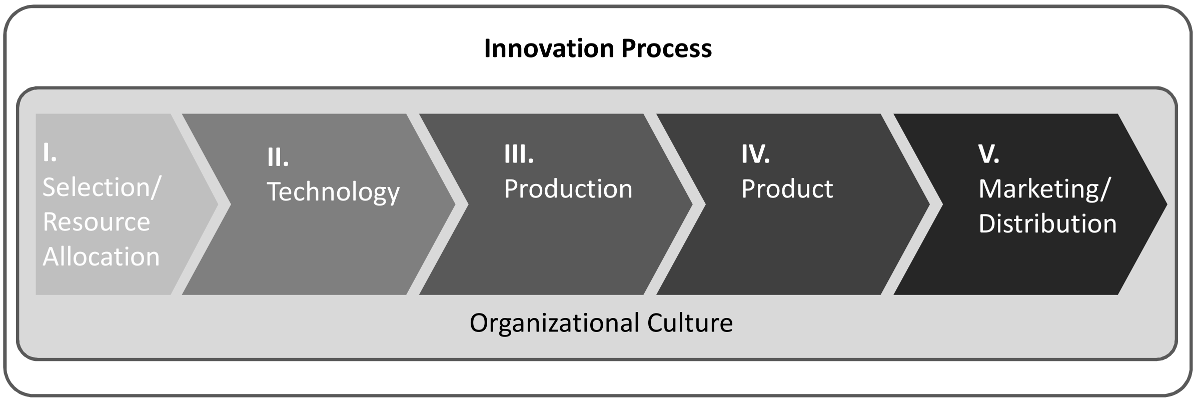
Thus far, the theoretical framework has provided a finer definition of what constitutes the distance inherent in novel knowledge. To an equal extent this chapter intends to provide a finer understanding of the capabilities involved in the matching and utilization of distant/novel knowledge at technology-intensive firms. Teece et al. (1997) defined organizational capabilities as the combination of routines, processes, systems and structures. Organizational capabilities, in essence, are therefore bundles of aspects of a complex organization, which are unified by a purpose and the goal of achieving a particular objective (McEvily and Marcus, 2005). In commercial organizations, an overriding goal is likely to consist of profit maximization, which naturally explains the strong tendency of firms to efficiently exploit current assets and protect short-term revenue streams.

This would also explain that, as organizations mature, they become subject to increasing path-dependence. As stressed earlier, path-dependence is manifest in lock-in in the existing technological trajectory (Dosi, 1982), which moves to a dominant design (Bettis and Prahalad, 1986). Routines become increasingly efficiency oriented, with a focus on process innovation, which makes firms prone to "core rigidities" (Leonard-Barton, 1991), or competency traps (Levitt and March, 1988). The way organizations organize their value-creation processes, in other words, their business model, also becomes increasingly entrenched with progressing maturity (Chesbrough and Rosenbloom, 2002; Chesbrough, 2006; Teece, 2009). Competition is increasingly fierce, and companies aim their products at the top-end of the customer base, attempting to gain short-term competitive advantage by introducing more and more incremental feature improvements (Christensen, 1997). Compounding this trend, organizations are becoming increasingly self-similar, in a process of organizational isomorphism. Thus, new products and practices are replicated because of institutional pressures, rather than rational choice (DiMaggio and Powell, 1983). "Industry recipes" govern collective code of conduct, heuristics, and decision-making processes (Spender, 1989). The informal organization and culture, too, becomes increasingly self-similar. This is the general consensus view of how organizations evolve from exploration to exploitation focus.

With regard to innovation processes, these dynamics are evident at all stages of the process from selection to commercialization. In combination the impact of path-dependence and its manifestation in innovation processes also affects the search behavior of firms. Search processes tend to organize themselves according to the optimality of the existing technological and organizational architecture (Cohen and Levinthal, 1990: Henderson and Clarke, 1990; Rosenkopf and Nerkar, 2001). External knowledge sources will thus commonly consist of actors in the immediate environment of the firm, such as suppliers, universities, or buyers (Cohen and Levinthal, 1994; Stuart and Podolny, 1996). Local search leads incumbents to introduce designs that are similar to those incorporated in their existing products (Martin and Mitchell, 1998). Thus, firm's search activities perpetuate technological and organizational path-dependence and contribute to incremental product and process improvements.

This chapter will use an innovation process view in order to illustrate the effects of firm maturity on each step in a generic innovation process. Such an innovation process will serve to highlight the impact on decision making more immediately, particularly considering the innovation process view applied in the empirical part of this thesis.

Figure - 14 Generic Innovation Process



Source: Own

4.3.2 Selection/Resource Allocation

In mature industries, the focus on efficiency and lean processes demands considerable scale. Such scale in turn requires strong division of labor and specialization (Mowery, 1983; Teece, 1996). The associated hierarchy to govern such complex division of labor is detrimental to radical search in several ways:

Principal Agent Distortions/Low-powered Incentives

In small start-ups, the owners have a strong personal attachment to the invention, beyond commercial motives (Freeman and Engel, 2007; Harryson, 2007). In larger incumbents, however, managers are likely to trade-off overall business performance for personal gain (Teece, 1997). Personal gain in large incumbents is mostly associated with career progression, which affects compensation only in the long-term. Otherwise, there is no or very low co-variance with employee compensation and business unit performance, a condition described by Williamson as "low-powered incentives" (Williamson, 1985:153). This is insofar detrimental to innovation as short periods of tenure militate against longer-term innovation projects and investment without short-term return. In addition, managers are likely to avoid the risk associated with innovative projects and favor less risk-prone, "safe bets" consisting of more incremental improvements (Dushnitsky and Shapira, 2008).

Budgeting/Control

The budgeting process in mature incumbents is tied to the financial reporting cycle (Freeman and Engel, 2007). This impedes flexible and fast resource allocation, in particular when costs cannot be accurately projected from the outset of an innovation project, which is highly likely with more radical innovations. Further, controlling mechanisms will factor in the considerable sunk costs into cost/benefit calculations. These sunk costs are likely to be high in large and mature organizations due to considerable investment into production and distribution facilities. Managers may make the mistake of confusing accounting-based depreciation with real economic depreciation and conclude that a business is still profitable when it isn't anymore. In addition, traditional budgeting and control doesn't take into account the opportunity costs of *not* doing a project (Christensen et al., 2008; Teece, 2009). Thus, budgeting and control which is applied to the existing business strangles innovation since search within the existing trajectory may seem more profitable since it utilizes existing assets (Kanter, 2006).

Anti-cannibalization bias

Technology or knowledge from novel domains often threatens the status quo. This applies both to the existing managerial power structure, as well as the technological regime. Managers feel threatened if new, potentially discontinuous technology looks likely to make their skill set obsolete. In the same vein, technology can potentially render existing production and distribution structures obsolete, exacerbating the anti-cannibalization bias. (Freeman and Engel, 2007; Tidd and Bessant, 2009).

Bureaucracy and Political Distortions

Donald Schon (1963) addressed the political dimensions of barriers to innovation as well as the slow decision making resulting from bureaucracy. In addition to formal and objective structures for decision-making, mature firms display political constellations which may impede innovation efforts due to subjective decision-making, for instance, based on particular power alignments behind an innovation effort (Pettigrew, 1974; Van de Ven, 1999).

4.3.3 Technology

As the technology, the surrounding skills and capabilities mature, they become increasingly standardized and codified. Codification aids distant communication, but also increases the risk of spillover. This enables the sourcing of non-core technology tasks through the market, but it also requires more formal contractual arrangements as transaction with external actors is less trust-based and more distant. The focus on efficiency reduces the number of external actors to an optimum by reducing redundant ties (Gilsing and Nooteboom, 2004). Thus, firms outsource tasks which are considered peripheral and they thus focus on "core competencies" (Prahalad and Hamel, 1990). The downside of core competencies is that an exclusive focus on them causes lock-in, turning them to core rigidities (Leonard-Barton, 1992). At the same time, the external network remains reduced to those actors with immediate relevance for the existing operations. Thus, maturity leads to standardized products which leave only little room for incremental improvement. The more standardized, perceived non-core activities are outsourced, the less scope there is for improvement, let alone innovation.

4.3.4 Production

Focus on Process Innovation

In Abernathy and Utterback's (1978) innovation lifecycle model, product innovation shifts to process innovation. Products or technologies have attained a dominant, standardized design, which restricts product innovation to incremental improvement. Further, as products and technologies have become standardized, new entrants intensify competition. Increased competition exerts pressure on price, which demands lean, efficient processes, in particular in production and distribution (Gilsing and Nooteboom, 2004). A focus on efficiency entails considerable routinization and formalization of activities inside the firm.

Routinization

The role of routines as the most central repositories of acquired knowledge from an organization's experience (Levitt and March, 1988) has been most prominently highlighted in the work of Nelson and Winter (1982). Routinization creates sequences of tasks that require relatively little attention and ensure that inputs are transformed into outputs. Employees that execute routine tasks only deal with a few exceptions and a narrow range of problems; therefore, routinization limits the search for new external knowledge and narrows the scope of information processing (van den Bosch et. al, 1999). Routinization can lead to "competency traps", i.e. when favorable performance with an inferior procedure leads an organization to accumulate more experience with it, which makes experience with a superior procedure less rewarding to use (Levitt and March, 1988:323).

Formalization

Formalization denotes the extent to which such routines are formally documented. Documentation entails significant restriction in terms of frame of reference, and will constrain behavior which will deviate from formalized routines and rules. Moreover, "*formalization also inhibits rich, reciprocal knowledge interaction and hinders individuals' assimilation of new external knowledge. Accordingly, formalization negatively influences acquisition and assimilation of the new external knowledge"* (Jansen et al., 2005:1002). Routines tend to become institutionalized and assume "taken-for-granted" status, and are at times de-coupled from decisions merely based on rational choice. Their taken-for-granted status prevents managers from questioning the underlying logic inherent routine, which leads to "single-loop learning" (Argyris and Schön, 1978), which reinforces the existing technology/organization/market trajectory and makes managers oblivious to developments which do not fit with these routines.

Diffusion of Process Management to other Parts of the Organization

Since the late 1970s, process management techniques associated with production and efficiency have extended to all parts of the organization. Process management ideology and techniques have also reached research and development processes, more recently with tools adapted from financial risk management, such as portfolio management techniques. Eventually, this led to the adoption of sophisticated measurement and filtering tools, stage-gates processes and, increasingly, portfolio management concepts which had been adapted from financial controlling tools (Cooper and Kleinschmidt, 1986). In essence, these measures aim to improve transparency, facilitate identification of projects with high potential early on and enable the killing of weak projects before development costs escalate. However, process management techniques and ideologies are highly inimical to anything but incremental improvements and crowd out search and exploitation of more radical innovation (Abernathy and Utterback, 1978; Benner and Tushman, 2003).

4.3.5 Product

After the invention of a new technology, imitators create various alternative designs. A high number of actors enter the market, with high failure rates. Eventually, a dominant design, or standard[14] emerges, leading to shake-out, and later, consolidation to few players. The time until a dominant design emerges varies according to industry. It took roughly 20 years for a dominant automotive design to emerge. Conversely, dominant designs for social network websites may emerge in a matter of one year or several months. As the know-how for standard technology and products is widely dispersed, differentiation advantages erode, forcing incumbents to differentiate themselves through marketing and/or price (Porter, 1985).

[14] "A standard is a format, an interface or a system that allows interoperability" (Grant, 2005:346).

4.3.6 Marketing and Distribution

As organizations, their routines, methods and products mature, so do their markets. Inasmuch as organizations become locked-in in decision-making heuristics and process improvement focus, do they eventually become locked-in in a vicious circle of marketing based on differentiation and/or cost (Kim and Mauborgne, 2005). Mature organizations have mature markets, which entail considerable segmentation, and not only in one or few markets, but often on a global scale. Christensen (1997) argued that established firms increasingly aim their product offering at the top end, most sophisticated segment of the market in order to marginal differentiation. Product specifications are based on extensive, predominantly quantitative market research. However, as von Hippel (1994) noted, existing customers develop a so-called "functional fixedness" with regard to products, i.e. their usefulness in predicting new product demands is restricted to the extant specification of a product or technology and its usage. Being dependent on large volumes required by the growing size of their operations, large firms apply innovation screening criteria which reflect such a market size. For instance, large consumer products firms applied screens requiring several hundred million dollars of revenues within two years of launch (Kanter, 2006). Overloading products and technology with features which are high-cost to make and cater only to the absolute top-end of the market further opens opportunity for creative destruction by smaller suppliers with less sophisticated offerings and more competitive price. The example of Nintendo Wii is a point in case. The top three game console manufacturers were interlocked in a spiral of ever-improving product specifications and marginal price reduction which significantly eroded margins. Nintendo, close to being forced to exit the market, realized the potential for a much simpler, lower-cost games platform aimed at an entirely different market segment than the traditionally targeted hard-core gamers (Lampikoski, 2009).

4.3.7 Organizational Culture, Mental Models and Biases

Organizational Culture

In addition to the formal parts of an organization, the informal organization plays an important role in constraining incumbents' ability to search and transfer novel knowledge. Formal and informal organization are likely to be mutually reinforcing. Hofstede (1980:43) defined culture as "the collective mental programming of the people in an environment". Organizational culture, therefore, could be described as the shared pattern of beliefs and thought patterns of its members (Schwartz and Davis, 1981:33). It is manifest in language, attitudes, mental models, rituals, norms and values. Organizational culture evolves in tandem with the formal organization, but not necessarily at the same speed.

Socialization

An organizational culture is formed through socialization tactics to structure shared socialization experiences (cf. Ashforth and Saks, 1996). Socialization tactics hamper the ability to tap into new external knowledge sources (Cohen and Levinthal, 1990) and impede a unit's ability to acquire and assimilate new external knowledge. On the other hand, socialization tactics enhance the combination of newly acquired and existing knowledge through facilitating "bisociation" among unit members, which entails the ability of actors to recognize two apparently incongruous sets of information and combine them to arrive at a new schema (Zahra and George, 2002:190).

Socialization mechanisms ensure that new members of the organization are socialized and conform to the cultural norms inside the organization (March, 1991). The dominant cultural norm, or dominant logic (Prahalad and Bettis, 1986) is powerful influence on decision making inside the organization. It influences heuristics that may even go beyond the individual firm to an entire industry, in the form of industry recipes (Spender, 1989). In such as case, managers are shaping, and being influenced by an industry, in a process of organizational isomorphism, certain practices diffuse within an industry based on social pressure, rather than pure rational choice (DiMaggio and Powell, 1983). A strong dominant logic prevents managers to question the underlying rationale of taken-for-granted norms. Thus, learning is consigned to "single-loop" learning (Argyris and Schon, 1978) inside the current dominant logic. More radical learning is suppressed by these mechanisms, posing a considerable barrier to radical search and subsequent commercial exploitation.

Language and Coding Schemes

Organizations develop their own specialized language, symbols, metaphors (Nooteboom, 2000). Such a common language, or as Allen and Cohen (1969) referred to it, common coding schemes, greatly improve the efficiency of internal communication. Yet they also create a trade-off since they inhibit communication from others outside the organization (Cohen and Levinthal, 1990). In the extreme, an internal language, coding scheme, or more generally, any particular body of expertise could become sufficiently overlapping and specialized that it impedes the incorporation of outside knowledge.

Mental Models and Biases

As part of the growing cultural homogeneity inside the organization, individuals develop certain biases, and to some extent, a "citadel mentality" (Teece, 1996:275). Katz and Allen (1982) showed how such biases, particularly to the outside of the organization, emerge after a certain time period of continuous project tenure. Individuals develop an exaggerated self-efficacy which leads them to undervalue information which comes from outside of their social system. Katz and Allen (1982) referred to this phenomenon as the Not-Invented-Here Syndrome (NIH) (see also Lichtenthaler and Ernst, 2006). According to Katz and Allen (1982:7), NIH describes the phenomenon where "a group of engineers whose membership has been relatively stable for several years may begin to believe that it possesses a monopoly on knowledge in its area of specialization. Such a group therefore does not consider very seriously the possibility that outsiders might produce important new ideas or information relevant to the group”. These problems are exacerbated in the presence of continuous free cash flows (Teece, 1996) - a common condition in the heyday of the corporate R&D lab. Hence, powerful and successful organizations or technical leaders are often less inclined to learn from their mistakes (Levitt and March, 1988), and less adept at reacting to sudden changes in the environment. Further, research within the organizational learning stream has highlighted that decision makers are boundedly rational and depend on heuristics for decision-making (March and Simon, 1958) often at the detriment of revising underlying assumptions (Cyert and March, 1963). The contributions describing the constraints facing an incumbent organization with regard to change and adaptation and the main contributing authors can be summarized as follows:

Table - 8 Author Summary

Innovation Process Step	Dimension of Innovation Constraint	Author (s)
Search	- Mature firms restrict their search activity to areas close to their existing knowledge base.	*Cohen and Levinthal, 1990; 1994; Henderson and Clark, 1990: Henderson and Cockburn, 1994; von Hippel, 1994; Stuart and Podolny, 1996; Martin and Mitchell, 1998; Rosenkopf and Nerkar, 2001; Birkinshaw et al., 2007.*
Selection	- Managers act risk-averse and favor incremental innovation over more radical, high-risk projects. - Budgeting has a bias toward current business activity. - Anti-cannibalization bias	*Williamson, 1985; Teece, 1996; 2006; Kanter, 2006; Freeman and Engel, 2007; Dushnitsky and Shapira, 2007.*
Production	- Business focus has shifted to process improvement entailing high routinization and formalization.	*Abernathy and Utterback, 1978; Argyris and Schön, 1978; Levitt and March, 1988; Abernathy, 1994; van den Bosch, 1999; Benner and Tushman, 2003; Gilsing and Nooteboom, 2004, Jansen et al., 2005*
Technology	- Dominant design has emerged - Standardization and commoditization of technology - Non-core tasks are being outsourced resulting in core rigidities	*Dosi, 1982; Leonard-Barton, 1992; Gilsing and Nooteboom, 2004.*
Marketing	- Cost leadership or differentiation strategy - Increased segmentation - Market lock-in	*Von Hippel, 1994; Christensen, 1997; Kim and Mauborgne, 2004.*

Organizational Culture	- Organizational language, codes and values increasingly homogeneous - Non-rational biases develop, such as not-invented-here syndrome	*March and Simon, 1958; Cyert and March, 1963; Allen and Cohen, 1969; Argyris and Schon, 1978; Katz and Allen, 1982; DiMaggio and Powell, 1983; Hannan and Freeman, 1984; Prahalad and Bettis, 1986; 1995; Levitt and March, 1988; Spender, 1989; Cohen and Levinthal, 1990; March, 1991; Nooteboom, 2000; Lichtenthaler and Ernst, 2006.*

4.4 The Technological Gatekeeper

For the several employments and offices of our fellows, we have twelve that sail into foreign countries under the names of other nations (for our own conceal), who bring us the books and abstracts, and patterns of experiments of all other parts. These we call Merchants of Light.
We have three that collect the experiments which are in all books. These we call Depredators.
We have three that collect the experiments of all mechanical arts, and also of liberal sciences, and also of practices which are not brought into the arts. These we call Mystery-men.
We have three that try new experiments, such as themselves think good. These we call Pioneers or Miners.
(cf. Sir Francis Bacon, in "The New Atlantis")

4.4.1 Introduction

The last two sections have provided an overview of the literature on "distance" of knowledge and the sources of path-dependence inherent in the innovation process of mature, technology-intensive firms. This section concludes the chapter with a review of a mechanism to overcome some of the path-dependence. In their 2003 article, Rosenkopf and Almeida investigated the suitability of alliances for overcoming local search bias. They found a strong predominance for local search bias in alliances and suggested that mobility of individual knowledge carriers such as engineers and scientist enables knowledge transfer regardless of distance. In this section, a more recently somewhat neglected mechanism for overcoming local search bias is reviewed. The technological gatekeeper literature describes the behavior of individual engineers or scientists which display high communication activity inside as well as outside of their organization. In so doing, they are able to mediate highly valuable knowledge from outside of the organization to the inside. As the following review demonstrates, gatekeeper behavior in the classical sense does not extend to knowledge which is both outside the organizational *and* technological context, and thus, perpetuates path-dependence and local search bias. However, the gatekeeper literature provides compelling empirical evidence, using innovative social network analysis. Thereby, the gatekeeper literature provides a meaningful precedent with regard to the micro-foundations involved in matching external knowledge with internal routines on which to base further investigation in the empirical part of this study.

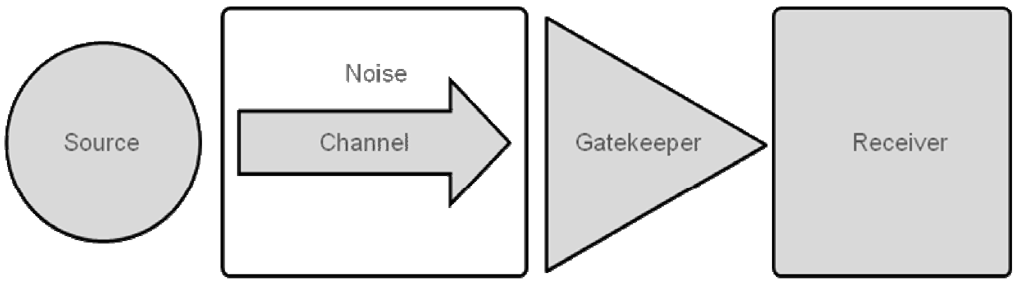
The following section provides a detailed review of the classic technological gatekeeper literature. It highlights the assumptions underlying the conceptualization of the construct, describes the characteristics of gatekeepers identified, and contrasts them with the current open or dispersed forms of innovation. This review provides some propositions as to how novel knowledge can be matched with existing routines. Together with the insights developed in the first and second part of this chapter, they will form the basis of data collection and analysis.

4.4.2 Technical Communication in R&D

Thomas Allen (1964) recognized early on that R&D is an ardent consumer of information and knowledge. Based on this insight, he attached the understanding and explanation of the flow of technical information foremost priority. Little research existed in the area of R&D management until the 1960s and all researchers had to go by was anecdotal, biographical or purely technical work (Freeman, 1991). Thus, Allen took his cue from research on mass communication (e.g. Lazarsfeld et al., 1948; Katz and Lazarsfeld, 1955; Katz, 1960; Coleman et al., 1966).[15]

The term 'gatekeeper' was first applied in a communication theory context by the social psychologist Kurt Lewin. Lewin (1947) had developed a theory of 'channels and gatekeepers' to understand how to produce widespread social change in communities. Observing the eating habits of families, he assumed that the entrance to a channel and to its sections is a "gate" and that the movement within and between the channel and its external environment is controlled by one or more "gatekeepers" which could consist of socially influential individuals or, alternatively, a set of rules (Lewin, 1947). In so doing, Lewin applied a basic communication model to social systems. His conceptualization is consistent with early communication process theory, such as Shannon and Weaver's sender, channel and receiver model (1949)[16].

Figure - 15 Classic Communication Model with Gatekeeper



Source: Own

---

[15] This area of research identified the role of high-status and high-trust individuals, opinion leaders, who were key to the diffusion of mass communication. Katz and Lazarsfeld (1955) refuted the hypodermic needle model, which assumed the effects of mass communication to be direct and instead found evidence for human agency in the spread of mass communication.

[16] This may be an oversimplification of their model; in its entirety it covers sender, message, transmission, noise, channel, reception and receiver. In any case, despite being widely recognized as the foundation for information theory, their model is rooted in a technical conceptualization of communication. In social systems, communication is less linear and the complications in transmitting messages without considerable ambiguity substantial.

4.4.3 The Classic Conceptualization of the Technological Gatekeeper

Innovation Sources

In his seminal book "Managing the Flow of Technology" from 1977, Allen described the information-seeking patterns in the early, idea generating phase of research as primarily directed toward local search for technical problem solving. The sources of technical information he found included internal, formal sources such as journals, reports, books, as well as informal, personal contacts. He discovered that a greater number of problem-solving ideas came from outside the organizations than all other internal sources combined. Among these outside sources he counted customers, vendors, consultants, government, universities and non-profits.

Communication Boundaries (Noise)

However, he had also discovered that the positive effect on performance (as a corollary of improved problem-solving) and performance achieved through utilization of external information sources produced a curvilinear function (Allen, 1966). Thus, performance in fact decreased as more external sources were used. This effect, he reasoned, stemmed from a mismatch in coding schemes between sources from outside the organization and the prevailing coding schemes inside the organization. In a 1971 working paper, Allen, Piepmeyer and Cooney further identified national differences as a communication boundary in international technology transfer to developing countries[17] (see also Cooney and Allen, 1974). Tushman (1977) further elaborated on communication boundaries, arguing that intra-organizational communication boundaries are apparent between different R&D units, between R&D and other functions, in addition to extra-organizational to intra-organizational boundaries. These boundaries, he argued, arise due to idiosyncratic norms, values, time schemes, language, and coding schemes. Allen (1966) first proposed and was then able to prove (Allen and Cohen, 1969) that these communication boundaries could be overcome by human nodes in the technical communication process capable of translating between these schemes – *technological gatekeepers.* After having been introduced by Allen in 1966, Allen and Cohen (1969:13) defined technological gatekeepers as those individuals who "occupy key positions in the communication network of the laboratory; that is, those to whom others in the laboratory most frequently turn for technical advice and consultation, [and who] will show more contact with technical activity outside of the laboratory". Based on the literature review, a more differentiated picture emerges:

Characteristics of Technological Gatekeepers

Technological gatekeepers are not an organizational function but individual engineers or scientists who display significantly higher levels of communication both to others inside the organization as well as outside the organization. Although individual gatekeepers may be connected to other internal gatekeepers (Allen, 1970), they do not form a function or are in any other way coordinated in order to achieve a

[17] In this instance, Ireland.

particular division of labor. Further, these individual gatekeepers attain their gatekeeping status by virtue of superior technical skill and knowledge. This skill enables them to access and understand external sources of information which would otherwise be incomprehensible to the rest of the R&D unit (Allen and Cohen, 1969; Allen, 1970; 1977). Their specialization further predicates them as a valuable source of consultancy for internal colleagues. Gatekeepers, Allen and Cohen (1969) held, arise spontaneously rather than through official designation by management, which was also later supported by others (Frost and Whitley, 1971; Hall and Ritchie, 1975). Allen, Tushman and Lee (1979) further argued that the formal reward systems and career progression had a detrimental effect on the presence of gatekeepers, due to the conflict in incentives inherent in knowledge sharing as opposed to furthering one's career. Adequate incentivization of gatekeepers, thus, has also been reason for much discussion. Allen and Cohen (1969) emphasized the discrepancy between the considerable benefit from gatekeeping activities accrued to the organization and the lack of recognition by management. Apart from largely general recommendations to create appropriate incentive mechanisms (e.g. Tushman 1977), little is offered in the classic gatekeeper literature in terms of prescription how the *intrinsic* motivation of gatekeeper could be supplemented.

Allen and Cohen (1969) had initially derived that status and prestige of gatekeepers had a positive influence on the flow of information, based on the finding that 8 out of 10 gatekeepers were at the same time first-line *supervisors*. In the same vein, Frost and Whitley (1971), drawing on UK-based data argued that supervisor status was the decisive determinant of the degree of gatekeeper status of an individual, since hierarchy brings a certain amount of external contacts with it. Another replication study undertaken in the UK by Hall and Ritchie (1975) confirmed this result. Taylor (1975; Taylor and Utterback; 1975) on the contrary, controlled for supervisory status and found technical competence as the underlying determinant for gatekeeping status, which may also imply that in terms of causality, technical gatekeepers are competent and thus often promoted to supervisory status. Taylor (1982) later returned to the same site and was able to prove that gatekeepers had retained their gatekeeping status despite organizational changes, which would have disrupted their supervisory status. Tushman and Scanlan (1981a) also found that supervisory status was neither necessary nor sufficient for attaining gatekeeper status. In a second paper (Tushman and Scanlan 1980b), they reasoned that supervisory status was contingent on the nature of the task for which information was sought. In routine tasks of operational nature, supervisors were likely to assume gatekeeper roles, whereas in research environments with highly specialized but dynamic information, individual, direct contact was more important (Tushman and Scanlan, 1981b). They also found that gatekeepers were not restricted to hierarchy, but that in fact 68 percent of the gatekeepers identified in their sample consisted of bench-level scientists and engineers. This, they reasoned was due to the fact that technical competence was the most important antecedent of gatekeepers.

Information Transfer Process

Having discovered the role of technological gatekeepers in overcoming communication boundaries, Allen and Cohen (1969) characterized gatekeeping as a two-step process, consisting of search and transfer. Later, however, Tushman and Katz (1980) suggested that the gatekeeping process is not merely a one-way process, but also works in the sense that gatekeepers act as a channel for search requests by internal colleagues. In a later article, Katz and Tushman's (1981) added that gatekeepers who were at the same time managers, not only gathered and disseminated external information, but also improved the external interface of their engineering subordinates by helping to direct, coach and interpret their external communications.

The Locus of the Technological Gatekeepers

Tushman (1977) made a distinction between different roles for information processing in different stages of the R&D process. He stressed that the early, idea-generating phase was the most dependent on external information, whereas subsequent stages required closer coordination with internal stakeholders, such as production and marketing. Tushman further highlighted how the nature of the task for which information was sought determined the information seeking process. Tasks of idiosyncratic and tacit nature require hierarchical information channels or technological gatekeepers, whereas information for more universal tasks could be accessed through direct contact. Scientists, for instance use direct contact to communicate with their "invisible college" which transcends organizational or communication boundaries (Allen, 1977). Allen et al. (1979) subsequently found that the level of technological turbulence was another determinant of the information channels used[18]. Technological gatekeepers as information channels are appropriate when technology is turbulent and the task tacit or 'local'. These findings were later supported by Brown and Utterback (1985), who found that under conditions of high levels of uncertainty, people in research and development organizations will seek more contacts outside of their organization while conversely, in organizations with low levels of uncertainty, information mediation will be carried out by the formal hierarchy. De Meyer (1984) regarded technological turbulence and task locality as a product of an organization's stage in its lifecycle. At an early growth stage of the organization, he too found that direct contact to outside sources was more prevalent, whereas in later, mature stages stable architectures demanded more hierarchically controlled exchanges with well-defined outside sources.

Internal Network

With regard to the internal transfer aspect of the gatekeeping process, Allen (1970) stressed the positive effect of facilitating informal communication networks on information sharing in R&D units. Further, he found a strong correlation of geographic distance on the probability of communicating with other R&D

[18] This is consistent with Burns and Stalker (1961), who suggested more organic organizational structures when the environment is less stable and Lawrence and Lorsch (1967) who proposed that organizations in turbulent environments require a higher use of integrating roles and departments.

members. He had also found that gatekeepers inside the organization frequently communicate amongst each other, forming a network of gatekeepers. Tushman and Katz (1980) and Katz and Tushman (1981) highlighted that gatekeepers are often used by local colleagues as a channel for finding solutions to a particular problem from the outside. Revisiting the same data set later, Katz and Tushman (1983) were able to demonstrate that engineers working under a gatekeeper who was at the same time a supervisor were more likely to progress their career. Table 9 summarizes the key insights about technological gatekeepers from the literature:

Table - 9 Summary of the Classic Technological Gatekeeper Concept

Dimension	Characteristic	Author(s)
Information Sources	• Journals • Reports • Books • Vendors • Universities • Customers	*Allen, 1964; Allen; 1970; Allen, 1977*
Communication Boundaries	• Coding schemes • Norms • Values • Time schemes • Language	*Allen, 1966; Allen and Cohen; 1969; Allen, 1970 Allen et al., 1971; Cooney and Allen, 1974; Tushman, 1977*
Gatekeeper Characteristics	• Highly technically competent individuals • Specialists • Arise spontaneously, not designated role • Intrinsically motivated • High status	*Allen, 1969; 1970; 1977 Allen and Cohen, 1969, Frost and Whitley, 1971; Taylor, 1975; 1982, Hall and Ritchie, 1975; Tushman, 1977; Allen et al., 1979; Tushman and Scanlan, 1981a; Taylor and Utterback, 1985*
Information Transfer Process	• Search and transfer • Mediating search requests from internal colleagues	*Allen and Cohen, 1969; Allen, 1970; Allen; 1977; Tushman and Katz, 1980; Katz and Tushman, 1981*
Locus of Gatekeeper	• Early, idea-generating phase of innovation	*Allen, 1977; Tushman, 1977; Allen et al., 1979; De Meyer, 1984; Brown and Utterback, 1985*

Internal Network	• Other gatekeepers • Informal network	*Allen, 1970; 1977 Tushman and Katz, 1980; Katz and Tushman, 1981*

There is little treatment of the technological gatekeeper concept in recent studies. Cohen and Levinthal's 1990 article incorporated the concept, appointing it a central role in the facilitation of absorptive capacity; however their treatment of gatekeepers is brief. Nochur and Allen (1992) found that formally assigned gatekeepers do well in respect to connecting with the source of new technology, but fail to disseminate knowledge gathered to the relevant receptors in the central R&D unit, concluding that gatekeepers should either already be well connected to their receiving audience, or have high technical competence and support by top management to build strong networks internally and externally. MacDonald and Williams (1993) addressed the intrinsic motivation of gatekeepers. They suggested that gatekeeping consisted of opportunistic information acquisition for personal benefit, with dissemination to colleagues as a reluctant by-product. Harada (2003) added the notion of transformation to the two-step process proposed by Allen and Cohen (1969). Cranefield and Yoong (2007) proposed a stronger task division within the gatekeeper role.

Some studies have also addressed the impact of advances in IT on gatekeepers. Ettlie and Elsenbach (2007) argued that due to changes in communication media, gatekeepers are no longer primarily first line supervisors, but increasingly bench and engineering staff. One study from the German tradition of the champion/promotor literature stream (Hauschildt and Schewe, 2000) attempted to integrate gatekeeper and champion/promotor concepts in order to enable 'Organizational agility', yet their contribution only provides a very basic treatment of the gatekeeper concept. Another study in the same tradition (Gemuenden et al., 2008) alluded to the effect of open innovation on innovator roles such as the gatekeeper and champion, yet this is neither reflected in their conceptualization of those roles nor in the research design.

While the technological gatekeeper concept seems to be consigned to relatively little research activity, similar concepts continue to be discussed and developed. In particular, the concept of boundary-spanners has more recently expanded on the idea of the technological gatekeeper. For instance, Carlile (2004) developed an integrative framework for transferring, translating and transforming knowledge across boundaries in the context of new product development. He also provided a conceptualization of this process which aligned the complexity of boundaries with correspondingly complex communication process. Kellogg et al. (2006) studied how, in an interactive marketing organization, members of different communities conduct boundary-spanning tasks. They found that members of these communities make their work visible and legible to each other, thereby enabling on-going revision and alignment. Although the literature on boundary-spanners and related concepts such as knowledge mediators or brokers shares insights and may offer additional insights not yet covered in the technological gatekeeper literature, this review will be restricted to the technological gatekeeper concept. This is done due to the consistence in empirical research methods, terminology, and relevance for technology and innovation management, which is not always given with other strands of research such as the boundary spanners. The results of this study, however, may nevertheless be equally interesting to scholars looking at these related concepts.

In summary, the "classic" technological gatekeeper is an individual with high competence in his[19] field of specialization. His competence allows him to understand different coding schemes which he is able to translate and transfer to his colleagues, as well as to other gatekeepers inside the organization. At the same time, internal colleagues use the gatekeeper to search for internal problems externally. His high level of competence often entails promotion. However, the gatekeeper is neither formally assigned nor rewarded by top management. The importance of gatekeepers is contingent on organizational characteristics as well as the characteristics of the particular development for which information is sought. For organizations which operate under turbulent technological conditions, direct contact by R&D members to external sources may be more appropriate. Organizations which operate under stable technological conditions should have more routinized, hierarchy-driven information processes. Also, when a task is highly tacit, either hierarchy or gatekeepers are the appropriate information channel. Information for universal tasks can also be accessed through direct contact.

4.4.4 Technological Gatekeepers in the Context of Distant Search

Technological Gatekeepers remain an important mechanism through which R&D organizations economize on external information seeking within the existing technology trajectory, particularly in large technology-intensive organizations. Gatekeepers emerge as part of the organization's informal communication network, which seeks to organize itself according to the optimality of the existing technological and organizational architecture (Henderson and Clarke, 1990). However, technological gatekeepers restrict their search and transfer activities to areas close to the existing technological trajectory and organizational structure. Gatekeepers thus do not reach beyond technological and organizational boundaries to identify sources for more radical innovation and reinforce organization and technical path-dependency (Rosenkopf and Nerkar, 2001).

The previous chapters highlight the importance of innovation search activities, in particular the increasing criticality of distant search, which entails looking outside of the organization and outside of the existing technical domain and the current source for information or knowledge. Further, the previous sections present the nature of information lying outside of existing search channels. Such knowledge becomes more tacit, uncertain and distant, the more it is removed from the current knowledge base. Search and

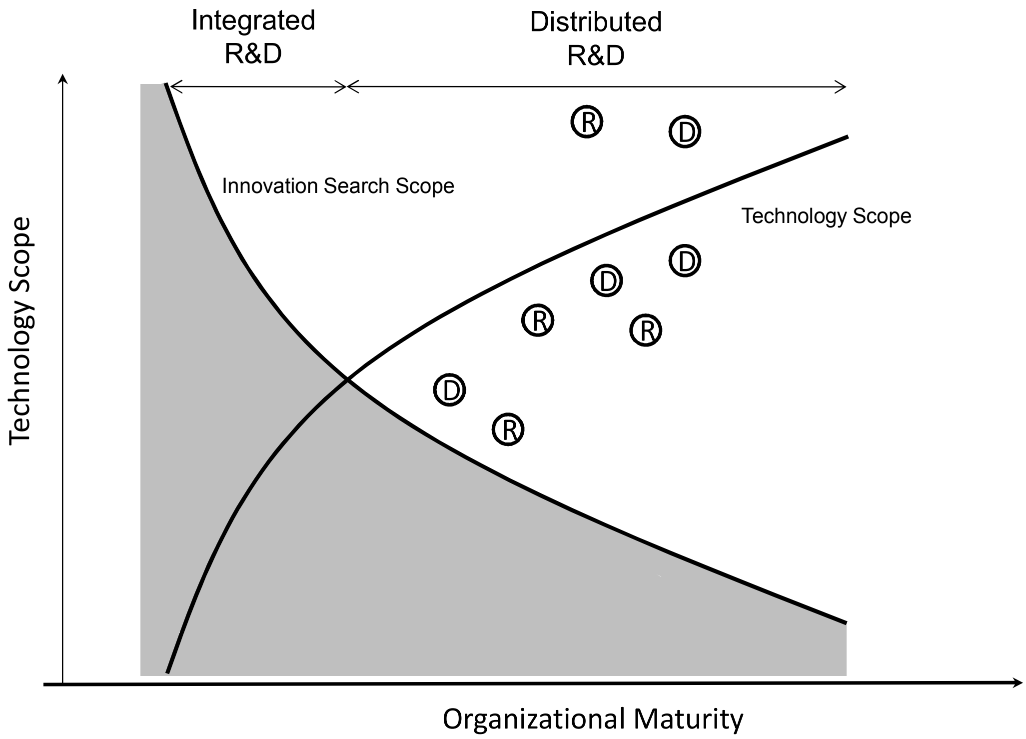
[19] The masculine pronoun "he" is here used to denote both the masculine as well as the feminine pronoun "she".

integration for such distant knowledge becomes increasingly difficult. In addition to the nature of novel technical knowledge, this chapter describes some of the main sources of organizational constraints or inertia. Due to the rigidity of their existing operations, particularly mature firms are severely constrained in their ability to search and utilize knowledge which lies outside of their existing scope of operations. In the light of the nature of novel technical knowledge and the extent of organizational constraints to innovation, the characteristics of technological gatekeepers may be necessary, but in how far are they sufficient in order to warrant the search and transfer of novel technical knowledge? The following paragraphs are intended to contrast some of the central findings and underlying assumption of the classic technological gatekeeper literature with the implications of considerable mismatch between knowledge and organizational capabilities. The purpose is to use the technological gatekeeper research as a precedent on which to base the subsequent analysis of mechanisms fulfilling a boundary-spanning function for distant knowledge.

Distance of Sources of Innovation

In the classic technological gatekeeper literature, internal technical specialists engage with their external network on the basis of personal contacts or publications. Such a network of sources implies that the gatekeeper draws on knowledge from his field of specialization which is likely to be aligned with the gatekeeper's task inside the organization and aligned with the organization's technological trajectory. As chapter 2 emphasizes, the proliferation of technology and science entails the dispersion of technical knowledge among different economic actors. This development, on the one hand, improves efficiency of markets for technology, making transacting in the market for technology within the existing trajectory more efficient than using internal resources. On the other hand, the likelihood of discontinuous or disruptive change from outside one's familiar niche is greatly exacerbated. Both the opportunity inherent in greater market efficiency as well as threat of disruptive change require search for technical knowledge outside the "usual suspects". The implications are, as discussed, that innovation search must deal with a heterogeneous set of increasingly uncertain, tacit, and distant sources of knowledge:

Figure - 16 Search Scope and Distance of Knowledge in Open Innovation



This simple schematic illustrates the effects of the increase in innovation sources quite drastically. On the one hand, this affects search for external solutions to current internal problems, and on the other hand, search for new ideas outside of the traditional firm environment. In both instances, search activities may be an altogether more taxing activity. In order to minimize search costs, prior search criteria are advisable. These criteria must come from a general strategic direction, or must be determined by more short-term, immediate problems looking for external solutions. Absent such search criteria, the innovative potential of the inputs sourced may increase, yet the ability to act on and absorb these inputs will decrease. Organizations may balance the ratio of problem-oriented and less concrete, exploration-oriented search in alternating, or cyclical mode, a 'cycle of discovery' (Gilsing and Nooteboom, 2006) or conduct both at the same time and to the same degree.

Seeing that new innovation sources will complement the traditional ones, existing formal and informal communication channels will not suffice in meaningfully channeling the information obtained from these sources. Also with respect to external communication channels traditionally associated with the fuzzy front end of innovation, such as R&D personnel, but also, purchasing, conflicts are likely to ensue over responsibility for external relationship/communication management, for instance when organizations attempt to integrate lead users. This increases the complexity in managing interfaces. Further, research on knowledge transfer (e.g. Easterby and Smith, 2008) highlights the willingness to transfer knowledge both at sender and receiver. For instance, open source communities are largely dependent on intrinsic motivation of their members (von Krogh, 2008). Conversely, transacting with entities outside of traditional ecosystems may result in different bargaining constellations where an eligible source of innovation may not be willing to transact.

Communication Boundaries

As a result of the proliferation of innovation sources, the information obtained from these sources will be highly heterogeneous. The classic technological gatekeeper literature assumes the communication boundary as a one-dimensional barrier between the external source and the internal organization. However, the greater heterogeneity of sources in more open forms of innovation is likely to be manifest in communication boundaries which can be mapped along several dimensions, including technical, geographical, cognitive and cultural. ICT is a great leveler in facilitating information exchange with a large number of heterogeneous sources, removed in geography, technology and industry. Therefore, ICT has been a fundamental enabler of more open and dispersed forms of collaboration. As knowledge bases become more removed, however, less information will be codifiable and transferable through ICT. Moreover, especially at the early phase of innovation, uncertainty and highly incomplete contracts necessitate high trust and rich information media, rendering ICT necessary but not sufficient for efficient transacting. Codified communication channels are likely to require complementary social exchange, frequent face-to-face, and relationship building in order to accrue social capital which is required as a lubricant for transaction and mitigation of communication boundaries (Roberts, 2000; Storper and Venables, 2003; Florida, 2008). Socialization tactics to mitigate noise are also likely to instill a sense of motivation and generally higher willingness to transact and share knowledge, as indicated by Storper and Venables (2003).[20] The more innovation potential innovation sources yield, the more communication boundaries are likely to 'stack up' (Phene et al., 2006).

As opposed to the classic technological gatekeeper literature, therefore, the mitigation of communication boundaries or noise can only be managed by either a number of different specialists, or more likely, by technical generalists who have relatively broad knowledge and can draw on the relevant experts in the organization. In order to match heterogeneous, distant knowledge with a set of heterogeneous internal roles a generalist either in personal union or as a multi-person function with a task division of several specialist roles may be required.

[20] Harryson, Dudkowski and Stern (2008) illustrate in an in-depth case study the collaboration of a Swedish automotive manufacturer and an Italian design house - with a particular focus on how the collaboration was facilitated through well-orchestrated socialization tactics.

Organizational Constraints to Novel Technology

The classical gatekeeper literature presents technological turbulence and locality of task inside the organization as a determinant for the prevalence of information mediation from hierarchy, gatekeepers, or through direct contact. Otherwise, it treats the organization largely as a black box. However, in accordance with advances in organizational economics, and strategy, in particular the resource-based view, a more differentiated view seems advisable. Section two of this chapter presents a more differentiated view on the sources of path-dependence manifest in innovation processes. These sources of path-dependence need to be addressed appropriately, with failure to address all of them simultaneously presenting a major barrier for the subsequent integration of distant knowledge.

4.4.5 Guiding Themes Derived from the Technological Gatekeeper Literature

The review of the technological gatekeeper literature has revealed a rich research base which can serve as a point of departure for the conceptualization of a function mediating between external innovation sources and the inside of the organization. Technological gatekeepers will continue to play an important role in organizing knowledge flows between R&D lab and external sources of innovation, particularly in knowledge fields closely associated with the existing technology base. In mature organizations, thus, R&D personnel will feature technological gatekeepers and, at the same time, hierarchical roles responsible for mediating more stable information flows. Conversely, in young and growing enterprises, technological gatekeeping roles will be assumed in a decentralized manner by individual member of the organizations.

In order to stay abreast of developments outside of the existing technological trajectory, thereby precluding disruptive technological change and enabling identification of new opportunities for growth, however, particularly mature organizations may require a dedicated function which much expands the traditional gatekeeper role.

Task and Skill Division

As opposed to technological gatekeepers who are specialized *individuals*, an organizational function designated to match distant knowledge with existing routines may require less narrowly specialized knowledge, but rather, a broad and diverse knowledge and skill set. Contingent on the complexity of innovation sources and internal network, this may entail considerable division of labor among different individuals with a broad range of technical skill which enables them to overcome a variety of communication boundaries. Task division and task overlap, as well as mechanisms for capturing sourced information may also be key to overcoming agency problems, to ensure that knowledge is primarily utilized for the benefit for the organization and less for personal goals, as opportunistic behavior by members of the orchestration function may favor investment in personally valuable information in favor of organizational viable information.

Internal and external network

A matching function for distant knowledge may require an external *and* internal network. Whereas the gatekeeper is externally enrolled in his 'invisible' college of technical or scientific peers, and internally to other gatekeepers and co-workers, this will likely entail previously untapped sources of innovation externally outside the immediate technological and business focus. Research on knowledge transfer stresses the importance of motivation of the source to transfer knowledge (e.g. Easterby-Smith et al., 2008). In order to motivate willingness, the orchestrator needs to position the central firm as an attractive partner for information exchange, or further forms of collaboration. Internally, technological gatekeepers seem to fulfill a concrete demand by the R&D organization for problem-solving knowledge. In the case of distant knowledge, there may be no latent demand. Insofar as the information sought has been determined by problem-oriented search criteria, the recipients of information are pre-defined internally. In the case of undirected search, appropriate recipients inside the organization are more difficult to identify. Knowledge management tools inside the organization represent an important aid in identifying appropriate recipients, however, since such information sourced is likely to be fuzzy and its application subject to considerable uncertainty, personal face-to-face contact and social capital may be essential for successful internal transfer. Previous ties and accrued social capital on the part of the orchestration function could play a key role. Regardless of the strength of existing ties, considerable effort may need to be expended on marketing and legitimizing such information, as not-invented-here and fixedness on current business model create boundedly rational biases against the new.

Status

Status, either based on competence or seniority in tenure, may increase in significance as the knowledge mitigated is less certain, and rather than objective, measurable criteria, will be judged by reputation and status of the arbitrator of such knowledge (Davenport and Prusak, 2000). Cyert and March (1963) held that routines and beliefs change through trial and error experimentation and organizational search. With the former, adoption of a new routine depends on in how far it is associated with success in meeting a target. Thus, the legitimacy of a new routine depends on its (perceived) track record of success, which, in individuals or organizational functions, may be reflected in their perceived status. A boundary-spanning function may, due to resource constraints, need to make a trade-off between external and internal status. One-sided focus on reputation-building on either side may result in decay of reputation on the other. In either case, high status internally is required to ensure acceptance and avoidance of Not-Invented-Here (Katz and Tushman, 1982), whereas externally, reputation and status effects will increase the willingness of external parties to transact (Lichtenthaler and Ernst, 2007). Recruiting criteria for members of a boundary-spanning function may also need to take into account that high-status should ideally be present ex-ante, absent high status, high technical competence may be an important precedent (Nochur and Allen, 1992).

Motivation and Incentives

A key issue raised by many publications within the technological gatekeeper literature is that of appropriate support and incentivization of gatekeepers. Research in knowledge management (Davenport and Prusak, 2000; Foss and Mahnke, 2003) indicates an agency problems in the sense that knowledge is often deliberately withheld, since actors inside the organization generate considerable advantages from information asymmetries. Thus, as in the case of gatekeepers, knowledge search and dissemination may conflict with career progression. Gatekeepers are intrinsically self-motivated, when designing a dedicated matching function, however, the importance of such a function must be recognized, appropriately remunerated and accepted as a viable career path. As indicated by research on international business and intercultural communication (e.g. Taylor and Osland, 2003), the importance of designing appropriate incentives is compounded by the tendency of 'marginal' functions of the organization to become peripheral and considered less important by the rest of the organization. Further, while marginal status brings with it a much broader set of sources of information, this information will be of less value than similar information from a member more centrally anchored in the organization (Taylor and Osland, 2003).

Channeling internal search requests

As discussed, the amount of external sources and the heterogeneity could result in escalating search costs and pre-empt subsequent absorption. Due to the high number and heterogeneity of distant knowledge, search criteria which are aligned with the organization's long-term growth strategy may be required. Again, since bounded rationality or technology biases may influence even long-term strategy, these search criteria should cover some areas which may not yield immediate utility, but which present possible future technological options. The ratio of highly directed to undirected search is contingent on the maturity of industry or organization and the projected sustainability of the current business model.

Knowledge Transfer Process

As opposed to the two-step knowledge transfer process found by Allen and Cohen (1969), searching, transferring and matching distant knowledge is likely to entail a much higher degree of complexity and more process steps.

The classic technological gatekeeper literature has yielded some important insights regarding the micro-foundations affecting successful search and transfer of external knowledge. Revising the findings from the gatekeeper literature in the light of open innovation and therefore, a different set of knowledge sources vis-à-vis much higher communication boundaries due to organizational path-dependence, has provided a good basis for framing the subsequent empirical analysis. The conclusion of this chapter will synthesize the theoretical perspectives discussed in this chapter into a coherent theoretical framework to be used to formulate interview questions, structure the case study narratives, as well as to provide the basis for the implications to be drawn from the empirical findings.

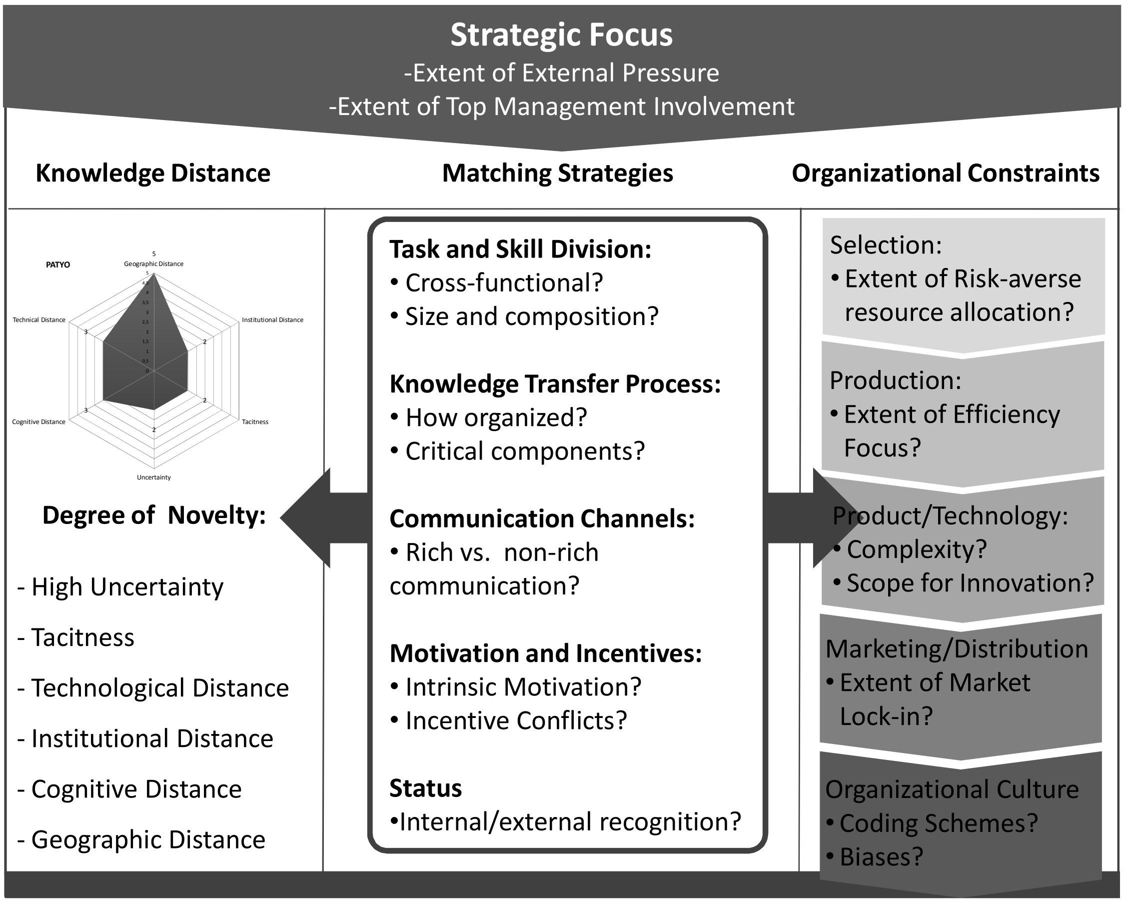
4.5 Conclusion

The aim of this theoretical chapter was threefold. First (1), this chapter intended to generate a finer conceptualization of the dimensions of novelty which influence the distance and ambiguity in relation to a firm's existing knowledge base. This conceptualization consists of the high uncertainty associated with radical, novel knowledge, in terms of technology, market viability, and business model. Further, it addresses the high tacitness of distant knowledge, both manifest in low codifiability and low appropriability. It also addresses the distance in technology, institutional framework, cognitive structures and geographic space between a source of knowledge and the existing knowledge base. Second (2), the sources of organizational inertia, and particular the organizational routines favoring local search activity are discussed, with a view of generating a more comprehensive, workable conceptualization of concepts such as core rigidity, path-dependence, inertia, exploitation-focus, industry recipes, dominant logic. Third (3), this chapter reviews theory on a prominent concept in the technology and innovation management literature – the technological gatekeeper. Technological gatekeepers mediate external knowledge with the internal R&D organization. The findings from the technological gatekeeper literature are carefully scrutinized and compared to a scenario were external sources of knowledge are distant and highly heterogeneous and the boundaries to be spanned consist of path-dependent innovation processes.

The three components of the theory form the analytic framework for the data collection and analysis. The rationale behind choosing the dimensions of distant knowledge and the sources of organizational inertia as the major components is motivated by a desire to define how the two can be matched. A clearer theoretical basis is therefore mandatory in order to make sense of the highly rich qualitative data. In addition to the three components discussed so far, another variable will be considered. The methodology chapter highlights that case studies are an appropriate research tool if phenomena are difficult to disentangle from their context. Further, this study uses a multiple case study, the purpose of which being the observation of the same phenomenon within slightly altered contexts – following a replication logic. As also highlighted in the methodology chapter, in this study, the deviation in context is mainly manifest in differing extent of strategic focus of the functions studied.

Strategic focus is intended to take into account the extent of external or internal pressure for change. According to classic literature in the organizational learning/ knowledge management field, learning, and thus behavioral change, takes place in response to external shocks. The section on organizational inertia highlights that these constraints are highly cumulative in nature. This is why organizational learning scholars and knowledge management scholars have usually argued that a change in these patterns can only occur in response to severe external shocks. For instance, Cyert and March (1963) argued that learning occurs in response to external shocks and is manifested in rules, procedures, and routines (Easterby-Smith and Lyles, 2003). Pressure for learning or change, manifest in strategic priority of the search functions studied, may therefore be a necessary, but not a sufficient condition for the success in matching distant knowledge and existing routines, and therefore, the creation of new innovation. In summary, therefore, the theoretical framework will be structured as illustrated in figure 17:

Figure - 17 Summary of Theoretical Framework



5. Disaggregation of R&D in the Automotive Industry and the Need for Distant Search

The previous chapters introduce the purpose of this study, the scientific method chosen, and the theoretical framework guiding empirical analysis. Before presenting the findings of the case studies, this chapter provides a brief background about the automotive industry, highlighting how the dynamics of technology convergence and divergence and the ensuing disaggregation of R&D increasingly entail search for innovation among sources distant from current technological and organizational context. Moreover, it highlights how successful distant search seems to represent a key competitive advantage of automotive original equipment manufacturers (OEMs).

5.1 Introduction

The world's automotive industry affects almost all of us in some way. It employs millions of people directly, tens of millions indirectly. Its products have transformed society, bringing undreamed-of levels of mobility, changing the ways we live and work. For much of the developed world, and increasingly for the developing world it is a pillar industry, a flag of economic progress. Without an automotive industry it is impossible to develop an efficient steel business, a plastics industry or a glass sector – other central foundations of economic progress. The automotive industry has been a core industry, a unique economic phenomenon, which has dominated the twentieth century. (Maxton and Wormald, 2004:1)

In Germany alone, the automotive industry generates around €290bn turnover each year, almost a fourth of the whole aggregate turnover of industry (VDA, 2008:5). In North America, Europe and Japan combined, the automotive industry accounts for 11% of GDP and one in nine jobs. Around one million new passenger cars and commercial vehicles are built every week. The industry utilizes 15 per cent of the world's steel supply, 40 per cent of the world's rubber supply and 25 per cent of all glass (Maxton and Wormald, 2004). In 2007, almost 75 million cars and trucks were produced – a single passenger car consisting of around 8,000 individual parts (ANE World fact book, 2008). The German engineer Karl Benz invented the gasoline-powered car in 1885. In the early days of automotive design, inventors experimented with a variety of different approaches. Rudolph Diesel, for instance, pioneered his "Otto" engine, which is still in use today. Even fully electric drive-train alternatives were tested, such as the "Lohner-Porsche" from 1904. Eventually, the internal combustion engine prevailed as the dominant design, endorsed by a rapid succession of product innovations during the first 20 years of the industry. The major product innovations comprised:

- The first four-stroke cylinder (by Karl Benz in 1890)
- The honeycomb radiator (by Gottlieb Daimler in 1890)
- The speedometer (by Oldsmobile in 1901)
- Automatic transmission (by Packard in 1904)
- Electric headlamps (by General Motors in 1908)
- The all-steel body (adopted by General Motors in 1912)[21]

By 1912, the most critical aspects of product technology had arrived at a basic dominant design, and during the remainder of the 20th century, different technologies and design converged. As the fundamental product innovations had been incorporated, exploration for major breakthroughs was increasingly replaced by full exploitation of current assets. The evolution of the automotive industry continued with important breakthroughs in process innovations and advances in organizational design. Ford opened its Highland Park Assembly Plant in October 1913, introducing revolutionary production methods such as interchangeable parts and the famous first moving assembly line. Half a century later, Toyota pioneered a system of "lean production", introducing just-in-time scheduling (JIT), team-based production, flexible manufacturing, total quality management (TQM) and Kaizen.[22] During the 1970s and 1980s, these process innovations diffused to most other car manufacturers (Clark and Fujimoto, 1991; Benner and Tushman, 2003).

The industry dynamics responsible for the maturation of the automotive industry and the ensuing shift to process innovation, shakeout of a large number of players and diminishing rents have also had a major impact on the organization of R&D in the automotive industry. The major process innovations introduced mainly targeted cost improvements in production and logistics. However, R&D has, particularly in the past 30 years, become a priority target for further efficiency gains. Especially the simultaneous proliferation of technology required for cars and eroding margins due to competition, geographic spread, regulatory pressures, and considerable diversification of the product offering have led to a high degree of disaggregation of R&D. 75% of the value chain has already been outsourced to suppliers. Automotive OEMs have greatly diminished their number in a series of takeovers and mergers. Currently, strategic alliances are commonplace, even between close competitors. Especially in the volume segment of the industry, the returns on innovation are diminishing continuously, as product characteristics are converging. Innovations diffuse at a rapid rate from premium players to volume producers. In addition, new entrants are entering the industry. The shift from purely internal combustion-based drive-trains to hybrid and fully electric drive-trains has enabled newly formed ventures to capture a small

[21] See Grant, 2005:304.

[22] The philosophy of Kaizen, meaning sustained incremental problem solving, underpinned Japanese management techniques such as Just in Time (JIT) and Total Quality Management (TQM) (Tidd and Bessant, 2009).

fraction of experimental and forward-looking customers. New business models, too, jeopardize the industry.

Thus, on the one hand, automotive OEMs need to look for new developments distant from their existing context in order to generate innovation which enables a more sustainable differentiation advantage. Toyota's Lexus range, for instance, required extensive ethnographic studies in California which provided the Japanese engineers with the necessary knowledge to devise a new luxury range car brand. BMW also draws on the latest developments in Silicon Valley, where its iDrive controller and its Head-Up display were conceived by a specialized R&D outpost. Conversely, the example of Better Place and Tesla Motors illustrates the growing threat posed by new entrants and potential economic and technological discontinuous change. The automotive industry, therefore, may be prototypical for the changes in corporate R&D outlined in chapter 2. It also underlines the growing need to organize search activities for innovation outside of the current organizational and technological context. This chapter applies the theoretical considerations from chapter 2 to the automotive industry, providing a thorough context in which to view the findings presented in chapter 6.

5.2 Technology Convergence and Divergence Dynamics in the Automotive Industry

Over the last 100 years, cars have developed into a complex, high-tech product. Current generations of cars combine the state-of-the-art in mechanical engineering with the latest developments in electronics, material sciences, information technology, sensors, consumer electronics, entertainment and human-machine interface technology. There has been a continuous need to incorporate newer and better technology, primarily as a result of intense competition. Car makers have always aimed to differentiate themselves through advances in the basic product attributes, such as performance, reliability and quality, and longevity. Premium makers usually excelled at these basic product attributes, and, in addition, consistently created important incremental breakthroughs in car design. As the scope for significant product feature breakthroughs has decreased and classic performance characteristics such as acceleration, top speed and range have converged across premium as well as volume car makers, premium players increasingly resort to incorporating innovations from adjacent technology areas in order to provide the customer with a superior product experience. Besides consumer and competitive pressure for new features, automotive original equipment manufacturers (OEMs) need to meet stringent regulatory requirements. Passenger and pedestrian safety have for a long time been the most pressing requirements for OEMs (KMPG, 2008). However, the environmental impact of cars has in recent years become the most central priority in policy-making. Carbon dioxide (CO_2) has been singled out as the most serious of pollutants responsible for man-made climate change, and passenger cars are estimated to account for 12 per cent of overall CO_2 emission (PWC, 2008).[23] Some regulation targets car use by imposing externalities such as congestion charges or prohibitively high taxes on car prices or gasoline. In addition, automotive OEMs are not only forced to develop more fuel efficient gasoline or diesel powered engines, but also to invest in the development of alternative drive-train technologies. The alternatives currently cover a wide range, from hydrogen variants, eco-fuel, natural gas, hybrid electric/combustion drive-trains, and fully electric, battery-powered designs. Car makers are thus faced with the need for significant R&D investment in new competencies. Moreover, they are faced with high technological and market risk, all the while operating in highly competitive markets.

Due to the investments required to achieve differentiation advantages and in order to conform to stringent regulatory requirements, R&D costs have been spiraling[24]. The returns on R&D investments, conversely, have not grown accordingly. For instance, while consumers expect more and more features, the inflation-adjusted sticker price of new automobiles has, on average remained stable in the last 20 years. Between 1990 and 2003, the real price of the VW Golf model has only risen 0.7 per cent while three new generations of the model have been introduced with significantly improved performance and functions over this period (McKinsey, 2003:13). New innovations diffuse quickly from first introduction to becoming industry standard, giving innovators very little scope for appropriating the returns. Intense competition depresses price, even in the so-called premium segments. Recent market research also suggests that low emissions are considered a hygiene factor in purchasing decisions, and as such, attract low willingness to pay for extras (PWC, 2008). Owing to the fact that growth in the automotive market has been largely stagnant in the developed world and intense competition means that the returns on R&D investment are becoming increasingly marginal. [25] Innovation has become a preserve for premium players who to a great extent compete on short-lived first-mover advantages in the introduction of new features, often representing investment in brand equity rather than providing a compelling product advantage for customers (Becker, 2007). Even though some of the premium OEMs have to some extent been able to recover their high R&D investment through their premium positioning and price, they too, have been faced with escalating R&D costs. Over the past 30 years, the combination of the technological complexity

[23] In the US, Congress mandated a 40 percent improvement in fuel economy by 2020. California has been pioneering its own emission targets for several years. The European Union has proposed to cut CO2 emissions by about 25 percent by 2012 creating an incentivizing mix consisting of rebates, higher taxes on polluting cars congestion charging and other schemes (Reed, 2008).

[24] In the US, total industrial R&D spending rose from $155 bn. in 1997 to $208 bn. in 2004 alone. Non-inflation-adjusted this equals an increase in aggregate R&D spending of 34% in a period of 7 years and a year on year increase of around 5 per cent (NSF, http://www.nsf.gov/statistics/nsf09301/pdf/taba7.pdf; accessed 08 July 2010, Teece, 2003).

[25] The industry has, for many years expected the emerging markets to provide new areas for growth, with optimistic projections estimating an 18 times higher growth rate in emerging markets between 2007 and 2015 (PWC, 2006). Yet, in absolute numbers, these markets are still comparably small. Moreover, considerable structural problems in, for instance, the BRIC countries, mean that automotive OEMs may not be able to rely on robust high demand from these markets in the short or medium term.

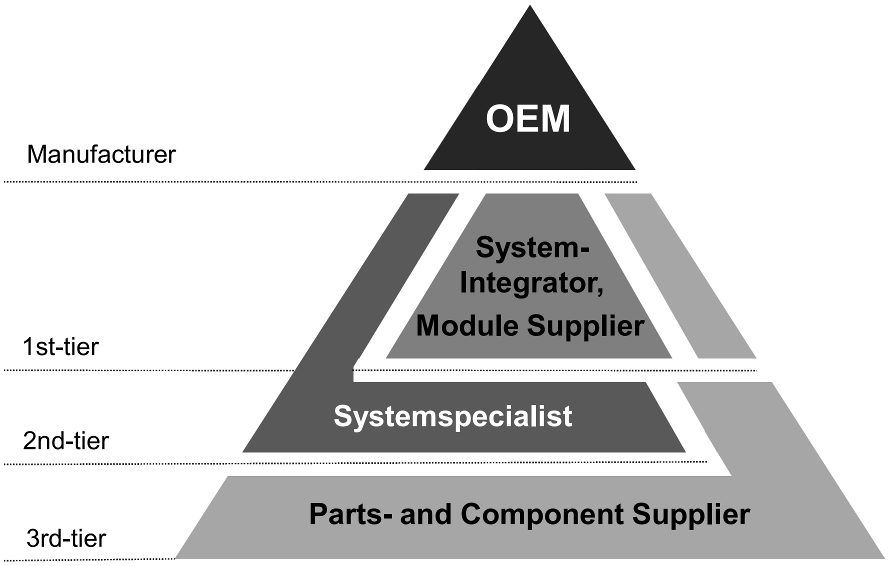
associated with cars, requiring an ever-increasing range of technological competence, as well as competitive pressures and the maturity of the market have resulted in a considerable disaggregation of the automotive value chain, including large parts of the R&D value chain.

5.2.1 Outsourcing of R&D to Suppliers

Henry Ford famously owned his own rubber plantation Today however, OEMs have outsourced large parts of their value creation. Increasingly, the scope of outsourcing encompasses complex R&D tasks, which are conducted by large, so-called system integrators and sub-system suppliers. Whereas in 1955 automotive OEMs on average conducted 75% of their value creation in-house, by 1995, vertical integration dropped to 25 %, measured in total cost of vehicle, as illustrated by figure 5 in chapter 2.

Automotive suppliers are structured in three main tiers. Third-tier suppliers provide standardized parts requiring low manufacturing and development know-how. Second-tier suppliers integrate parts and components into more complex systems, a task demanding a high level of technical competence but little manufacturing know-how. The first-tier module suppliers need less technical know-how but a high degree of assembly competence in order to ensure that the integrated modules are compatible. At the top of the supplier pyramid, directly facing the OEM, the system integrator combines a high level of technical competence and manufacturing know-how. These system integrators effectively provide a large amount of development work for the OEM (Becker, 2007). For instance, as in the case of the German Bosch GmbH, system integrators command at least an equal degree of development competence as the OEM. Further, in recent years so-called 0.5-tier suppliers have emerged. These 0.5-tier suppliers have effectively forward integrated, often providing highly advanced new product development capabilities, in addition to state-of-the-art production facilities. Automotive OEMs frequently use these suppliers as flexible development and manufacturing partners (see Altshuler and Stern, 2006; Harryson et al., 2008) Figure 21 describes the tiered automotive supplier structure as a pyramid:

Figure - 18 Supplier Pyramid



Source: Becker, 2007:168

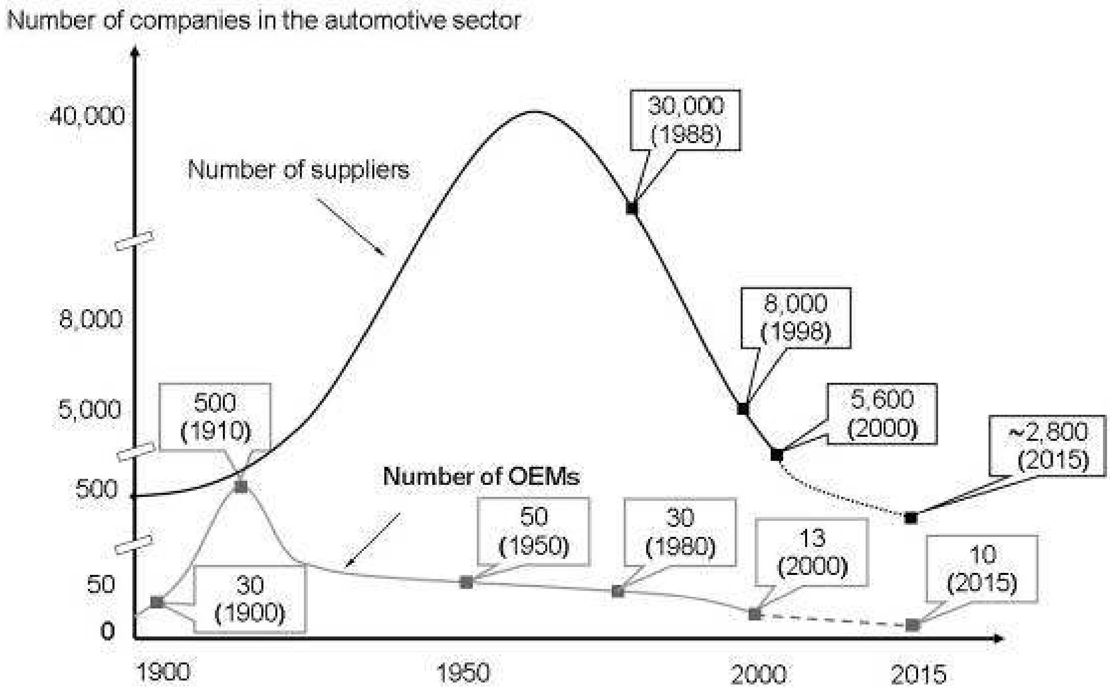
The outsourcing of parts and components, lower order systems and modules has enabled automotive manufacturers to offset their overall cost base. For many decades, OEMs have exerted considerable bargaining power over their supplier base, demanding high year-on-year cost cuts from their suppliers. Moreover, the higher-order R&D suppliers, mostly specialized technology providers and system integrators, are required to provide warranties for the development risk of the innovations they supply, thus taking on a large share of overall development cost. The implications for automotive OEMs are that they often only retain the necessary R&D competence in-house which still enables them to successfully integrate supplied modules, sub-systems, and higher-order systems. Although this enables them to focus on development core competences, which form the basis of competitive advantage, it also restricts their scope for more radical innovation. Further, the high degree of outsourcing of R&D competence leads to product convergence and standardization, further restricting scope for differentiation. This is compounded by concentration among OEMs and suppliers. In particular the larger system integrators are so concentrated that they supply competing OEMs with the same technology, often with only short periods of exclusivity.

5.2.2 Industry Consolidation and OEM Alliances

During much of the 1990s, OEMs greatly reduced their number in a series of mergers and acquisitions. One time 'national champions' have quickly consolidated into a smaller number of considerably larger 'global champions'. Out of the top 20 OEMs listed in 1965, 12 have since been merged or acquired (Anonymous, 2004). Suppliers, too, have consolidated from 30,000 in 1988 to 5,600 in 2000, with Mercer

Management Consulting expecting that number to decrease further to around 2,800 in 2015 (Mercer, 2004).[26] Figure 22 illustrates the consolidation of manufacturers and suppliers between 1900 and 2015:

Figure - 19 Consolidation Among OEMs and Suppliers



Source: adapted from Anonymous, 2004.

In the most well-known unification of them all, one of the largest industrial mergers ever valued at $38 billion, Daimler (ranked 14th in 1995) merged with Chrysler (12th), creating a group with nearly half a million employees and assets of $160 bn. Daimler divested Chrysler in 2007 after the expected synergies did not materialize.[27] M&A activity, however, has continued to be highly dynamic, most recently with the Indian OEM, Tata Motors acquiring Jaguar and Land Rover for $2.3 billion (PWC, 2008). At the end of 2009, the Chinese manufacturer Geely announced its plans to acquire the Swedish Volvo (Lindner, 23 December 2009). In addition, alliances among OEMs are entered in order to pool resources for research and development. PSA and BMW, for instance, have been collaborating since the inception of the first Mini, with PSA providing competence in Diesel engine technology, and BMW competence in gasoline

[26] A recent prominent case was Continental's acquisition of VDO from Siemens in 2007, amounting to €11.4bn – "a new benchmark in the industry" (Reeds, 2008:2).

[27] "Their corporate cultures could hardly have been more different, with Daimler the high-tech upline doyen of the European automotive industry and Chrysler the happy-go-lucky twice-rescued from bankruptcy folksy feisty American" (Maxton and Wormald, 2004:221).

engines. Daimler collaborates with Renault on a small four-seater, and Toyota and Mazda have declared plans to collaborate in hybrid technology (Financial Times Deutschland, 16 September 2009). The implications of industry concentration both among OEMs and suppliers have been even greater standardization and product feature convergence.[28] The suppliers, providing the majority of development effort, have been reduced to a few players, with the largest system integrators working for several competing OEMs. Exclusivity of new features is often limited to a short time window, sometimes the diffusion of a new product innovation from a premium manufacturer to a volume maker is less than one year. Development alliances further reduce diversity in technical developments.

The industry dynamics described above have powerful implications for the organization of innovation in the automotive industry. The competitive pressures which require the continuous introduction of new features and convergence of novel, previously unrelated technology areas, as well as regulatory demands have caused R&D costs to spiral out of control. As a result, OEMs have had to outsource the majority of their value chain to a complex web of suppliers. With large parts also of technology development thus becoming standardized, the scope of product differentiation is continually eroding. Mergers, acquisition, and alliances among OEMs further reduce diversity, resulting in ever less and short-lived innovation advantage. In order to identify truly novel sources of innovation, automotive OEMs are increasingly forced to look beyond their immediate industry context. Yet, while the identifications of new sources of innovation is becoming imperative in order to create new growth and ensure competitive advantage, identifying potential discontinuous change from new entrants has grown in importance.

5.2.3 New Entrants

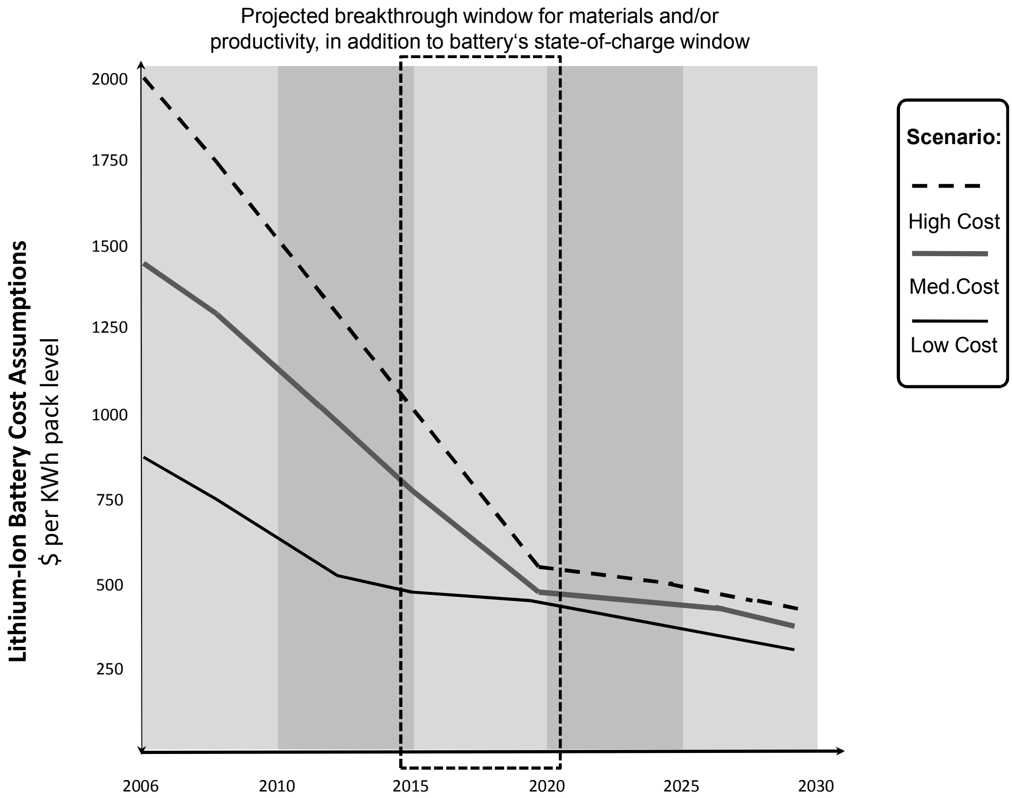
Moreover, while the significant increases in technological complexity, convergence of several areas of technology and continuous competitive and regulatory pressure to incorporate more and more features have caused high disaggregation of the innovation chain in the automotive industry, the same industry forces have created opportunities for new entrants. Since large parts of the automotive value chain have been outsourced, entry barriers to new entrants have significantly lowered. Rather than needing to build up concept, development, production and distribution by themselves, new entrants can today resort to know-how, development facilities, and production facilities provided by automotive suppliers. Particularly in North America, venture capital has been easily available, and in the aftermath of the dot-com bust, venture revolving around mobility, and in particular energy efficient mobility, brick and mortar ventures are better received by venture capital companies (VCCs). Demand-side factors, too, provide an attractive window of opportunity for new entrants. Volatile oil prices, most recently the small oil shock of 2008, and various regulations manifest in positive and negative externalities such as subsidies for “green” cars, high congestion charges and high volumes of traffic and congestion in urban areas have created growing

[28] By 1999, the ten largest automobile makers accounted for 80 percent of the world vehicle production (Sutherland, 2005:240).

demand for smaller, fuel efficient cars. Current new players in the automotive industry have thus been given new impetus and capital to address latent market demand and exploit regulatory opportunities. Tesla Motors from Silicon Valley, for instance, was created by a former IT specialist. The company's business model centers around a fully electric car with premium features such as performance and design (www.teslamotors.com, accessed May 07 2009) The company has been highly innovative in solving the technological bottlenecks, mainly energy storage and applied battery storage technology from consumer electronics to their car design.. Fisker, also from California, in a similar vein has created the first "luxury plug-in hybrid vehicle" with its Karma model (www.fiskerautomotive.com, accessed May 07 2009). Founded by a former car executive, Fisker has been using automotive suppliers' know-how to rapidly bring an electric vehicle to market.

The threat of new entrants has, as already highlighted by Professor Clayton Christensen in 1997, been assessed by comparing the performance and cost characteristics of electric vehicles with the current characteristics of internal-combustion-based cars. In this context, performance and cost depend, to a great extent on the available energy storage technologies, i.e. batteries. Extended research on battery storage technology may, however, soon prove to provide viable battery technology for electric vehicles suited for a mass market, as these projections by Hensley at al. from McKinsey (2009) illustrate:

Figure - 20 Projected Cost for Development of Lithium-Ion Batteries 2006-2030



Source: Adapted from Hensley et al., 2009

In addition to discontinuous change stemming from technological innovation, traditional business models in the industry, too, have experienced some degree of innovation. In response to the growing urbanization as well as the mounting total cost of ownership (TCO) of cars, companies such as "Zipcar" target casual drivers, offering a flexible, subscription model. Zipcar is a car share service which allows participating members to flexibly rent a car on an hourly or daily basis, with petrol included. For occasional drivers, such a model cuts out the generally high costs associated with car ownership. With improving public transport, congested road, and growing urban populace, the model has enjoyed considerable success and has since been copied by car rental agencies, and even, OEMs, such as Daimler. Better Place, too, offers an alternative business model, using a razor-razor-blade approach. Better Place proposes that customers buy a highly subsidized basic product, the car, and are then charged for the energy they consume in the form of battery re-charges.

5.2.4 Emerging Strategies for Tapping Distant Knowledge

These industry dynamics force automotive OEMs to increasingly look outside of their current technological and organizational context for innovation, for competitive advantage as well as to protect themselves from discontinuous change from outside their niche. Recent developments in conjunction with the global financial crisis suggest that the capability to anticipate and act on knowledge from outside one's niche is paramount to competitive fitness – and ultimately, survival. For instance, some European and Asian manufacturers have displayed resilience and adaptability, both in quickly providing fuel-efficient technology, innovative services and novel car concepts. Although sales have dropped dramatically for all OEMs in a global re-adjustment of demand, Japanese manufacturers are continuing their efforts with alternative drive-train technologies, most notably the hybridization of the drive-train. Daimler is testing fully electric Smart cars, BMW launched 500 fully electric Mini vehicles in urban areas of California for a large-scale field test. Thus, companies such as Toyota, BMW and Daimler have, on the one hand, demonstrated quick, after the fact responsiveness, and, on the other hand, have been visionary in introducing concepts such as the combination of conventional internal combustion technology with battery-powered electric motors.

These companies seem to command superior routines and processes for coping with change, and as a component of these routines, considerable capacity for recognizing impending change and reacting to or pre-empting such trends. Harryson (1998) describes in a detailed case study how Toyota pioneered ethnographical market research in order to create the Lexus brand. Toyota engineers were placed for months in American families which represented the ideal market segment for the new brand and studied their habits and needs in order to devise a perfect product offering to meet those needs. Also, many car manufacturers have established so-called "technology listening posts" (Gassmann and Gaso, 2004) in socially and technologically advanced and distant locations in order to search for innovation distant from normal search activity. Daimler set up a technology office in Palo Alto, in the heart of Silicon Valley in 1994 to keep abreast of new societal and technological trends. Other German manufacturers followed, and even the supplier Bosch has an office in Palo Alto now. BMW set up camp in Palo Alto in 1997, with the broad mission to scout ideas of relevance to BMW from outside of the automotive industry. A few years later, BMW revolutionized automotive human-machine interface with its iDrive button, a centralized command unit which could access all technical systems and sub-systems at a flick of the wrist. Although initially criticized for exceedingly complex menu navigation, all premium car manufacturers have since adopted and refined the concept. BMW had been able to conceive the idea due to inspiration by the gaming industry, and was able to develop early prototypes with the help of design specialists from Stanford University and a small supplier.

In addition to technological listening posts, OEMs have also discovered the worldwide web as a valuable source for novel ideas and technology. Once again, BMW pioneered the use of the internet by launching a web-based, virtual innovation agency in 2001. BMW uses its brand pull and reputation for excellent engineering to attract ideas from all over the world. Innovative suppliers, too, have realized the need for more distant innovation search. As already mentioned, Bosch supports a technology listening post in Silicon Valley. However, the task of searching and subsequently transferring and applying knowledge from such distant sources remains challenging, owing to the strong exploitation focus of even the most innovative OEMs.

6. Findings

6.1 Overview of the Cases

Chapter 5 highlights the industry forces responsible for the need for searching and transferring knowledge from outside of the automotive industry in order to generate new sources of innovation and growth. This chapter presents the data collected and structured according to the methods discussed in chapter 3 and the theoretical framework proposed in chapter 4. The data was collated into 3 narratives.

All of the cases analyzed in this study have the process of searching and matching distant knowledge with existing capabilities as their unit of analysis. In all cases, the rationale behind the processes is to effectively "widen the net" of the traditional sources of innovation and to go beyond the immediate automotive context. The cases vary in the sources they tap for novel knowledge and in the structure of the function. The first case (PATYO) consists of a "technology listening post" (Gassmann and Gaso, 2004; Gaso, 2005), a decentralized R&D unit scouting for new knowledge in distant areas which are rich in innovation potential. The second case (VIA) introduces a web-based innovation platform which uses the pull power of the popular corporate brand to attract ideas from beyond the current context. The third case (Webasto) consists of an approach relying on the involvement of end users into the development process, through a variation of Eric von Hippel's (1988) lead user approach. The fundamental rationale behind the creation and continuation of these processes is the same. It consists of the perceived need to reach outside of one's current technology/product/market context in order to identify sources of innovation and growth which are expected to result in sustainable competitive advantage. In addition, the cases share a narrowly defined industry context. All cases are derived from a small sample of organizations considered highly innovative from within the wider population of the German automotive industry. Moreover, two cases are set in the same organization, BMW Group. The third case is set in an automotive supplier. As described in chapter 3, basic organizational attributes which are commonly associated with innovation capability are held constant. The variation in the cases, however, is the immediacy of the strategic rationale underlying the creation and continuation of the different processes. This variation in strategic rationale is further manifest in the locus of innovation search, and the mechanisms employed for accessing and transferring knowledge from the respective search locus. A further variation in the cases is the differential outcome of the processes. The PATYO case can be regarded as a successful example of the orchestration of distant knowledge with existing capabilities. The cases VIA and Webasto, on the other hand, can be regarded as failure cases, since, although achieving positive impacts in some areas, they failed to achieve the overall goal of continuously providing the basis for new innovation and growth. The case narratives are summarized in brief:

BMW's Palo Alto Technology Office (PATYO)

PATYO was established in 1998 as a technology listening post in California's Silicon Valley. Since its inception, it has become an integral part of BMW's R&D network, finding solutions for problems in the R&D headquarters and initiating projects based on new developments in the IT and electronics space emerging in Silicon Valley. In addition, PATYO forms a platform through which BMW engineers are socialized into the entrepreneurial culture in Palo Alto. PATYO boasts several successful transfers of relatively radical innovations such as the "iDrive", the iPod integration and Google search functions inside the car. While revealing a sophisticated process for accessing, matching and transferring distant knowledge, the case nevertheless highlights the limitations imposed by the lack of a counterpart in the central R&D organization to drive highly radical innovations.

BMW's Virtual Innovation Agency (VIA)

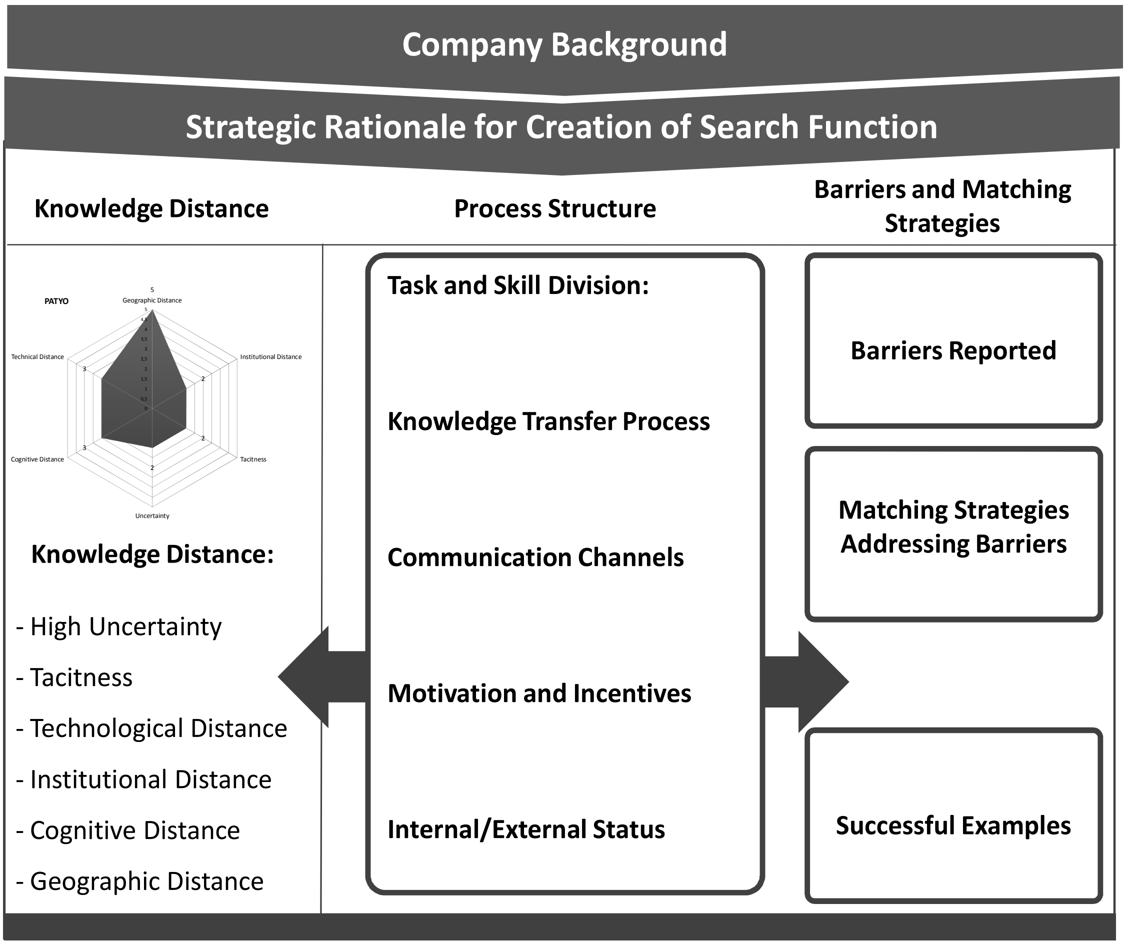
Since 2001, BMW Group has used the worldwide web to solicit ideas from anyone willing to submit suggestions through its Virtual Innovation Agency. With its portal, BMW was one of the first companies to tap the internet for ideas for innovation. This case described the process behind the web portal in the period between 2001 and 2008, before the portal was re-launched and updated. During this period, despite a relatively high number of ideas, only few suggestions were implemented. Of those ideas which were implemented, all were limited to relatively minor incremental improvements. The case narrative provides insights about the limitation of the process, and the underlying reasons for the lack of success.

Webasto's Lead User Process

Webasto is a supplier of temperature control systems and roof systems to the automotive industry. The choice of an automotive supplier as a case reflects the shift in innovation competence from manufacturers to suppliers. Due to this development, automotive suppliers face intense pressures to innovate. In order to address this pressure, Webasto's Innovation and Marketing department initiated a process by which the traditional source of innovation, the development counterparts at manufacturers, could be replaced by directly tapping innovative end users of Webasto's products. A variation of the classic lead-user method, Webasto's Innovation and Marketing department gathered ideas from a sample of highly innovative end customers and subsequently diffused them to the R&D organization. However, after several years of refining the process, results did not materialize, and, at the end of 2008, the lead user process was abandoned.

The write-up of the cases is structured as follows. Based on the data gathered from interviews with professionals and experts, workshops, field notes, and secondary data, such as news articles, internal documents, presentations, literature, the write-ups are divided into first, (1), the strategic rationale behind the decision to initiate radical search activity. Second (2), the extent of search activity is described. Third (3), the composition, and tasks of the function responsible for the search are described in detail, adhering to the structure proposed in the theory. Fourth (4), the process whereby novel knowledge is sought, identified, transformed, and transferred is described. Fifth (5), the barriers and constraints imposed by the formal and informal organizational structure are addressed, as well as sixth (6), if they are, under which circumstances these are overcome. Finally, (7) concrete instances of successful and/or unsuccessful novel technology being integrated are presented to illustrate the process:

Figure - 21 Structure of Cases



6.2 Overview of BMW AG

Bayerische Motoren Werke (Bavarian Motor Works) AG (henceforth referred to as BMW) is a multi-brand automotive manufacturer that focuses on the premium segments of the worldwide automobile and motorcycle markets. It has three brands: BMW, MINI and Rolls-Royce. The company's BMW automobile range includes the 1 Series, available as a sports hatchback, a coupe and convertible; the 3 Series, including sedan, touring, coupe and convertible models; the 5 Series, available in sedan and touring models; the 6 Series, available as a coupe or convertible; the 7 Series large sedan; the Z4 roadster and coupe; the sports utility vehicles, X1, X3, X5 and X6 and M models, such as M3, M5, M6, and X6M. A variety of motorcycles are also available under the BMW brand. The company offers 10 varieties of the MINI. The Rolls-Royce brand offers three luxury cars, Phantom, Drophead Coupe and the latest model, Ghost. In October 2007, BMW acquired Husqvarna Motorcycles, a maker of sporty off-road motorcycles. In addition to automobiles and motorbikes, BMW also offers financial services. BMW is based in Munich, Germany, and has manufacturing, assembly, service and sales subsidiaries throughout the world. Table 9 summarizes some of the main company figures for 2007:

Table - 10 Overview BMW AG

Key Figures BMW AG (2007 data)	
Headquarters	Munich, Germany
Central R&D Center	Munich, Germany
International R&D	California Innovation Triangle: Palo Alto Technology Office, Designworks, Engines and Emissions Center; Scouting Office Japan, Scouting Office China
Production Sites	Germany, Austria, UK, United States, South Africa, China. Assembly plants in Thailand, Malaysia, Russia, Egypt, Indonesia, India
Total Employees	107,539
R&D Staff	~9,000
Turnover	€56 bn.
EBIT	€3.13 bn.
R&D Intensity	5.2 % (€2.92 bn.)
Ownership Structure	46.6 % of shares owned by Quandt family, 53.4 % in diversified holdings

Source: www.bmwgroup.com, accessed 16 December 2008

6.3 BMW's Palo Alto Technology Office (PATYO)[29]

6.3.1 Strategic Rationale for the Creation of PATYO

In the mid-1990s, BMW looked back at over 20 years of sustained growth, technical excellence, and solid financial performance under Eberhard von Kuenheim, CEO since 1971. When he handed over the reins to Bernd Pischetsrieder in 1993, Pischetsrieder was eager to make his mark on the company, and decided to drive forward the expansion of the company. Under Pischetsrieder, the formerly highly centralized organization started to open up considerably. Despite continuing success and relative stability of the premium automotive segment, management believed that, in the long-run, BMW could only survive as a volume car maker. At the beginning of the 1990s, the major Japanese competitors had all launched their own premium brands – Lexus, Acura and Infiniti, and also, other car companies such as Ford and Daimler-Benz diversified and expanded (Kiley, 2004). Particularly on the North American market, competition intensified considerably. After considering various options for acquisition targets, BMW acquired Rover Group for £800m in 1994. The acquisition represented the main component of their medium- and long term growth strategy. Rover Group was headed by Wolfgang Reitzle. He had been appointed CTO in 1987 and was often described as a visionary engineer. A large part of the technical and commercial success under von Kuenheim was attributed to his ingenuity. In addition to pursuing a growth strategy based on acquisition, BMW also expanded its R&D activities to further organic growth under Reitzle as CTO. The R&D organization changed from a highly centralized model relying solely on the sophisticated and demanding car market in Germany and the supply of highly skilled engineers, to incorporating several de-central R&D outposts. It was deemed necessary to source future innovations and more radical technological developments from other fields than mechanical or automotive engineering. Management had come to realize that advancement of traditional automotive technology was increasingly marginal and that major breakthroughs could not be expected. In order to sustain innovation and retain an edge over competition, it was believed that the company had to take advantage of technological developments outside the immediate technology, product, and market context.

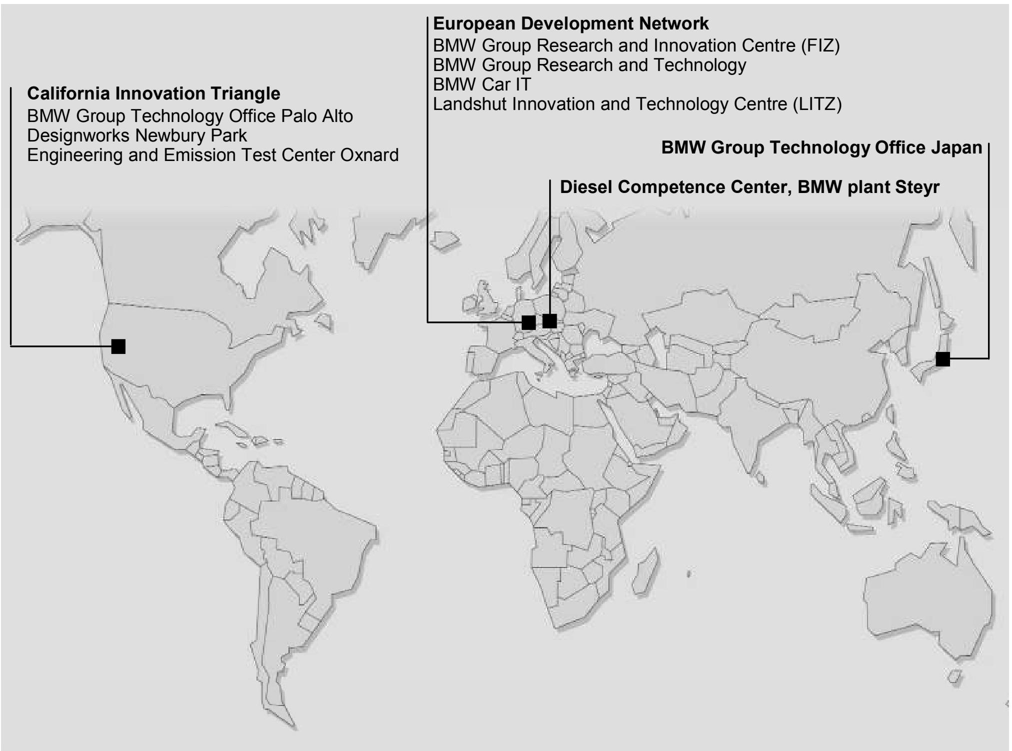
> *"The Tech Office certainly was a product of the Reitzle era. It was said that innovation is increasingly coming from non-automotive areas and that we need to be sure to be somewhere where we can find those technologies and transfer them into the car as fast as possible". (Interview, Dr. Bernardo Lopez Alvaredo, head of PATYO 2005-2008, January 20, 2009)*

In November 1998, BMW Group opened a de-central Technology Office in the high-tech Silicon Valley cluster in Palo Alto, California, the "Palo Alto Technology Office" (PATYO). Already in 1995, BMW had fully acquired the design studio "Designworks" in Los Angeles. In 2000, BMW opened its engineering and

[29] The events described in this account do not take into consideration any developments after April 2009.

emissions testing center in Oxnard, California. All three locations combined to form the "California Innovation Triangle" (CIT). Outside of the US, BMW Group established a Technology Office in Tokyo, Japan, responsible for technology observation, development and testing and validation. In close vicinity to the central R&D Center (FIZ), BMW Group has a separate research arm, research and technology, a specialized automotive IT unit, BMW Car IT, a production-oriented R&D unit and the Diesel Competence Center in Steyr, Austria. Figure 22 provides an overview of the company's global R&D network:

Figure - 22 BMW Group's Global R&D Network



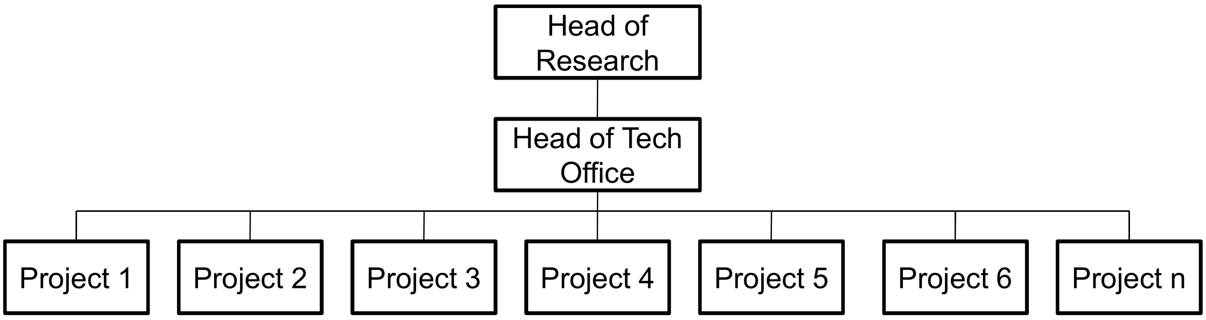
Source: www.bmwgroup.com, accessed 15/07/2008

The brief of the first engineers at Palo Alto was to "be creative, to work independently, and to be open to all kinds of influences beyond the realm of automotive engineering" (Anonymous, 2008:1). Expectations ran high:

"It must have been a great time to be there. The first people to go over to Palo Alto truly believed they could save the company!"
(Interview, Dr. Bernardo Lopez Alvaredo, head of PATYO 2005-2008, January 20, 2009)

While Rover was divested in 2000,[30] the Tech Office recently celebrated its 10th anniversary and has become an integral part of BMW Group's global R&D network. Formally, the Palo Alto Technology Office (PATYO) is a legal affiliate of BMW North America LLC, a subsidiary of the BMW US Holding Corporation. Functionally, the Tech Office forms part of the BMW Research and Technology GmbH in Munich. The reporting structure of PATYO reflects its strategic status. The head of PATYO reports directly to the head of BMW's research organization, who in turns reports directly to the CTO:

Figure - 23 Reporting Structure PATYO



The decisions leading up to the creation of PATYO and top management commitment reflected a strong concern over mounting competitive pressures, and also, a desire for preemptive action to address industry consolidation, technological convergence, and increasing product homogeneity. In terms of the urgency of the strategic rationale underlying the creation and organization of PATYO, the high priority of succeeding in finding and transferring distant knowledge is particularly endorsed by the close personal involvement of the then CTO, Wolfgang Reitzle.

6.3.2 Search Focus and Sources of Innovation

The strategic important of the Tech Office is also reflected in the choice of search mechanism and the location in Silicon Valley. Initially, after the launch of the Tech Office, its mission consisted of identifying "anything the engineers considered interesting and promising" within a wide corridor of search parameters and subsequently transferring it into new car models as quickly as possible. However, the initial euphoria soon waned, when the Tech Office and Munich management realized that few discoveries could be transferred into pre-development or even less likely, into serial production. The initial very broad remit posed the threat of turning PATYO into an engineering playground, thus losing its connection to central R&D. On the basis of the realization that transfer success would have to be improved by catering

[30] The Rover acquisition ended up incurring costs of €5bn. due to lack of potential synergies, outmoded production facilities and unappealing product line-up.

to urgent needs for solutions in the home-base, the Tech Office began to incorporate the search for solutions for precisely defined problems by the central R&D. The BMW terminology refers to these projects as "pull-projects". These pull projects represent 50 % of the overall projects handled by the Tech Office, while the remaining 50 % consist of so-called "push-projects". Push projects are independently initiated by PATYO engineers. Today, the Tech Office's main remit is to source novel technologies from beyond the immediate automotive context, by "exploring, evaluating, and transferring cutting-edge technologies primarily from non-automotive US industries to its partners within the BMW Group" (presentation, Palo Alto Technology Office, 2008). The technology scouting activities center on the following main areas, derived from BMW Group's main innovation focus which forms part of its innovation strategy (www.bmwgroup.com, accessed 20 January 2009):

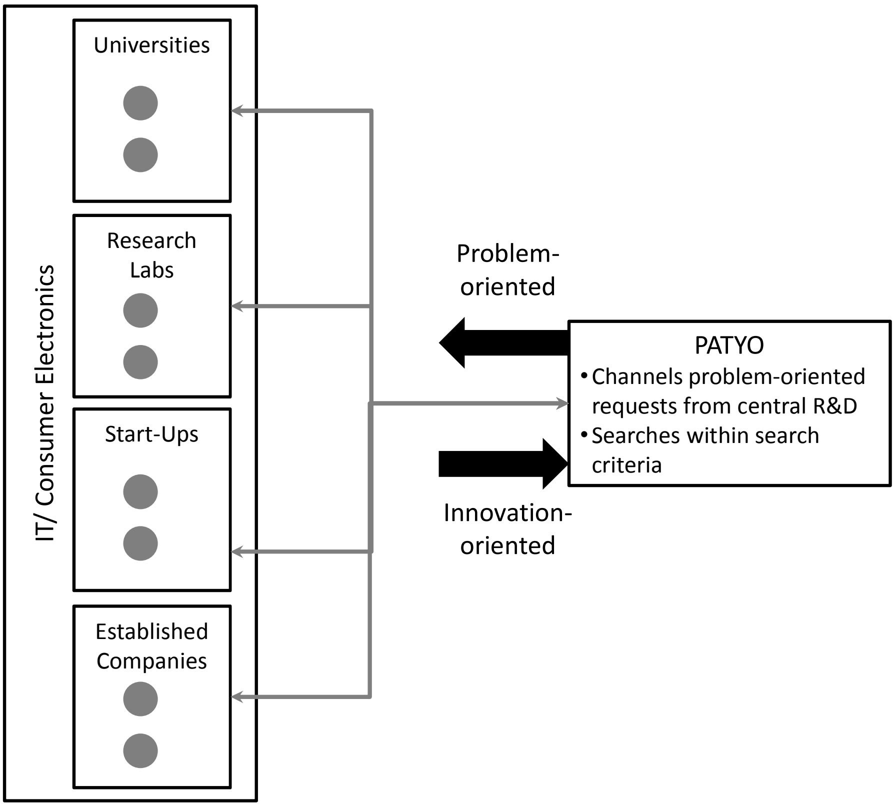
- **Human-Machine Interface (HMI)** for simplifying technology handling. The "iDrive" operating concept is an early example.
- **Mechatronics,** the integration of sensor technology, actuator technology, and electronics.
- **Information, communication, and entertainment** and their application in cars.
- **Driver assistance –** for instance through telematics.
- **B2X for new portals** and opportunities for business communication.
- **Materials and Production,** e.g. form-memory alloys production technologies.

In addition to conducting sensing and scouting based on these criteria, the Tech Office acts as a conduit for technical information requests from the central R&D unit, while acting as a consultant and intermediary to the community found in Palo Alto. Scouting involves visiting exhibitions, conferences, high-tech events, lecturing at universities and scanning the start-up ecology. The sources accessed thus comprise universities, research labs, start-ups and local, established companies from outside the automotive context. Most of these sources, by virtue of being located in Silicon Valley come from an IT or consumer electronics context.

> *"No two days are alike. I generally manage between two and six projects at once, and each one is typically at a different stage of maturity. One day I'm meeting with people from a well-known infotech company, the next I'm reviewing ideas from an unknown start-up. Or I might be debugging the electronics of one or our prototype vehicles in the morning and test-driving and experimental safety system in the afternoon".*
> *(Rob Passaro, PATYO, quoted in Anonymous, 2008)*

Figure 24 illustrates the "innovation ecology" which PATYO taps:

Figure - 24 PATYO's Partner Network



Source: Own

In addition to fulfilling its search and scouting function, PATYO is instrumental in socializing the German expatriates working in the office into the Silicon Valley working style, and the advanced lifestyle of Northern California:

> *"The primary goal first, of course, was to bring technologies and developments from California or the West Coast of America to development in Munich. A large part, however, is also to get to know the completely different working culture they have there and also bring that to Munich. And since people there change over quite a lot, you can, over time, introduce more and more people to the Silicon Valley working style. You simply don't have the opportunity to work like in a start-up in a large company otherwise." (Interview, Marc Lengning, PATYO Alumni, 15 July 2008)*

The knowledge distance associated with PATYO's scouting activities, could be characterized as follows. Since innovation sources accessed vary from universities, start-ups to established, non-automotive companies, the uncertainty of the knowledge accessed varies accordingly. Based on the data analyzed, however, a preference in projects originating from sources with moderate uncertainty, such as companies like Google, dominated. Tacitness, likewise varies, but is on balance moderate. Since the technological focus determined by PATYO's search criteria entails significant divergence from core, mechanical technology, yet pertains to technology already partly converging in existing cars, technology distance, too, is moderate. Institutional distance is comparatively low, although there are notable difference in formal and informal institutions between Munich and Silicon Valley. Cognitive Distance is moderate, mostly due to the different approaches to problem solving and underlying thought patterns reported by expatriate engineers. Interviewees often referred to the "Silicon Valley Way" vs. the "Munich or BMW Way". By virtue of it's the geographic location in Silicon Valley entailing significant physical distance to Munich, 9 hours of time difference and long travel time, geographic distance between central R&D and the sources PATYO taps is very high. Table 11 assigns the dimensions of knowledge developed in the theory a numerical value. Each dimension is ranked from 1 = very low, to 5 = very high according to the operationalization of knowledge distance introduced in table 7 in chapter 3. Figure 27 illustrates the dimensions of distance in a radar chart.

Figure - 25 Knowledge Distance PATYO

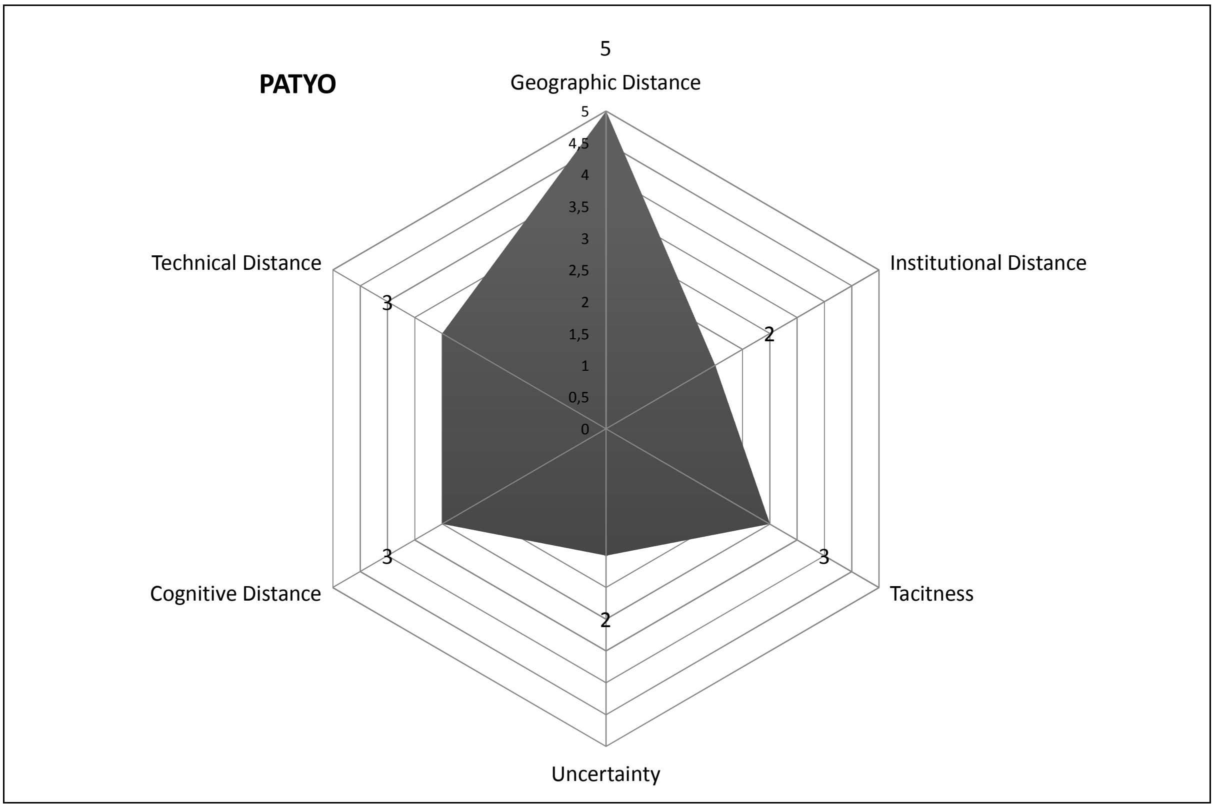


Table - 11 Knowledge Distance PATYO

Dimension of Novelty	Value	Explanation
Uncertainty	2	• Uncertainty differs between innovation sources; however, technical; market and business model uncertainty often mediated by dominance of collaboration with established non-automotive companies such as Google.
Tacitness	3	• Ideas scouted partly idiosyncratic. • Some university projects require students as mobile knowledge carriers. • Appropriability regime is moderate. • Minor language barriers.
Technical Distance	3	• Technology scouted in areas of technology convergence. • Technical-Scientific overlaps limited, technical distance therefore high.
Institutional Distance	2	• Some specific difference in regulatory framework, for instance emission targets, otherwise similarly advanced as Europe. • Moderate differences in norms, values and culture.
Cognitive Distance	3	• Mental models and thought models moderately different from Munich. • Different approaches to problem-solving and entrepreneurship.
Geographic Distance	5	• Silicon Valley is roughly 5850 miles from Munich. • Time difference between Munich and Palo Alto is 9 hours. • Travel time is around 12 hours by plane.

6.3.3 Skill and Task Division

The composition of the Tech Office reflects the overall discrepancy of knowledge bases between Munich and Palo Alto. PATYO effectively combines local know-how and know-who with know-how and know-who from central R&D, thereby creating a common basis of understanding through a closely-knit community of practice. Among the 15 engineers and scientists which permanently staff the office, half are expatriates "on loan" from the central R&D center FIZ in Munich. The other half is recruited locally, usually by virtue of having been educated at elite universities Berkeley, Stanford or Caltech, or on the basis of their experience at Silicon Valley technology companies. The head of the Tech Office is an experienced researcher or engineer from Munich. He or she holds the post for three years before returning to central R&D.

"All our current local engineers graduated at the local universities of Stanford and Berkeley and have good contacts to both universities with which we actively run projects. They help us use existing contacts and networks to companies and universities and to find new potential partners." (Interview, Simon Ellwanger, Project Manager Tech Office Palo Alto, May 15 2008)

The local hires usually have a background in engineering, IT and in the natural sciences. Their residence at the Tech Office is longer-term, on average four years. Conversely, German expatriates on long-term assignment stay in Palo Alto between a minimum of one to a maximum of three years. Expats on a short-term assignment related to a specific project stay between 3 months to 1 year. In addition, the team is usually reinforced by student interns from Germany, on a scheme that is intended to give them the opportunity to gain some international exposure. Other interns come from local universities and are usually drafted in conjunction with a research project at their institution. Expatriates staying at PATYO on a longer-term basis, between 1 to three years, are devoted to longer-term assignments and pursue various longer-term research projects. Those expatriates on a short-term stay come over to handle specific assignments required by their development unit. Thus, one group of expats is more experimentation-driven, while the other is looking for ready-to-go solutions to a specific problem.

"Especially in the daily work with predominantly non-automotive companies from the Silicon Valley the project-centered expatriates with their expertise and experience secure that projects are running on the right track and meet the automotive and BMW internal needs and requirements." (Interview, Simon Ellwanger, Project Manager Tech Office Palo Alto, 15.05.2008)

Typically, all German expats have at least five years of working experience at the BMW R&D center. This minimum period of residence is necessary to guarantee that the engineers have already established a sufficiently strong network in the organization. It also serves to ensure strong familiarity with the local processes and routines, as well as within the "BMW way", and ensures that they have been sufficiently socialized to be able to communicate effectively from a distance. Ideally, candidates for expat placement have succeeded in establishing a diverse network within R&D covering a range of different development units and hierarchical levels.

Such a composition and division of roles serves several purposes. First (1), engineers and scientist hired locally have a wide network of informal contacts within the Silicon Valley community of entrepreneurs and academia at their disposal. These ties are either passed on indirectly or, in some cases, become direct contacts of the long-term German expatriates co-located with the locals. Second (2) short-term expats use both the locals and the long-term expats as channels for finding solutions to their more short-term-oriented problems, with less direct interaction with the contacts outside of the office. Conversely, the short-term expats have the most current knowledge on the current strategy and priorities at central R&D. Local engineers possess the least knowledge of the needs of central R&D. Frequent rotation among the short-term expats ensures that the voice of central R&D is fairly up to date. There is, thus, an interlinking task and network overlap between three distinct groups at the office. Local hires command a strong network into Silicon Valley, on which expatriates can build in order to become integrated into Silicon Valley easily and quickly. Close socialization between local hires and expats further ensures that expats are rapidly made aware of "The Silicon Valley Way". Conversely, the expats make sure that the link to central headquarters is maintained, that centrally demanded protocol is followed, and that generally, legitimacy in the home organization is maintained, by bringing "The BMW Way" to Silicon Valley. As this quote illustrates, in a small organic setting, miniature versions of the Silicon Valley ecology and the combined competence of BMW's R&D organization are combined:

> *This structure has tremendous advantages because for example those people who are locals or part of BMW research it has the advantage that the entire company has a point of contact here in Palo Alto. If I say – I have a topic which might potentially be of interest to [unit XYZ] then I don't have to go to Munich but have someone sitting in Palo Alto in the Tech Office and can say – here, I have the following topic for [unit XYZ] what do you think, would this be of interest to them and who should I talk to". (Interview, Simon Ellwanger, Project Manager Tech Office Palo Alto, May 15, 2008)*

This form of task division seems to be fairly unique to technology outposts in Silicon Valley, especially in the automotive sector. VW Group, for instance, has a much larger technology office mainly consisting of local hires and usually run by German executives. Daimler also has a more locally focused set-up, as does Toyota (Interview, Project Manager VW, March 27 2009; Interview Eric Larsen, Tech Office Daimler, April 20 2009). The composition of the Tech Office also accounts for diversity in skill sets. Local hires usually have a background complementary to the mainly mechanical engineers from HQ. The locals mostly have degrees in computer science, electronics, and/or a more natural science-based educational background. Table 12 summarizes the task division in the Tech Office:

Table - 12 Task Division PATYO

	Locals	Long-term Expats	Short-term Expats	Interns
Training	Engineers, Scientists, IT-Specialists	Engineers	Engineers	Engineers, IT
Network Ties	Strong ties to local academia and Silicon Valley business community	Comprehensive Network in home R&D on various technical and hierarchical levels	Strong network to central R&D and home business unit	University
Task Specificity	Low – wide scouting within identified search areas	Medium to high, depending on pull- or push project	High- search for concrete solution for specified development project	Medium to high, project dependent
Duration of Stay at PATYO	4 years on average	1-3 years	1 month to 1 year	6 months

In this set-up of overlapping communities of practice, interaction and internal collaboration is actively encouraged. This is facilitated by the lack of hierarchy in the office. Below the head of the tech office, all other members, apart from interns, are on the same hierarchical level. In addition, regular communication between members of the Tech Office is formally instituted. For instance, members hold weekly reports on their project status. Once a project is successfully transferred, the project manager share the results and lessons-learned with other office members. Visitors from Munich are given a comprehensive presentation of all projects currently on-going at PATYO. In addition, the small organic structure of the office facilitates frequent informal contact. This can take place inside the office, in communal places such as the water cooler or kitchen, or during socializing after hours. Stephan Durach (Interview, March 27 2009), head of PATYO since late 2008 stressed, with its small, organic numbers, the office has attained an optimal size in terms of speed, which, in his opinion is the most critical aspect in scouting and quickly transferring emerging trends.

6.3.4 Knowledge Transfer Process

According to the interviewees, there is an even split between projects pertaining to concrete requests by mainstream R&D and those projects which are based on the initiative of PATYO engineers. As mentioned above, problem-oriented projects from central R&D are referred to as "Pull-Projects". "Push-Projects" on the other hand, are based on emergent technological, product, or market trends which are unique to the Palo Alto region and after initial assessment by the PATYO engineers, are considered of high relevance for automotive application.

In the case of pull-projects, development units in Munich encounter a problem and ask PATYO to identify a workable solution. In contrast to the push projects, pull projects are initiated from a central development unit of the BMW headquarters in Munich upon facing a problem or when identifying needs for change and innovation. These pull projects often concern trend scouting activities or university collaborations that conclude with a final report instead of a functional prototype. Depending on the complexity of the problem, development units from Munich send engineers for a temporary stay to work on a solution locally together with PATYO engineers and potential solution providers from the Silicon Valley area. These are those engineers which were earlier referred to as short-term expatriates.

> *"There is no difference within the project procedure of push and pull projects and the handling is quite the same. But projects that are initiated by a development unit in Munich start usually faster and the Tech Office is asked to come up with results promptly. In contrast, push projects which are established by the Tech Office often need some time until they can be started. The reason therefore is that we have to find a partner unit in Munich that is interested in realizing the project with the Tech Office and it can take some time to find this partner and to get their project commitment." (Interview, Simon Ellwanger, Project Manager Tech Office Palo Alto, May 15 2008)*

The other 50 % of projects pursued at any one time consist of ideas within PATYO's search focus which have been identified by the team itself. Immediately after a potential push project has been identified, PATYO engineers are required to identify a partner at central R&D willing to sponsor the project, as well as agreeing subsequent transfer and further development in central R&D. Ideas for push projects that don't spark the interest of a partner unit in Munich and thus will not get support from the BMW headquarter are usually not further pursued. Thus, even ideas identified in the local context by PATYO employees require approval by the central R&D before a pre-development project can be initiated. PATYO cannot develop prototypes solely on its own accord. For the PATYO engineers, this means that the survival of their ideas hinges on the willingness of a partner inside central R&D. There are several ways of finding a supporting partner:

> *"For the first contact ideally you already know some people and you have a network you can use in order to start a project with a development unit in Munich. The contacts and people I already worked with or talked to are mostly engineers. You can ask them easily if a project could be interesting for them or not. If I don't know anyone I usually get in contact with the head of the targeted department because he knows of course his engineers and which topics*

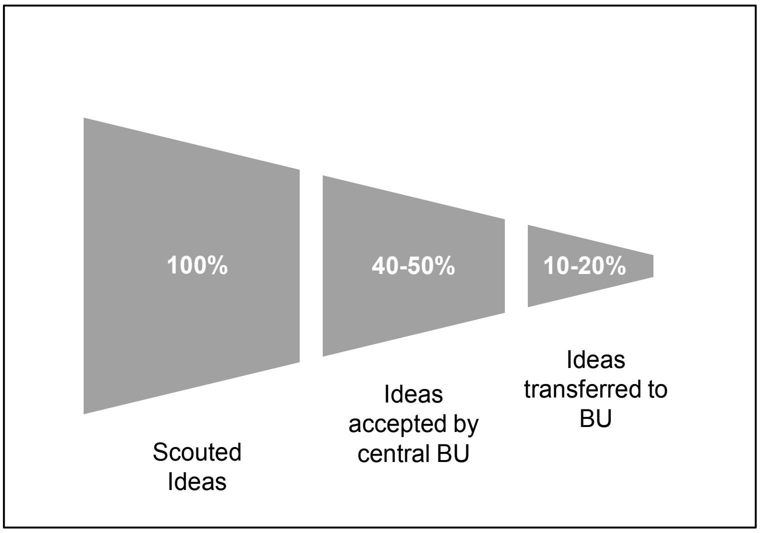
they are working on or have expertise in. Finally, I get in contact with the engineer the head of the department is telling me to present and discuss the project idea. The engineer usually decides whether the project is interesting for the department or not. If the engineer is interested to realize the project, he gets back to the head of department to ask for the official project agreement and funding." (Interview, Simon Ellwanger, Project Manager Tech Office Palo Alto, 15.05.2008)

You can contact people on operational level and say can we talk about it, but there are also things where you have to proceed differently, where you go from the top straight away, i.e. [Head of PATYO] takes it with him directly passes it on to [Head of Research in Munich] and he then delegates it to people directly… both is possible. It always depends on the task and the project and what you're looking to achieve and how you're thinking of reaching your targets. Sometimes you start at the bottom, sometimes you pour it in from the top you have to decide case-by-case. Both can make sense. (Interview, Marc Lengning, PATYO Alumni, 15 July 2008)

Another channel for the PATYO engineers is the constantly expanding network of PATYO alumni. These alumni are particularly open to ideas from Palo Alto and either champion ideas themselves in the home organization or function as enthusiastic brokers between Palo Alto and their colleagues at home.

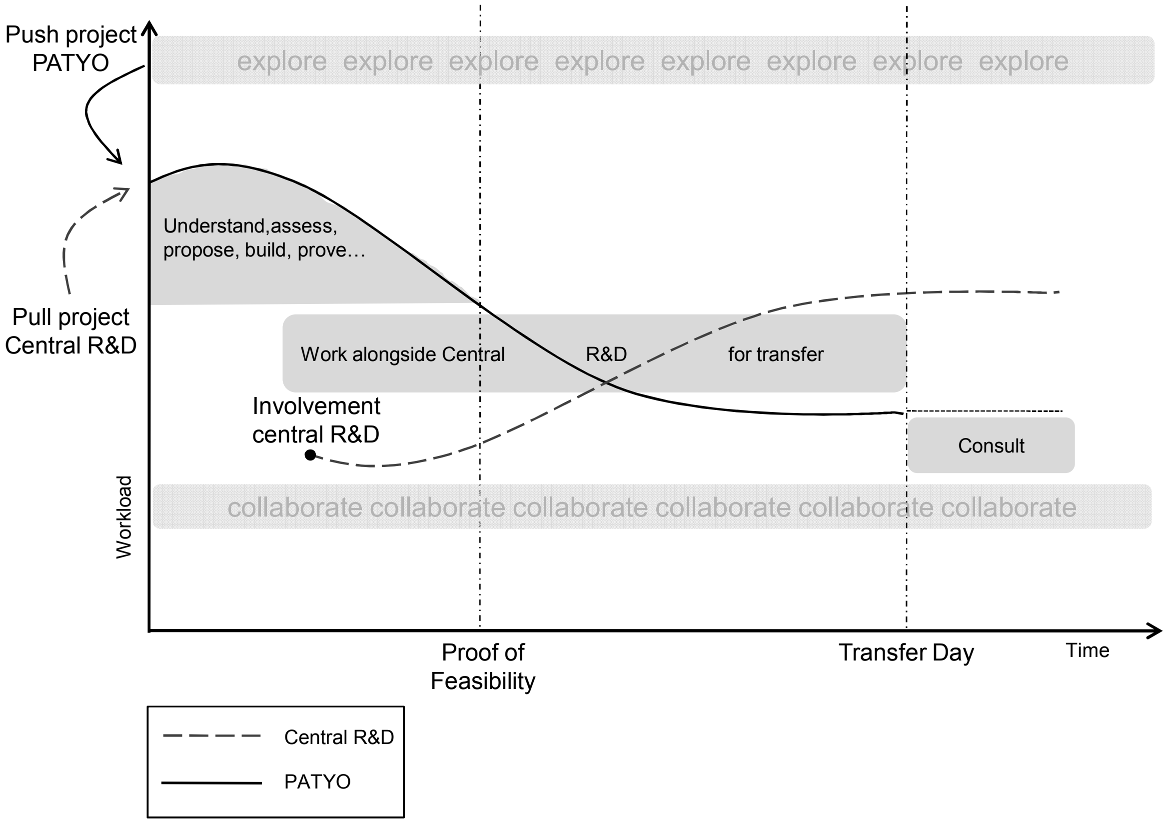
The Tech Office is able to start 40-50% of their ideas and scouted technologies as a project with a partner unit in Munich. Approximately 10-20% of these projects are successfully transferred to the partner unit in Munich, including the proof of feasibility and/or a functional prototype. Thus, 10-20% of the projects lead to follow-up projects and achieve the pre-development phase at the Munich research and development unit.

Figure - 26 Success Rate PATYO



In both instances, a transfer from Palo Alto to Munich takes place in a highly gradual fashion. From first conception of an idea or Munich's first communication of a concrete problem until the production of a prototype or feasibility study and subsequent assumption of responsibility by a business unit in Munich, the transfer process usually doesn't take longer than 6 months. Figure 27 illustrates the gradual change in responsibility from PATYO and Munich:

Figure - 27 Knowledge Transfer Process from PATYO to Central R&D



Source: Adapted from BMW internal presentation

Push ideas are managed by the PATYO engineer who initiated the idea. Pull requests from Munich are delegated to those with the relevant expertise, know-how and contact network. In the problem-driven pull projects, the business unit in Munich often sends its own engineer to head up the project on a short-term expat contract (3 months to one year). In either case, Palo Alto engineers and short-term expats are provided with a counterpart at the partnering business unit in Munich. The counterpart in Munich has the required expertise, as well as enthusiasm for the project to support and promote it inside the business unit.

Toward the beginning of PATYO projects, the onus is almost entirely on PATYO engineers. Predominantly, engineers are preoccupied with tapping their local networks. Establishing relationships and partnering with companies, universities (lectures and presentations at universities) and research labs is indispensable to explore, evaluate and apply trends and promising technologies and realize projects in cooperation with the BMW partner unit.

It is also based on or in collaboration with their local networks that PATYO proceeds to develop a proof of feasibility or a prototype, depending on the nature of the project. Here, a crucial aspect enters PATYO's process. A proof of feasibility and/or prototype needs to conform to the stringent requirements necessitated by BMW's standards and requirements. The PATYO engineers need to strike a fine balance between providing novel innovation on the one hand and maintaining conformity with central R&D on the other hand. Thus, a highly critical component of the process at this stage is transforming creative inputs into a form that is suited for absorption by the business unit in Munich.

Central R&D in Munich, conversely, has either passed on early responsibility through a request for a pull project, or it is approached only once some development has gone into a new idea. If the business unit in Munich has posted a request for a problem-centric solution, it will answer questions related to requirements. In the case of a push project, a sponsoring unit is approached early in the idea development to secure that further development into a prototype is relevant. Once a feasibility study is completed and/or the prototype finalized, PATYO prepares handing over the project lead to the business unit in Munich. From then on, Munich takes on responsibility for the further development into serial production, while Palo Alto can be tapped for further questions. Thus, after transfer, the Tech Office project is treated like any other pre-development project running within BMW Group's central R&D. As described earlier, the metrics employed to measure transfer success consider this transfer successful and complete at this point in time.

> *"The way we measure success is that we look at how many projects have been handed over from the Tech Office to a development unit in Munich. I think the process leading up to that hand-over has reached an optimum. It is true though that we cannot say much about what happens next. The process for finally realizing these ideas leading up to serial production requires more attention probably." (Interview, Dr. Bernardo Lopez Alvaredo, head of Palo Alto Technology Office 2005-2008, 20 January 2009)*

6.3.5 Communication Channels

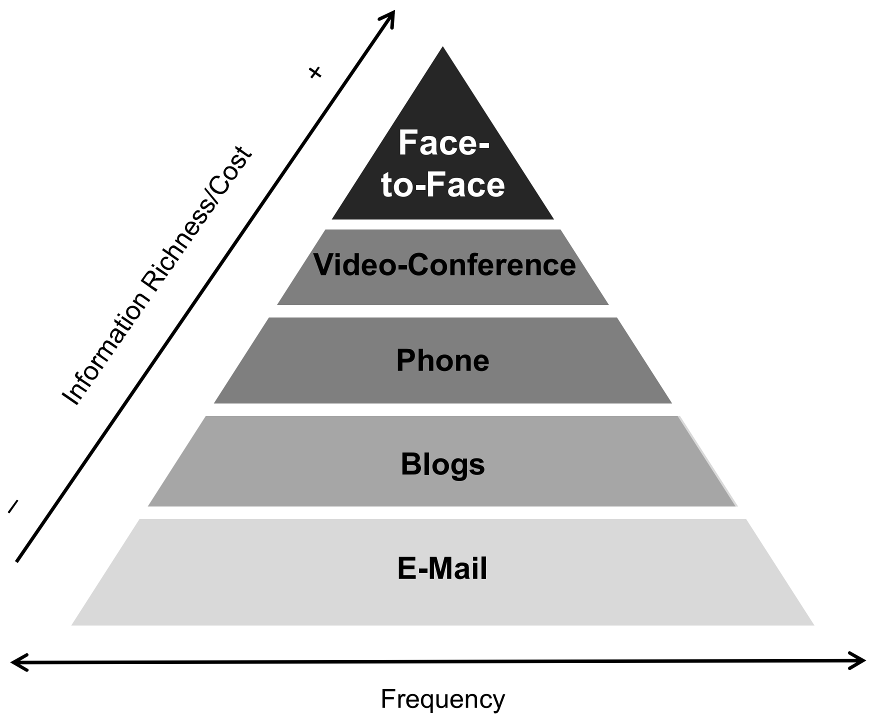
Once commitment to run a project is secured both in Palo Alto and Munich, each end defines one project leader to act as the central interface through which all communication takes place. The Tech Office engineer bundles all information received from universities, research institutions, and firms in North America. At the same time, he channels queries and requests coming from central R&D and transmits them to his/her network. The engineer at Central R&D fulfills the same interface function within the R&D organization, coordinating queries from PATYO and conversely communicating requirements from the units in Central R&D. Most frequently, the communication channels employed consist of e-mail, blogs, and phone and video conferences. Complementing internet and other distant communication channels, the PATYO project managers undertake two to three trips per year to Munich. The purpose of these visits is first, to meet with relevant counterparts to discuss the progress of the projects, second, to hand the project over, and to network and find potential partnering business units for future projects.

Interviewees stressed that these face-to-face meetings make or break the entire success of the Tech Office's operations.

> *"The Tech Office Palo Alto is dependent on the network and the employees` trips to Munich. Before we stop sending our employees to Munich we should close the Tech Office because it is quite impossible to establish new projects without face-to-face contacts. A well working communication ensures the success of the Tech Office and besides e-mails, telephone and video conferences regular visits from the Palo Alto staff in Munich are crucial and secure the integration of the Tech Office into the BMW development process." (Interview, Max Kicherer, Alumni Tech Office Palo Alto, 07.05.2008)*

Thus, face-to-face appears to be a crucial lubricant for securing smooth operation of the technology outpost. It serves to prevent communication decay as well as counters increasing drift to the organizational periphery. In addition, it is paramount to establishing new relationships, which might otherwise not find interested parties in the main organization. Engineers from central R&D also travel to Palo Alto should their presence be required for the continuation of a project and the necessary budget be available. In recent years, the short-term rotation has increased, as Stephan Durach notes (Interviews, March 27, 2009). Rotation was found to be more effective in transferring BMW relevant knowledge.

Figure - 28 Communication Channels Between PATYO and Central R&D



Source: Own

6.3.6 Motivation and Incentives

The motivation to spend time in Palo Alto for expatriates does not seem to be primarily for career progression. Rather, interviewees stress that there is considerable conflict of interest, since the time away from headquarters may mean that the absence compromises the pursuit of career opportunities. One of the most critical factors influencing promotion is to be continuously present and available and manage and expand the internal network. Intuitively, it would seem that spending time abroad Since half of the members of the Tech Office are expatriates from the home R&D center, incentivization is critical since an extended stay at the Tech Office can lead to "being out of the game" at the central R&D organization. Interviewees also stressed that the perception at the home organization of executives going abroad is always perceived as "slacking off" – especially going to California is associated at home more with surfing and beaches than high-technology and hard work. Such an attitude leads to considerable lack of appreciation for the achievement and the effort invested in expatriates. As Sven Beiker, a former member of the Tech Office notes:

> "*There are trade-offs. Your career will inevitably suffer. People at home think you're going on a holiday. Basically, you're career is on hold while you're in Palo Alto." (Interview, former team leader PATYO, 17 April 2009)*

The interesting side effect of this lack of appreciation is that engineers are aware of the consequences for their career, and their choice to spend time in Palo Alto thus reflects a considerable intrinsic motivation, curiosity and genuine interest in innovation rather than mainly careerist intentions, which would otherwise be difficult to identify among staff. Bernardo Lopez for instance notes that:

> *"Usually, the people that go over to Palo Alto are by default very open people. A while back, I asked a highly skilled colleague to come over for a while, but he refused on grounds to do with the change of location." (Interview, Dr. Bernardo Lopez Alvaredo, head of Palo Alto Technology Office 2005-2008, 20 January 2009)*

It could therefore be implied that the engineers who opt to spend time in Palo Alto are intrinsically highly motivated, which is ensured simply by the fact that geographical relocation mostly attracts individuals who have the desired qualities to really drive innovation simply for the enjoyment of having their own ideas realized – and making a difference. As one of the Alumni stressed – "you simply cannot work like in a startup in a big corporation". Candidates that opt to go to PATYO are therefore by default both networked internally, but have an open mindset which makes them well-suited for the task. This is endorsed by the high incidence of alumni pursuing projects they initiated in Palo Alto once back in Munich. Thereby, they become classical project champions, pursuing their "pet projects" to the greatest part for their own enjoyment.

The motivation to innovate is however not shared among the counterparts in central R&D. PATYO engineers stress that their often exists a goal conflict between their mission to find novel ideas and the goals and targets of central development units. This conflict of interest is reported to represent one of the main barriers to the transfer or PATYO push projects.

6.3.7 External and Internal Status

The German expatriates in Palo Alto must have had at least 5 years working experience inside the central R&D organization, and are required to be highly competent in their technical area. Thus, they are already well connected in the development units, and are expected to have a positive reputation back home. Naturally, the head of the Tech Office is more senior than the average PATYO expat engineer and has even better connections and standing within the home R&D organization. Mostly, engineers are seconded by their home development unit with a concrete remit to look for new technology:

> *"Then came the time at [engines development unit] when they said „ok, we also want an engine developer in Palo Alto", which was a little surprising since at the time it was actually an electronics office, for electronics development, internet in the car and things like that. Anyway they said let's send an engine developer to see whether we could find something out for engine development." (Interview, Marc Lengning, PATYO Alumni, 15 July 2008)*

Conversely, status and awareness of the PATYO engineers externally, in Silicon Valley, is enhanced by the general positive brand perception of BMW. As pointed out in many interviews, for instance:

> *"The name BMW is an incredibly powerful door opener. Even if I didn't have a clue about anything, I would still be invited into extremely many circles, simply because it's great to have BMW at the table".*
> *(Interview, Martin Ertl, Head of Innovation Impulses, 15 June 2008)*

Whereas BMW has a reputation which transcends the automotive industry, mostly by virtue of its products, it seems to be still necessary to invest in relationship building, particularly when the nature of the relationship is not ex ante clear. One engineer reports, for instance, that:

> *"In my case the problem was, I was the first engine developer, so I first had to advertise in order to spread the word that "there's someone who's doing engine and energy technology". With internet issues, people knew which interesting things they had with internet and cars, then they can go to the BMW Tech Office, but for energy issues, we first had to become known. So, naturally, first make visits to Berkeley and Stanford and say, hey, we are here".*
> *(Interview, Marc Lengning, PATYO Alumni, 15 July 2008)*

6.3.8 Examples of Successful PATYO Projects

BMW's iDrive

The inspiration for BMW's revolutionary iDrive interface came when, at the end of the 90s, the top-of-the-line cars had far too many separate control elements, buttons, signs and lights which took up most of the cockpit and had a negative aesthetic impact, in addition to generally confusing drivers. The idea behind the iDrive, thus, was to combine the majority of human-machine interface, apart from headlights control and heating into one system, so to speak into a one-touch button which would be able to control all relevant sub-systems of the car. The iDrive system premiered at the Frankfurt Moto Show in 1999, and was first presented in a serial car at the same show in 2001 (www.usautoparts.net/bmw/technology/idrive, accessed 28 August 2009). In order to develop tactile aspects of the iDrive, BMW collaborated with a Stanford spin-off company, specializing in tactile feedback mechanisms, primarily for the computer and video games industry called "Immersion Corp". Immersion provided the software which ensures that the visual image from the screen translates into feedback in the iDrive controller[31]. Subsequently, BMW also collaborated with Alps Electric, which provided mass production (Whitfield, 2002). Unfortunately, BMW suffered the classical drawbacks of being a first mover in relatively unchartered technology territory. Early versions of the iDrive were considered a user interface nightmare, and the user manual boasted more pages than the average phonebook. Nevertheless, BMW's bold move resulted in a relatively radical innovation, which soon diffused to all other automotive manufacturers. Such a fast and radical move could certainly not have been possible without the presence in Palo Alto. It seems, according to some of the unstructured interviews and informal conversations, that the then CTO Reitzle, toward the end of his tenure, was instrumental in pushing the iDrive further.

Google Search Function

Another representative example of PATYO's projects is BMW's Google enabled "Google Send-to-Car" and "Google Local Search" service. In October 2005, the idea to provide Google's search services in a BMW car was discussed in the Tech Office. One of the PATYO engineers suggested the idea to send Google search results, for instance for restaurants or other points of interests directly to the car's navigation system. Similar thoughts had already existed at the marketing department responsible for BMW remote assistance service "Connected Drive". Both sides set to work quickly. The Tech Office convinced Google to enter into a collaboration partnership and the internal marketing department created the formal contractual framework for the collaboration, as well as ensuring that internal technical and other requirements were met. Already in May 2006, the Tech Office had created a functional prototype. The service would enable customers to send Google maps search results, via their BMW "Assist" portal, to

[31] Later versions of BMW's iDrive discarded the tactile feedback logic since it slowed down menu navigation, in particular scrolling long lists.

their car, where it would be received in the form of an SMS and be available as a choice of destination in their navigation menu. Jeff Zabel, the responsible project manager, stressed that frequent face-to-face meetings were essential in making the collaboration work:

> *"Typically, big picture decisions were done face to face if possible, if not, we had multiple conference calls. The work we established at these meetings was traded between meetings via email" (Interview, Jeff Zabel, Project Manager PATYO, April 24 2008).*

In July 2006, the agreement to launch the service was signed by all parties, and on March 6, 2007, the service was launched in Germany. Subsequently, the responsible marketing department at BMW expanded on the initial idea and suggested to provide a full "local search" service to BMW customers as part of their connected Drive service. Again, the Palo Alto Tech Office facilitated the collaboration with Google. A working prototype was ready by March 2007, and already in September 2007, the local search service was launched.

6.3.9 Barriers to Knowledge Transfer

Yet, also based on data and analysis, the success seems limited to a certain maximum level of novelty which can be matched with the existing operations. By and large, although, especially compared with other actors in the industry, the success in integrating distant knowledge are considerable, the existing organizational routines preclude truly radical innovation.

Table - 13 Barriers to Knowledge Transfer PATYO

Barrier	Example
Selection	
Low-Powered Incentives at central R&D: Incentive structures at central R&D are indifferent or even adverse to higher-risk, innovation projects.	*"Palo Alto has good ideas that could be realized but in Munich you encounter budget freeze and people who won't work outside normal hours and a management structure which isn't awarded or is penalized if you don't come up with some new things regularly":*
Sunk-vs. Opportunity Costs: Ideas originating from Palo Alto are evaluated using the same evaluation metrics (e.g. NPV, value at risk) as internal incremental projects	*"If a Palo Alto employee creates a first design-prototype, the BMW HQ project manager evaluates the project according to all BMW Germany-specific criteria, which are applied to all projects which go into serial production later on."*
Cyclical Budgeting: After the yearly budget allocation process has been completed, there	*"…in times of restricted budgets it's always difficult for Palo Alto to find a partner here in Munich if people say – well*

may be little scope for taking on additional projects	*that may be interesting but I have neither budget nor time to support you."* *"80% of the time projects fail because of a lack of resources in Munich."*
Anti-Cannibalization Bias: Internal Project managers may perceive new ideas proposed by Palo Alto as threatening to their competencies	
Misalignment with Development Unit Strategy: Push projects may also be rejected due to non-fit with current strategy and goals of the development units, which may also be subject to relatively sudden change.	
Slow Bureaucratic Decision Making: Once ideas from the tech office have been transferred, they are subject to the same stage-gate processes applied to all other ideas. The advantage of speedy introduction of new features based on an advanced market such as California, often get lost in such a slow-moving environment.	**"***With project [XYZ] we've been fighting for 8 years, not sure how that's going to go on". (Interview, Marc Lengning, PATYO Alumni, 15 July 2008)*
Product/ Technology	
Regulation: When commencing a push project, it is often not possible to take into account all potential regulatory implications. Since the automotive industry is a heavily regulated industry, the scope for innovation is considerably restricted.	
Outsourcing of Non-Core Tasks: Ideas and technologies are rejected by a development unit on grounds of lack of internal competence since the competence has long ago been outsourced to suppliers. In such cases, there often don't seem to be clear guidelines as to which supplier or whether a supplier should pursue the idea identified.	
Complexity: Automobiles are highly complex products, thus components going into the cars	

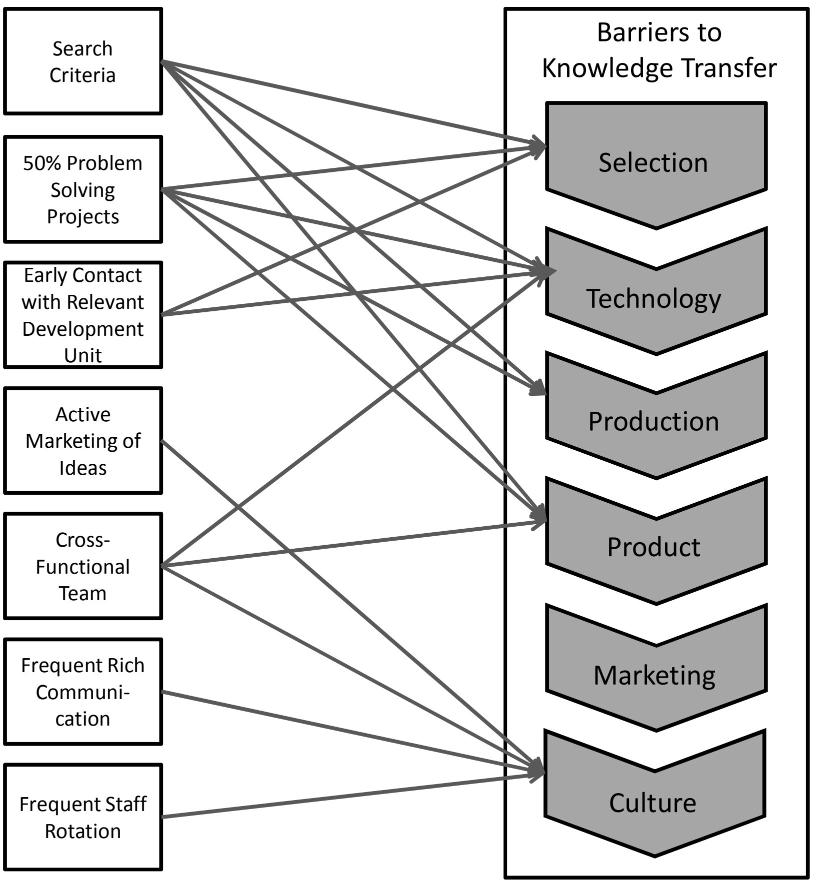
require highly systemic innovation. It is rare that components can be readily plugged into the existing system. Having the necessary space, which is scarce in the tightly packed subsystems of the car, for example is crucial. At times, in order to fit one component, another must go. Lacking interoperabiliy adds to the complexity. Especially electronic systems need to be able to successfully interact with the entire electronics structure of the car.	
Marketing/ Distribution	
Business Model: Push projects initiated by PATYO may not meet market requirements, or may not have an obvious stakeholder at BMW headquarter since idea does not fit in with existing business model.	*Although we have a lot of customer-centric innovations, we don't have any marketing or sales person from MINI and BMW in Palo Alto, which is wrong of course. So, you have these technology-crazy engineers working on all these things, I was never sure why we didn't have anyone here. That's an open question, why we don't have a customer's view here.*
Organizational Culture	
Ethnocentric Culture: BMW's culture is still largely homogeneous and ethnocentric **NIH:** NIH cited a major barrier as a characteristic of individual contacts in central R&D development units.	*I wish the company were more open.*

6.3.10 Matching Strategies Addressing Knowledge Transfer Barriers

Since its launch, PATYO's process has been carefully refined in order to address the barriers described above. Particularly the introduction of search criteria and the 50/50 split of push and pull projects ensured that the ideas scouted matched requirements and scope of central R&D. By hiring local experts, PATYO is able to tap the right sources in Silicon Valley effectively and efficiently. The comprehensive personal contacts of local engineer working in the Tech Office enable face-to-face interaction with relevant individuals without requiring the lengthy establishment of new relationships and contacts. Further, the local provide the Tech Office with the required expertise to recognize and understand technologies which lie outside of BMW's competence.

By combining the locals with expatriates from Munich, PATYO effectively creates communities of practice which create mutual understanding through direct involvement. This enables the transformation of locally source knowledge to conform to the requirements and "language" in Munich. The permanent presence of expats and frequent visits by people from central R&D also ensure that the knowledge sourced in Silicon Valley can be matched with the respective competence in central R&D. Even push projects require an interested partner before commencing further investigation or local pre-development – thereby ensuring subsequent relevance and transfer to central R&D. While these mechanisms address nearly all of the barriers cited by interviewees, one aspect has been omitted. The search criteria and pull project restrict the knowledge sought in terms of radicalness. Interviewees stressed, that breakthrough ideas originating in PATYO stand little chance of being implemented. Such radical ideas lack a counterpart in Munich and do not fit with the existing business model/market. Therefore, while on the whole, PATYO's process seems highly efficient in transferring a large scope of novel ideas to the mainstream business, the structures at home do not support radical innovation. Figure 29 illustrates how matching the matching strategy addresses the barriers in knowledge transfer:

Figure - 29 Summary of Mechanisms for Overcoming Knowledge Transfer Barriers:



6.4 BMW's Virtual Innovation Agency (VIA)[32]

6.4.1 Strategic Rationale for the Creation of VIA

Shortly before BMW opened its Technology Office in Palo Alto, the company started streamlining its internal innovation activities. Due to the same competitive pressures outlined in the previous case, the research and development function was streamlined for efficiency. This efficiency initiative also targeted the early, pre-development phase of new product development. Particularly development redundancies were targeted. Before 1997, R&D was conducted in technical silos with sometimes up to 1000 component and system innovations being developed simultaneously, leading to considerable task overlap and redundancies (BMW Science Portal, January 21, 2003):

> *"There wasn't any steering group that discussed development projects […]. Business units were oriented towards their components. The engine developer developed engines, vehicle developers developed vehicles." (Interview, Stefan Gabriel, Former Innovation Field Manager, June 07, 2008)*

The re-structuring of the early innovation phase would consist of several aspects. First (1), an Innovation Management function was created, consisting of generalists which had not previously worked in a particular development unit in order to avoid bias and favoritism toward their old development units. This management function was expected to act as an objective consultant and strategic staff function. Second (2), the Innovation Management function created overarching innovation themes, so-called innovation fields, derived from corporate and innovation strategy, which would ensure that all development projects contributed to BMW's strategic goals. These innovation fields further enabled that certain component development units with overlapping or redundant content could be combined.

> *"For example interior lighting, the idea was not anymore centered around the lamp, but how can I illuminate the interior, so this can be a lamp, but also foil, candles or anything, but it's about finding the appropriate technical solution to meet a customer need." (Interview, Stefan Gabriel, Former Innovation Field Manager, June 07, 2008)*

Third (3), the innovation fields, headed by an executive from innovation management representing a strategic point of view, convened in regular intervals for the prioritization of projects in a cross-function steering group with representatives from R&D, marketing, finance, and production. Thereby it was ensured that decision making was based not solely on technical grounds, as had been done before. Fourth

[32] BMW Group first launched their web-based innovation portal in 2001. In 2008, the portal was updated and much improved in terms of functionality. However, this account and analysis is restricted to the "first" version of the portal, and developments after the re-launch are not considered.

(4), this concept was extended to cover BMW, Rolls-Royce and Mini, in order to create modular platforms which could be used across all brands. Furthermore, as part of the streamlining effort, the prioritization of pre-development projects was given a cross functional steering group attached to it, combining technology, marketing, production and finance. Such a steering group was expected to significantly reduce uncertainty in decision making in the early phase of innovation, which up to then had been the sole responsibility of technical engineers.

Today, the Innovation Management department is part of R&D development strategy, which is directly subordinated to the CTO. It is split into innovation impulses, responsible for monitoring developments outside the automotive industry and creating future scenarios, Innovation Controlling, responsible for portfolio management of internal R&D projects, and Innovation Transfer, responsible for transferring pre-development projects to internal "customers" at serial development. BMW Group's Innovation Management has been awarded the "Outstanding Corporate Innovator" (OCI) Award by the Product and Development Association (PDMA) in 2002[33] and the "Best Innovator Award" Germany in 2004 awarded by the leading business publication "Wirtschaftswoche" and the management consultants A.T. Kearney, supporting BMW's reputation as an innovation leader also in processes.

In 2001, the Innovation Impulses team was extended by an online portal. This portal was called Virtual Innovation Agency (VIA) and was intended primarily as a channel for innovative smaller and medium sized companies outside of the automotive context. Such technology firms were expected to use the portal to get in touch with BMW and submit proposals for technologies which might be relevant for the car maker in the medium or long-term future. Although companies like Procter & Gamble have similar portals, BMW's Virtual Innovation Agency was unique in the automotive industry. Since the launch of VIA in 2001, the number of received ideas per year progressed from 350 per year to a record 1000 ideas received in 2004. The majority of submissions were made by private entities, rather than smaller suppliers or technology providers. Moreover, submissions have a strong automotive context, rather than the non-automotive context intended. In the years 2001-2007, only few ideas that were received had had an impact. Although official numbers cited a ratio of 800 received ideas to one implemented idea, in many instance it was difficult to entangle whether these had been truly novel ideas or whether they had been harbored internally for some time. Due to the disappointing results of the portal, in 2007, it was decided to re-conceptualize the logic and processes behind the portal. In summer 2008, a new version of the portal went live. This case, however, focuses on the processes behind the first version of VIA and tries to uncover why the portal failed to successfully transfer knowledge distant from the current context.

[33] The OCI award is considered the "Oscar" for new product development and innovation management processes and BMW was the first company outside of the US to be awarded the prize.

Whereas the creation of PATYO was driven directly by the CTO, VIA was the brainchild of equally visionary middle management. The idea of tapping the internet as a source for innovation was revolutionary at the time the first plans for VIA were drawn up in the late 1990s. It also made sense to make VIA part of Innovation Management since it therefore had excellent connections to all development units. Using a web-based platform also made sense in this regard from a cost-efficiency point of view. The website relied on the "pull-effect" of the BMW brand, requiring little investment for marketing the portal. However, as opposed to PATYO, VIA was much less driven top-down, but rather, bottom-up. This restricted VIA to be widely and firmly integrated with the rest of the organization. For instance, several years after the launch in 2001, the majority of R&D staff did not even know that VIA existed.

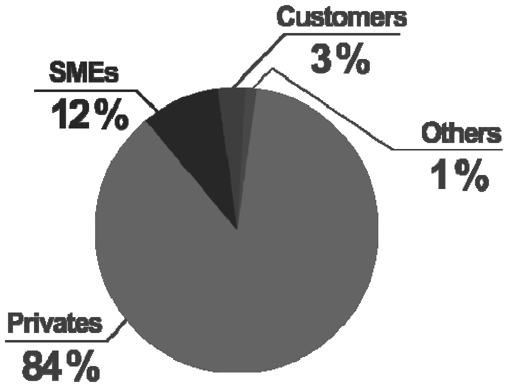
6.4.2 Search Focus and Sources of Innovation

BMW Group's Virtual Innovation Agency was deliberately open with regard to submission. In principal, every individual or organization could post or email ideas, concepts, or concrete technologies pertaining to products or processes related to BMW's activities. To some extent, this was a concession to providing a central interface for improvement suggestions which reach the company via many different channels, for instance letters or emails directly addressed at top management. However, the website clearly stated a preference for small and medium-sized -companies (SMEs), without any prior business with BMW, as their main target. Other than the statement on the first page of the VIA website, no further restriction applied to submitters. As Martin Ertl, Head of Innovation Impulses explained:

> *"Although primarily we look for, say, innovative start-ups, there is value in every idea. For instance, we had a shaman proposing to stand at the end of the production line and putting a curse on every car in order to prevent theft. Even though this may sound outlandish, it should nevertheless give us some food for thought. What could we do to really make car theft unpleasant for the thieves – for instance, cranking up the stereo to full volume to make it impossible to drive" (Interview, Martin Ertl, Head of Innovation Impulses, June 15, 2006).*

An analysis of the most common submitter groups conducted by the Innovation Impulses team annually, indicated however, that most submissions came from private individuals:

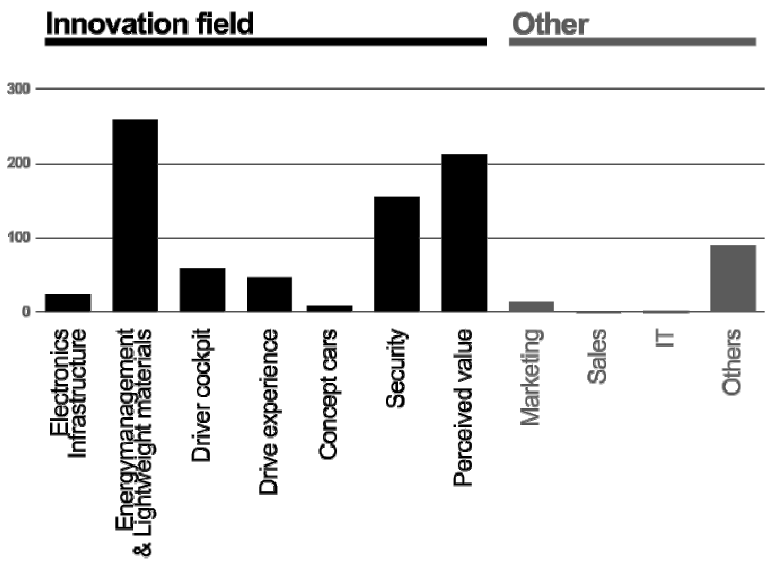
Figure - 30 VIA Submitter Classification



Source: BMW Group, Presentation (2008)

The category "Private" refers to private individuals, independent of organizational affiliation. Around 3 per cent of submitters owned a BMW car and often comment on a particular feature of their vehicle. 12 per cent of submissions originated from companies, offering ready-to-go products or services relevant to BMW products or processes. Geographically, according to Thomas Würtenberger, VIA administrator (Interview, March 21, 2007), there was also a strong predominance of submissions from the Middle East and China. Innovation Management believed that this was due to the especially high popularity of the brand in those areas and the comparatively high incentives should an idea be accepted. The maximum amount of €60.000 which VIA promised for successful ideas had a particularly high real value in countries with comparatively lower purchasing power parity. By virtue of the medium used, the Virtual Innovation Agency operated through a "pull" mechanism. Submissions to the platform were motivated in large parts by the very positive reputation of the car manufacturer in innovation and R&D, as well as by the general image of its products. Again, apart from a brief statement on the website, which specified that mainly small and medium companies are sought with ideas pertaining to BMW's products and processes, search criteria were absent. Also internally, no search criteria had been formulated, a deliberate decision to get an unbiased, full spectrum of ideas. Without having been prompted, the submissions in 2007 covered the following topics:

Figure - 31 Categorization of Submissions According to Topic



Source: BMW Group, Presentation (2008)

The large majority of ideas received thus, came from a very heterogeneous pool of individuals from all over the world, although, according to the interviewees, with a certain predominance of submissions from the Middle East and China. Based on the interviews and the statistics provided by the case company, the mean novelty of ideas coming in through VIA could be described as follows:

Figure - 32 Knowledge Distance VIA

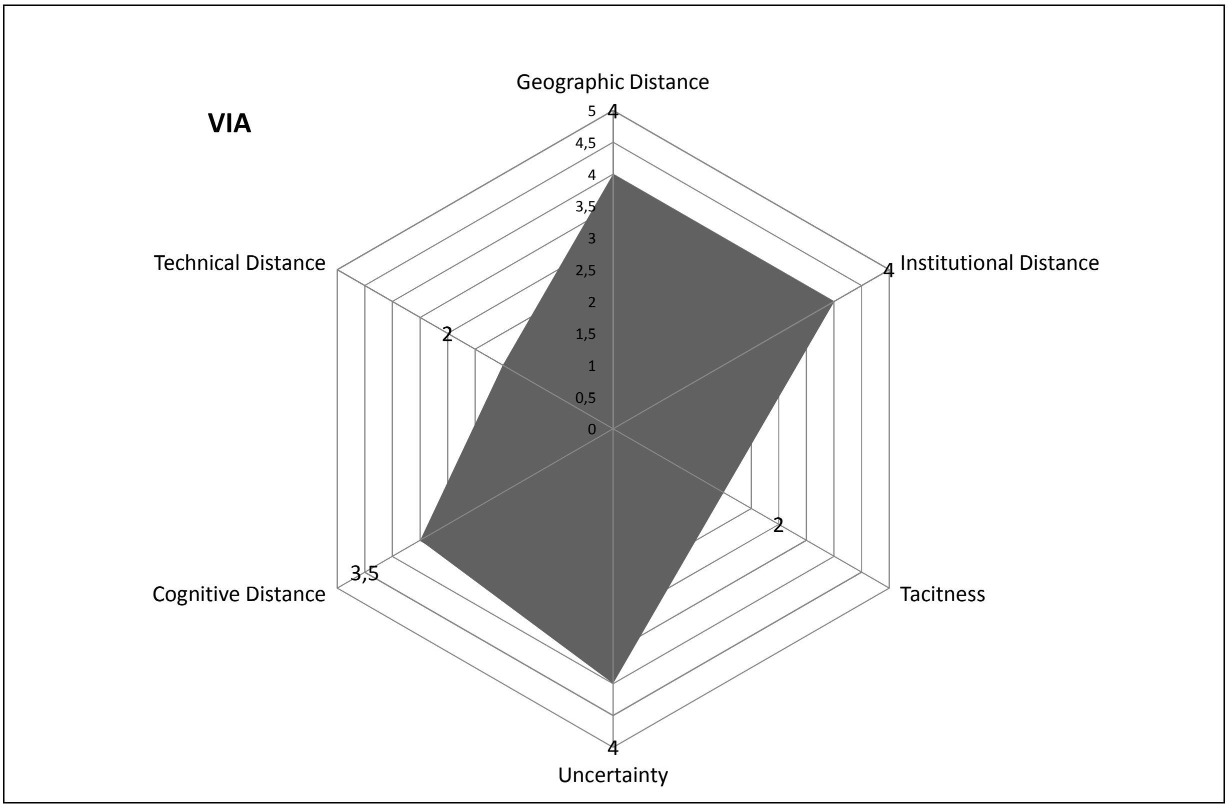


Table - 14 Knowledge Distance VIA

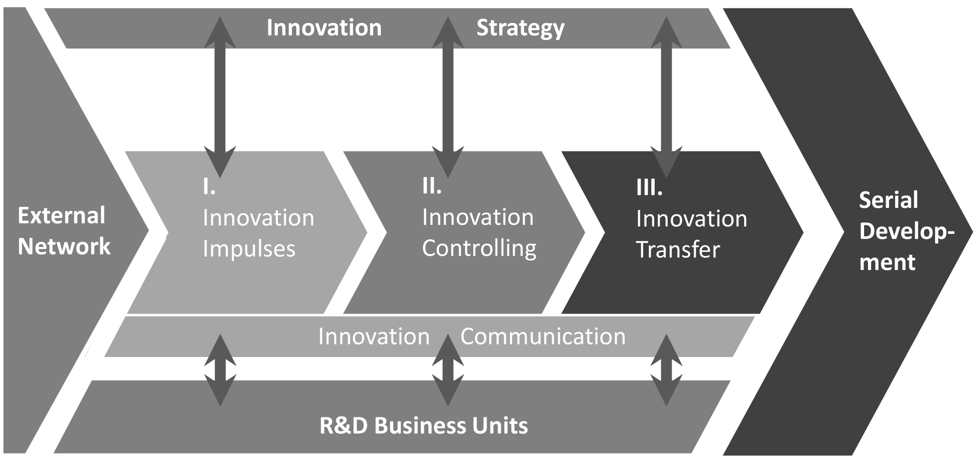
Dimension of Novelty	Value	Explanation
High Uncertainty	4	• Many submissions in idea stage with little description of technical implications. • Submissions lack thorough assessment of potential market. • Potential business model often little explored.
Tacitness	2	• Online medium requires codified knowledge to be transmitted but also restricts ideas less codifiable. • Appropriability high since submitters surrender potential IP to BMW or already have IP before submitting idea.
Technical Distance	2	• Technical distance low, since most submitters are BMW "fans" ideas have a strong automotive bias.

Institutional Distance	4	•	Both cultural as well as formal institutional context of ideas is often highly distant from BMW.
Cognitive Distance	3,5	•	On average, cognitive distance is moderate to high.
Geographical Distance	4	•	The world-wide-web enables submissions from all over the world, spatial distance, time difference and travel times high, particularly given the dominance of Middle Eastern and Asian submissions.

6.4.3 Skill and Task Division

Until 2008, BMW Group's Innovation Management function comprised around 25 FTEs, in addition to one or two student interns as well as 1-3 PhD students. The activities of Innovation Management were divided into a three-step process. The first step in the process is filled by the team responsible for Innovation Impulses. These impulses are intended to come from outside of the automotive industry, from areas such as IT, material sciences and alternative energy. In addition to the Innovation Impulses team, Innovation Management contains Innovation Controlling, which steers, monitors and budgets on-going internal development projects, and Innovation Transfer, which assigns development projects to a vehicle project in serial development.

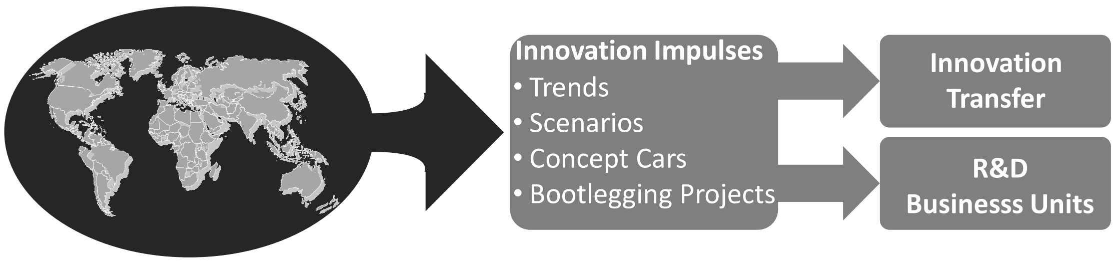
Figure - 33 Innovation Management Process at BMW Group



Source: Own adaptation of information provided by BMW Group

Innovation Impulses (I.) is intended to act as an "ear to outside of the automotive industry", and has been designed as a search function monitoring technology and developments outside of an automotive context. Innovation Impulses draws on, in addition to the virtual innovation agency, a web of external sources, including all the technology outposts and other components of the global innovation network. Based on the input from its wide range of sources, the impulses team derives a set of short, medium to long-term trends, particularly with a focus on non-automotive technological developments (Presentation, BMW Group, Oct. 27, 2007). These trends contribute to the strategy formulation process which is conducted by the innovation strategy unit. All the findings from the external innovation network are documented in so-called "technis-reports", which are essentially factsheets summarizing key developments and trends. These reports are disseminated to the R&D organization via the internal knowledge management system and via e-mail. The head of Innovation Impulses further carries out representative tasks for Innovation Management, representing BMW Group and Innovation Management in a number of industry networks, research and universities network, and acts as an expert speaker.

Figure - 34 Innovation Impulses Process BMW Group



Source: Own

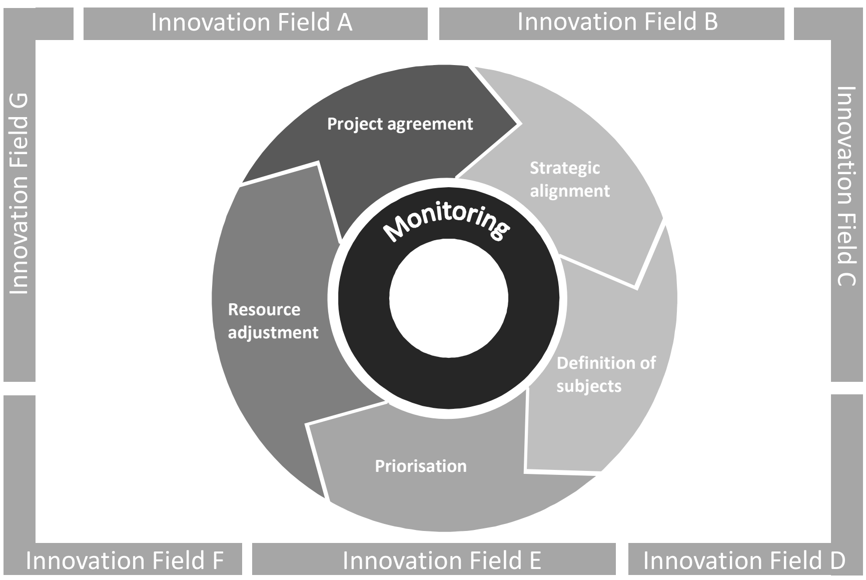
Innovation Controlling (II.) is a form of portfolio management of all the development projects contained in the early phase (pre-development) of the new product development process. The function's responsibilities comprise both budget- as well as technology coordination. In order to facilitate coordination of pre-development projects, Innovation Controlling contains seven different innovation fields, referred to as "councils". These innovation fields summarize several different development units according to an area defined by the innovation strategy. For instance, in 2002[34] innovation fields included:

[34] Innovation fields are regularly revised in accordance with the innovation strategy, so the current innovation fields are likely to be different from those communicated in 2002.

1. Concept Cars and Experimental Vehicles;
2. Energy Management;
3. Convenience & Service;
4. Driving Experience;
5. Lightweight Materials;
6. Safety and Security;
7. Value & appeal.

The council meetings, essentially steering groups, help to reduce redundancies in development by bringing interrelated development units together. Further, they involve cross-functional experts from research, development, production, marketing and sales. The cross-functional and cross-technology council is headed up by an "innovation field manager" from Innovation Controlling and jointly assesses, monitors and prioritizes on-going development projects. Innovation field managers are experts in the technology area that pertains to their council, which also enables them to interact with project leaders on a more detailed content level.

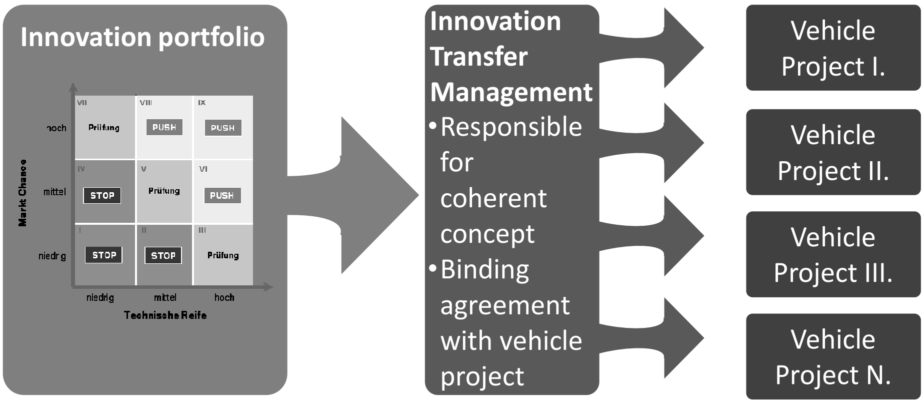
Figure - 35 Innovation Controlling Process BMW Group



Source: BMW Group Presentation, (2007)

Innovation Transfer Management (III.) ensures that the innovation portfolio is combined into a set of features which can then be implemented in a complete vehicle. For instance, Transfer Management defines which of the pre-development projects, will form part of the overall product offering of a new 7-series, making sure that the new technical features offered reflect the essence of the new product and underline its premium aspiration. As part of managing the transfer to the final product, Transfer Management creates comprehensive "business plans" which assess the individual pre-development projects' strategic, market, technical, and economic risks.

Figure - 36 Innovation Transfer Process BMW Group



Source: Own adaptation of material provided by BMW Group

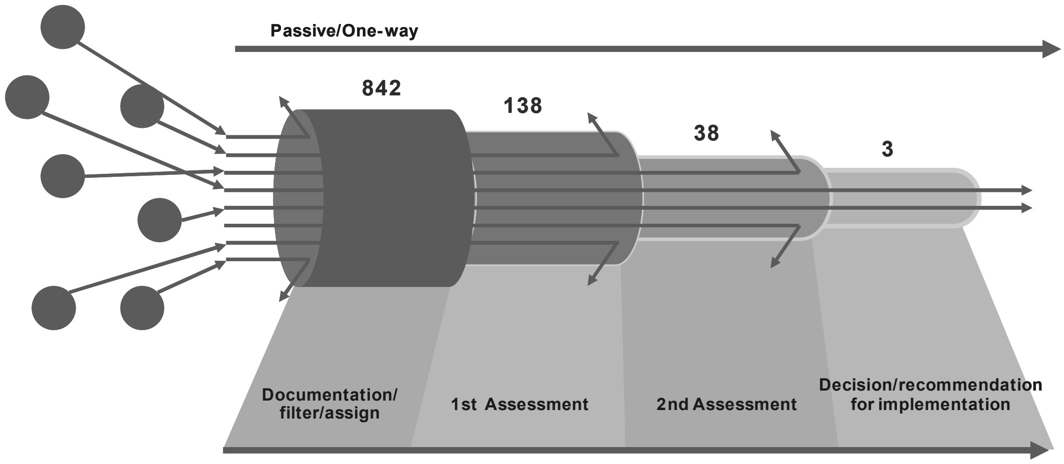
The Virtual Innovation Agency is thus intended as a component of Innovation Impulses' external innovation network and supposed to inform both the business units, as well as the innovation controlling and transfer teams. In practice, however, there is a strong degree of disconnect between on the one hand, "mainstream" Controlling and Transfer, and on the other, Innovation Impulses. The former two functions of Innovation Management are required to allocate resources for pre-development projects. This allocation is based on Value-at-risk, NPV, and a risk-minimizing, innovation portfolio. Subsequent transfer to serial production bases transfer recommendation on positive business cases, usually calculated using demand estimates provided by marketing and sales. While innovation field managers, who are members of the controlling team provide some important know-who to members of the impulses team with regard to relevant competence for the evaluation of ideas received, the assessment and diffusion of ideas from VIA clashes with their goals and criteria.

6.4.4 VIA Knowledge Transfer Process

The VIA portal consist of two static web pages. The submission page clearly states that ideas currently not protected by intellectual property are subject to BMW's terms and conditions. The terms and conditions offer compensation between €500 and €60,000 for ideas which are implemented. The submission site also includes an SSL-encrypted submission form, which is emailed to BMW as well as a submission form intended for postal submissions.

Once an idea has been submitted via e-mail or regular mail, it is screened by a member of the VIA team at BMW, the VIA administrator. The initial screening represents the first filter by which ideas are evaluated. If it is clear at this stage that the submitted contribution does not represent a novel idea or if it is of no relevance to the organization, the submitted documents are deleted or destroyed and a refusal reply sent to the submitter in the same format as the idea was supplied, i.e. by e-mail or post. Ideas with potential which require specialized technical knowledge for evaluation receive closer scrutiny. At this stage, the idea is forwarded to one or more innovation field managers responsible for particular innovation focus areas. The expert in the corresponding area of expertise is sent the more promising ideas for assessment. Should the innovation field manager recognize concrete value in an idea, he is able to pass the idea on to a relevant business unit which can assess more precisely whether and how the idea provides added value or represents a valuable innovation proposition. Once a development unit, contacted directly or after referral from an innovation field manager, has confirmed the relevance and value of an idea, the original submitter of the idea is contacted in order to exchange further knowledge, or in order to negotiate terms for acquisition of a solution. However, in most cases the innovation field manager will quickly assess the idea, and provided he or she seems any value in it, suggests a relevant person in R&D to contact. This means, that most of the time, the VIA administrator emails or phones contacts in R&D directly. On average, one out of 800 ideas is successfully recommended for implementation. It is not entirely clear, however, how many ideas are actually implemented, but based on the limited number of success cases, that number is likely to be significantly lower. The figure below illustrates the rate of ideas suggested for implementation in 2007:

Figure - 37 VIA Success Rate (2007)

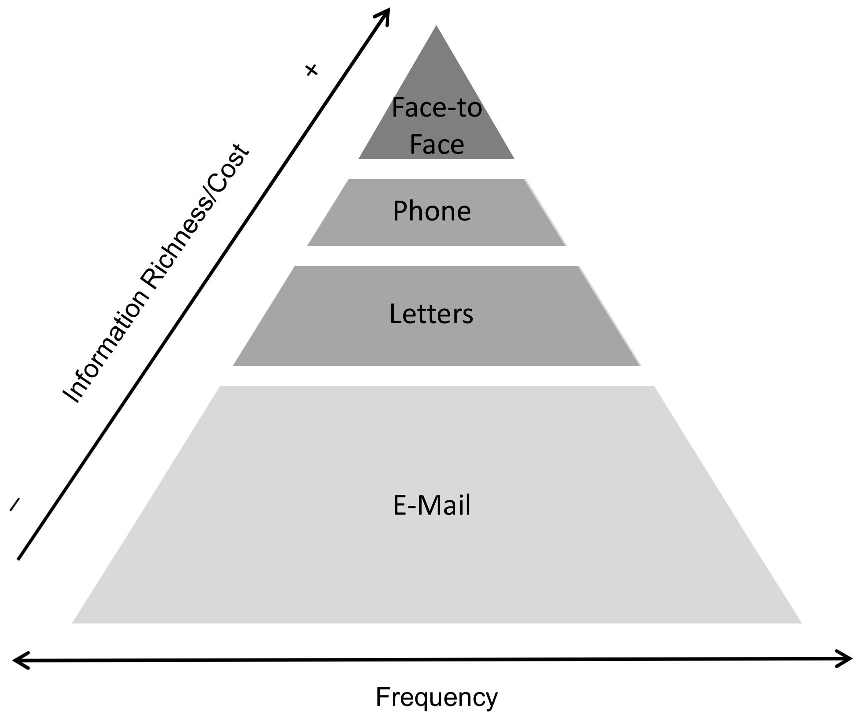


Source: BMW Group Presentation (2007)

6.4.5 Communication Channels

Since the majority of ideas are received via email, they are also forwarded to relevant internal experts through the internal email system. Those ideas which have been submitted by ordinary mail are forwarded through the internal mailing system. Phone contact to internal experts is used infrequently, only in cases where relevant experts cannot immediately be identified or in order to chase up outstanding evaluations by. Face-to-face communication is used rarely and reserved for exceptionally relevant and interesting ideas. The majority of communication in the diffusion of ideas coming in through VIA is thus conducted through e-mail system and by ordinary mail.

Figure - 38 Communication Channels Between VIA and Development Units



Source: Own

6.4.6 Motivation and Incentives

> *"Well, if I manage to get [Project XYZ] into the car out of my own motivation, I don't have any benefit at all. The best outcome would be to get the "Quandt"- Award Ring. But incentives are unknown at BMW. You may get your salary, and a far above average salary, but the performance you deliver, provided someone notices it at all, is not taken into account. And that's why you have to motivate yourself for a long time, until the end, always knowing that you don't get anything at the end." (Interview, Stefan Gabriel, Former Innovation Field Manager, 07 June 2008)*

There is a conflict of interest inside the innovation management function. On the one hand, for those working within steering and transfer, the department represents an important step on their career ladder. The department was often described as a "shark tank", full of ambitious and careerist future managers. There seems to be little incentive to jeopardize their careers by aggressively pushing more radical ideas, such as those coming from the impulses team. The impulses team, on the other hand, is peripheral and isolated, and despite having concrete targets for realizing more radical ideas, they are constrained by their limited reach into the development units which could provide the complementary resources. When the impulses team contacts development engineers directly, it is unable to generate more interest than through brief phone calls and e-mail, primarily due to a lack of human resources.

6.4.7 External and Internal Status

Several of the interviewees stressed how well received the Virtual Innovation Agency was when they talked about it at conferences and presentations. Despite the absence of external marketing of the portal, it is well known, and for instance often cited in academic publications on technology and innovation management. This may explain why it managed to attract such a relatively high number of submissions without otherwise actively marketing the portal.

Internally, on the other hand, the Virtual Innovation Agency was very little known. The launch of the platform was never internally communicated through any of the internal media. In addition, there was an internal idea submission system as part of an earlier total quality management which enabled employees to submit suggestions for improvement. Due to an effective incentive scheme, the internal idea submission system was well-known and established, whereas VIA was little known and understood. Therefore, when development engineers received emails from the Virtual Innovation Agency, they were neither familiar with the source nor with the process behind it. Furthermore, they sometimes mistook it for something related to the internal idea submission system.

By appointing an external manager from Audi in 2006 to head the Innovation Impulses team, the Innovation Management department succeeded in bringing in fresh blood and sound experience in innovation search and trend scouting. However, the new head of Innovation Impulses lacked the internal network and contacts which would facilitate the internal dissemination of the ideas received though VIA. Without having prior networks and intimate knowledge of the internal formal, and more importantly, informal organization, the impulses team was faced with a dilemma to expand external and internal networks simultaneously. While it is less difficult to build a network externally, mainly due to the excellent reputation of the company, building an internal network from scratch is an altogether more taxing activity:

> *"Internally I need to understand political factions, personal agendas, I need to understand networks, […] personal and formal networks, I need to understand the culture very much, especially BMW stresses networks strongly, every second word is network, network, network, network, even if you mean coffee-drinking and time-wasting, you hide it with the word network. In that respect I need a good feeling to know who are the opinion leaders, how are they networked, how does it work in the hierarchical system" (Interview, Martin Ertl, Head of Innovation Impulses, June 15, 2006).*

The innovation field managers, which are supposed to act as intermediaries between innovation impulses and the development units, do not have previous strong ties to those units, since they have to be impartial when it comes to budgeting decisions. This makes their status questionable in the eyes of the R&D organization, since they are perceived as the ones responsible for "red tape".

6.4.8 Examples of Successful VIA Ideas

Carbon Waste Recycling

In March 2007, a proposal was submitted through VIA by a small company in the UK. The company specialized in an innovative carbon-fiber recycling technology, which allows for high gradation recycled carbon fiber in areas which require less pure material composition. Since increasingly, carbon fiber materials are used in high-performance cars as a light-weight alternative to traditional materials, the first assessment by the VIA administrator was positive. In order to identify an appropriate expert within BMW, the VIA administrator approached the innovation field manager concerned with energy and lightweight materials. The assessment of the innovation field manager also turned out to be positive, and he directed the VIA administrator to a contact in the production plant where the models using carbon fiber were produced. Communication between admin and innovation field manager had up to then been verbal. In communicating with the respective production plant, however, the proposal and company information were forwarded by email. After a delay of several weeks, the production plant replied and confirmed that indeed waste accumulated in carbon fiber production was currently deposited on a special landfill and was relatively costly. Passing on carbon waste at no cost could therefore be a viable option. However, after several more weeks without action by the production plant, the impulses team organized a meeting with the respective persons in the production plant and the company. At this meeting, the business model and technology were further discussed and proved to be mutually beneficial. Upon completion of the meeting, Innovation Impulses passed on the responsibility for the further implementation to plant engineers and a delegate from waste recycling management. Final implementation of the proposal was still pending when data about this idea was gathered.

Country-Specific Satellite Navigation Information

At the end of 2007, a private businessman submitted an idea to VIA relating to the satellite navigation system. Since he was travelling frequently on business with his BMW limousine, he had, on many occasions, crossed country borders, for instance the border between Germany and Austria. Repeatedly, he had been penalized for violating traffic rules of which he hadn't been aware, and he suggested to BMW to implement a function which would alert the driver to the respective national traffic rules. The submission passed the first filter by the VIA administrator and was passed on to the innovation field manager responsible for human-machine interface. The innovation field manager also assessed the ideas favorably and contacted a development engineer working with the satellite navigation systems. As it turned out, the relevant development unit had already had such an idea earlier, but the suggestion from VIA gave the idea a new impetus. Technically, the idea could be relatively easily realized, the crossing of national borders could be detected through the GPS signal, the information required could be programmed onto the satellite navigation map DVD and would be triggered once the border was crossed. The idea was implemented in the latest 7 series model. Since the idea had already been known at BMW, the submitter was remunerated with a miniature car model and a personal thank you letter.

6.4.9 Barriers to Knowledge Transfer

The barriers cited by interviewees from innovation management should be expected to be roughly the same as in the case of PATYO. However, there was a strong tendency by those with lesser BMW experience and from younger interviewees, to blame "culture" or "lack of top management support" as major reasons for the difficulties in transferring ideas from VIA to R&D. This discrepancy may point to a general lack of understanding of the routines and processes in the R&D organization, which leads to blame non-success on issues such as NIH and lack of top management commitment, problems well-known from management education and popular management literature. Table 15 summarizes the barriers based on the interviews:

Table - 15 Barriers to Knowledge Transfer VIA

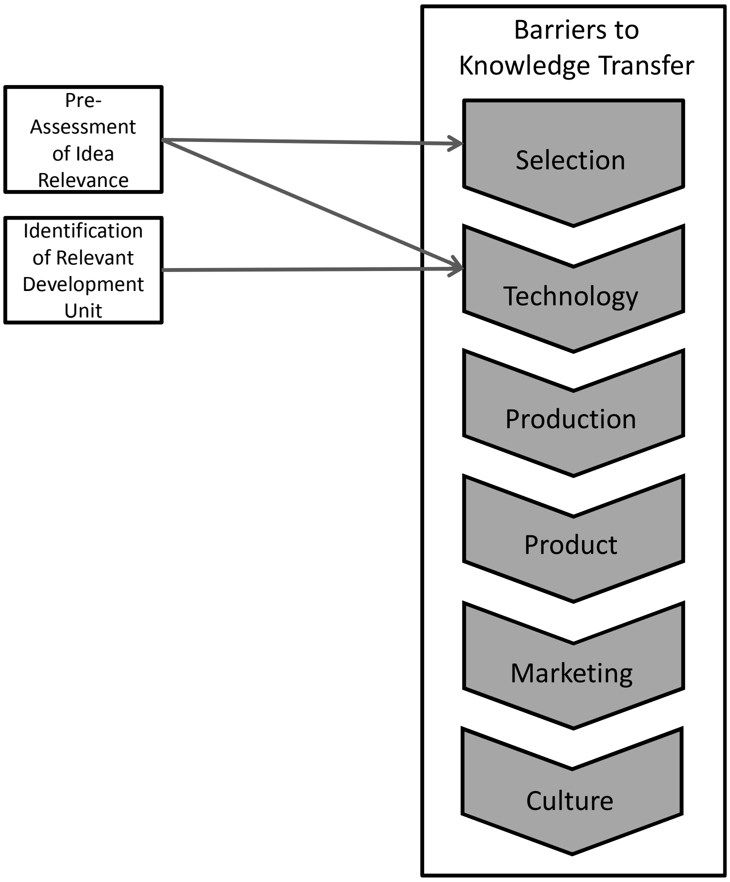
Barrier	Example
Selection	
Low-Powered Incentives: No extrinsic incentives for the active pursuit of more radical ideas provided. Potentially negative incentives due to risk of jeopardizing career progression.	*"You may get your salary, and a far above average salary, but the performance you deliver, provided someone notices it at all, is not taken into account."*
Cyclical Budgeting: After the yearly budget allocation process has been completed, there may be little scope for taking on additional projects	
Anti-Cannibalization Bias: Internal Project managers may perceive new idea proposed by VIA as threatening to their competencies	
Product/ Technology	
Product Complexity: The complexity of the product architecture restricts the range of potential novelty significantly.	*"The biggest problem is when the business units reject external ideas on the basis that is technically not feasible. It's not possible for us to contradict the expert's opinion, since you cannot match the expert's knowledge*
Marketing/ Distribution	
Lock-in to Existing Market: If innovations are too	*The market isn't ready [for project x] to adopt it. From*

radical, the mainstream majority of the market may be alienated, as the case with iDrive, Chris Bangle's innovative design language. First mover advantage questionable – better late and great.	*this perspective it's better to introduce innovations once the customer understands it. With every innovation step there's a danger that the customer is left behind.*
Organizational Culture	
Cultural Homogeneity: Strong engineering and technology focus, little international exposure of staff.	*"I would say that [the reason for rejection of VIA ideas] is 90% per cent cultural!"*
NIH: Reputation for technical excellence breeds overly confident developers.	*"I'm starting to get the impression that everybody just wants to develop everything themselves".*

6.4.10 Matching Strategies Addressing Knowledge Transfer Barriers

The impulses team was restricted in its scope for addressing the considerable barriers it is facing when trying to disseminate ideas received through VIA, identifying a relevant development unit, and supporting realization and implementation of these ideas. This was mainly due to the nature of the online medium. The web page did not allow for a concrete search focus. In addition, resources within the Impulses team were limited, restricting the scope for frequent face-to-face meetings in order to communicate the sometimes highly radical ideas to the appropriate R&D counterparts. In terms of matching, the Impulses team could only aim to efficiently and accurately identify appropriate receivers of the ideas inside R&D. In addition, it acted as a first filter for ideas, eliminating some of the more outlandish suggestions and ideas already previously received. Figure 39 illustrates how VIA's matching activity affected the barriers to knowledge transfer:

Figure - 39 Summary of Mechanisms for Overcoming Knowledge Transfer Barriers:



6.5 Webasto's Lead User Process[35]

6.5.1 Overview of Webasto AG

Webasto AG is a world-leading automotive supplier. Founded in 1901 as 'Eßlinger Draht- und Eisenwarenfabrik Wilhelm Baier, Eßlingen/Neckar' by the mechanical engineer Wilhelm Baier, the company originally manufactured goods made of cut and bent metal. In 1932, Wilhelm Baier developed the first folding car roof which could be easily opened and folded manually – a first step towards becoming an automotive supplier. In 1935, Baier designed a "fresh-air heating system" for water-cooled machines. Throughout its history, the company has continued to introduce innovations such as the first steel sliding roof, the first glass sliding roof and the first five-piece retractable hard-top (www.webasto.de, accessed 24.04.2008).

Still independently owned and controlled by the founding family, Webasto today is the global market leader in two segments, with a 50 % global market share in both roof systems and temperature management systems. Overall, Webasto draws on a production network of 26 production plants. In addition, it has 43 sales subsidiaries. In 2006, turnover reached €1.6bn, while R&D investment amounted to €133m, representing 8.3% of sales (www.webasto.de, accessed April 24, 2008). Year on year growth in turnover was 8.5 % 2004 to 2005, 8.1 % 2005 to 2006 and 15.2 % 2006 to 2007. Webasto's relatively high R&D to sales ratio reflects the company's strategy of being an innovation leader in its market. "Competitors operate with an R&D to sales ratio of around 1% - we consciously retain high R&D investments in order to sustain our competitive edge" (Presentation, Alexander Lang, Director Marketing and Innovation, 31 July 2008). High R&D investment, among other things, enables Webasto to develop sophisticated show cars used to demonstrate new ideas at the major automotive exhibitions and events. As an indicator of its R&D productivity, Webasto has filed 900 patents between 2004 and 2007 (Company brochure, 2008). With a presence in 56 countries, Webasto's 6,286 employees are based mainly in the three factories in Germany, the production facilities in the UK, the Netherlands, Italy, Portugal, Turkey as well as China, Japan, Korea and the US. 13 % of the overall workforce is made up of engineers (Presentation, Alexander Lang, Director Marketing and Innovation, July, 18 2006). Webasto's core product range presently consists of roof systems, heating systems for personal cars and cooling and air conditioning systems for trucks, travel vehicles and boats.

[35] The events described in this account do not take into consideration developments after January 2009.

Table - 16 Overview Webasto AG

Key Figures Webasto AG (2006 data)	
Headquarters	Stockdorf, Germany
Central R&D Center	Stockdorf, Germany
International R&D	Tokyo, Japan
Production Sites	Germany, UK, Holland, Italy, Portugal, Turkey, China, Japan, Korea, US
Total Employees	6,286
R&D Staff	817 (13% of total)
Turnover	€1.6 bn.
EBIT	€33.4 m.
R&D Intensity	8.3 % of sales/€133 m.
Ownership Structure	Independently owned and controlled by founding family

Source: Webasto Company Brochure, 2008; www.webasto.de, accessed 25 June 2008, Presentation, 18 July 2006; 31 July 2008.

Both Webasto's history of engineering excellence and its track record of numerous successful product innovations, underlined by its prominent market position in both roof systems and temperature management systems, have created a strong-engineering-driven culture accustomed to success achieved through technical problem-solving. Traditionally, market demand had played a minor role in the company's process and culture, especially with its B2B focus and a strong reliance on new leads from sales. The spirit instilled by its founder Wilhelm Baier is still part of Webasto today, manifest in a staunch engineering culture and pride.

> *Our engineers claim that we have the best project management process and that we make roofs. It's difficult to convince them of the need to start developing entirely new products.*
> *(Interview, Alexander Lang, Director Marketing and Innovation, March 04 2008)*

6.5.2 Strategic Rationale for Creation of Webasto's Lead User Process

In 1999, the second externally appointed CEO in Webasto's history, Franz-Josef Kortüm, initiated the transformation from module and component supplier to what he referred to as a "Total Process Partner". Kortüm had previously been ousted as the Audi CEO by Ferdinand Piëch, before joining Webasto as a member of the board in 1994 (Langer, 2003). He had realized that Webasto's competitive advantage stemmed increasingly from delivering engineering know-how in addition to providing support to the OEMs in a larger number of process steps of the development value chain (Presentation, Alexander Lang, Director Marketing and Innovation, July 31, 2008). With automotive OEMs becoming progressively more vertically disintegrated, the supplier field had had to shoulder yearly cost reduction pressure which leading to increasingly diminishing margins and competition mostly based on price. In only ten years, between 1988 and 1998, the global number of automotive suppliers had shrunk from 30,000 to 8,000 (FAST 2015, 2004) with the wave of consolidation aimed at creating synergy effects set to continue. Before Kortüm's appointment, Webasto had been successfully led by the great-grandson of the founder. Werner Baier. Baier, who had taken over the helm in 1970, remained CEO for 20 years.

With Kortüm brought in a perspective shaped by years of experience working for automotive OEMs. Marketing and the search for new, longer-term sources of growth received his immediate attention. He appointed Alexander Lang as the new Director of Marketing and Innovation in 2002. One of the main objectives of his appointment was to re-focus market research in order to identify new areas of growth. This was not an easy task, since Webasto didn't have access to end users and only had limited scope to identify new growth potential, let alone validate early concepts with OEMs. Traditionally, the business model of automotive suppliers such as Webasto was characterized by sheltered development of existing products, as well as occasional innovations driven by particularly dedicated engineers, so-called "Champions". Once incremental or novel developments had reached prototype stage, they were presented to automotive OEMs, often directly through personal contacts by Webasto engineers or sales representatives. Market signals had played a minor role for the R&D organization, apart from the leads identified by the sales department. Development required a high degree of secrecy, loss of ideas or concepts at early stages of development to an OEM or competitor could dramatically erode the marginal competitive advantage achieved by being ahead in terms of lead time. Thus, the pressures for efficiency and competitive advantage based on cost leadership led Webasto to pursue a differentiation strategy achieved by augmented product and service offerings derived from innovation leadership. At the same time, Webasto tapped directly into the end user market which enabled it to identify new market trends directly rather than through the intermediary OEMs and to validate internal developments from an end customer perspective early on. Thereby, market risks would decrease, lead times improve and sales could use the "market tried and tested" label as an additional sales argument.

As a B2B supplier, Webasto depended on OEMs' demand, which in turn derived their decisions for new modules from their own innovation strategies which had been determined, amongst other things, by the OEMs' marketing and sales channels. When proposing innovations which had been developed without a concrete demand from an OEM, Webasto placed a bet every time it presented a prototype to an OEM. Prototypes are required since earlier revealing would erode any lead time advantage attained form having the idea first. Too early revealing could mean a loss of a non-protectable idea to the OEM or to a competitor who might have more favorable cost structures[36]. However, in order to improve R&D effectiveness, reduce flop rates, and offer a more compelling value proposition to OEMs, Webasto couldn't rely on internal assessment and the use of classic market research alone. Lang's vision, therefore, was that "rather than being a solely OEM-oriented supplier, Webasto should become an organization which develops and produces innovations geared towards end-users" (Presentation, Alexander Lang, Director Marketing and Innovation, July 18, 2006). In 2002, Lang partnered with the lead user expert Eric von Hippel in order to apply von Hippel's lead user method at Webasto. Research on the sources of innovation and the role of lead users holds that the methods used for identifying customer requirements through ordinary market research fail to reveal truly radical innovation since the majority of users have developed a functional fixedness towards products caused by repetitive use. Conversely, so-called lead users, according to Eric von Hippel (1988), are at the cutting edge of trends in new products or process needs since they expect to obtain a high benefit from innovations addressing those needs.

Lang hoped that by involving highly innovative end users of Webasto products in the early development phase he could generate new concepts and products which would lead to new areas for organic growth. However, in contrast to von Hippel's methods, Lang stresses, Webasto "only uses 'real' users, not experts from other industries" (Interview, Alexander Lang, Director Marketing and Innovation, March 04, 2008), which means that Webasto's definition of lead users relates to actual private users of Webasto systems in other product, e.g. users of a Webasto roof systems in a Volvo C70, Mini Convertible or a VW Eos.

Although Webasto's lead user method became widely known for its conceptual rigor and compelling logic within and beyond the German automotive industry, however, it ultimately failed to achieve the goals set at the outset. At the end of 2008, the lead user process was discontinued. Between the initial design of the lead user process in 2002 and the discontinuation of the lead user method in 2008, Webasto had conducted 12 workshops with lead users. Only one idea out of around 100 per workshop had in the meantime been implemented and progressed to a pre-development project with an automotive OEM. The following account uses the structure developed in the theoretical framework and applied in the VIA and PATYO cases to explore why.[37]

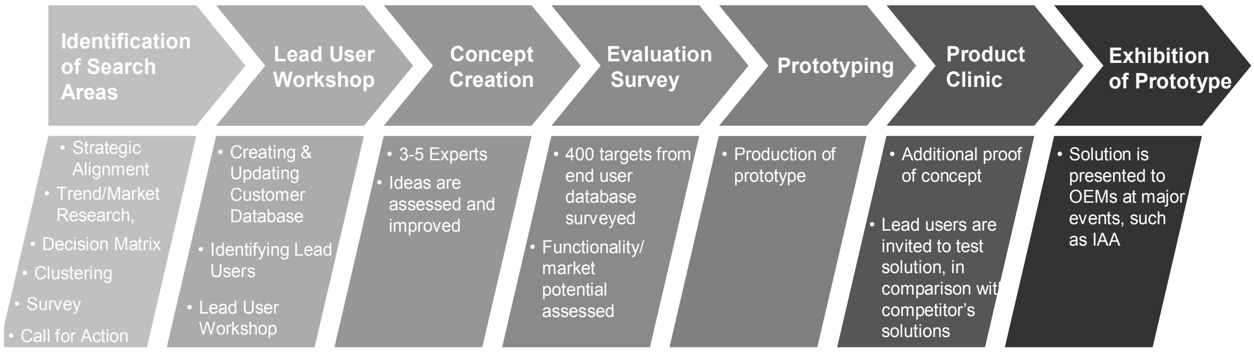
---

[36] This is a classic economic problem in the market for know-how, described by Teece as follows: "The market for know-how is […] confounded because in order to provide full information to the buyer, the seller of know-how may have to disclose the object of the exchange, but in doing so the basis for the exchange evaporates, or at least erodes, as the potential buyer might now have in its possession that which he was seeking to acquire" (Teece, 1996:269).

[37] The description of the lead user process uses the present tense, primarily for stylistic reasons.

Webasto divides its lead user process into 7 steps. These steps consisted of (1) Identification of Search Areas, (2) Lead User Workshop, (3), Concept Creation, (4) Evaluation Survey, (5) Product Clinic, (6) Prototyping, and (7), Exhibition of Prototype:

Figure - 40 The Lead User Process at Webasto



Source: Own

6.5.3 Search Focus and Sources of Innovation

As a first step of the process, the lead user process analyzes corporate strategy and matches it with the expectations of top management in terms of timing, costs, customer or technology orientation, segments for innovation, focus on EBIT or growth and whether radical or incremental innovations are sought. This strategic alignment is then compared to general customer, societal, technological trends, coupled with market segmentation and surveys among relevant customers. Subsequently, all services and technologies available to the company are surveyed and collated. These inputs are entered into a matrix which is sent to 30-50 decision makers in the company. Where different factors align, these nodes are marked as a priority. This could be, for example, battery storage technology for mobile phones. The resulting search areas are clustered according to priority. Finally, the clusters are again verified through a survey and finally formulated as calls for actions, such as "Empower the Move". Calls for action are formulated in such a way that they convey a holistic topic, ideally consisting of several interrelated problems and technologies. Webasto therefore identifies search areas top-down, based on trend extrapolation and medium to short-term growth strategy. Current, mainstream R&D topics are not considered.

Over the course of five years, Webasto managed to create a database comprising 10,000 end customers, i.e. customers who are using Webasto systems in their cars or commercial vehicles. The benefit of using a proprietary customer database, rather than purchasing one from third parties, is that its provides Webasto with a source of fresh contacts which are ideally suited to Webasto's requirements (Gero Schling, Manager of Market Research, Presentation, July 31, 2008). From this database, Webasto is then able to select customers who have a matching profile for the specific requirements of the different lead user workshops. These users are identified using a method which measures knowledge about the product as well as social competence. Webasto chooses lead users according to "customer's esthesia to innovate", or CE2I®. CE2I ®, developed in partnership with the Humboldt University in Berlin.

From the customers who match the lead user criteria, around 25 are invited to take part in a lead user workshop which is held in a hotel in the German Alps. So far, according to Alexander Lang, no one has turned down an invitation to one of the workshops, which is noteworthy considering that apart from receiving free accommodation and food, the only remuneration participants receive are two petrol vouchers at a value of €20 each. Participants are also asked to create models or drawings of ideas they might have already thought of and bring them into the workshop. This ensures that the participants are all equally prepared.

The knowledge sources Webasto taps could be characterized as having overall low knowledge distance. Figure 41 illustrates the knowledge distance along the theoretical dimensions from chapter 4, table 17 explicates the rationale in the scale applied.

Figure - 41 Knowledge Distance Webasto Lead Users

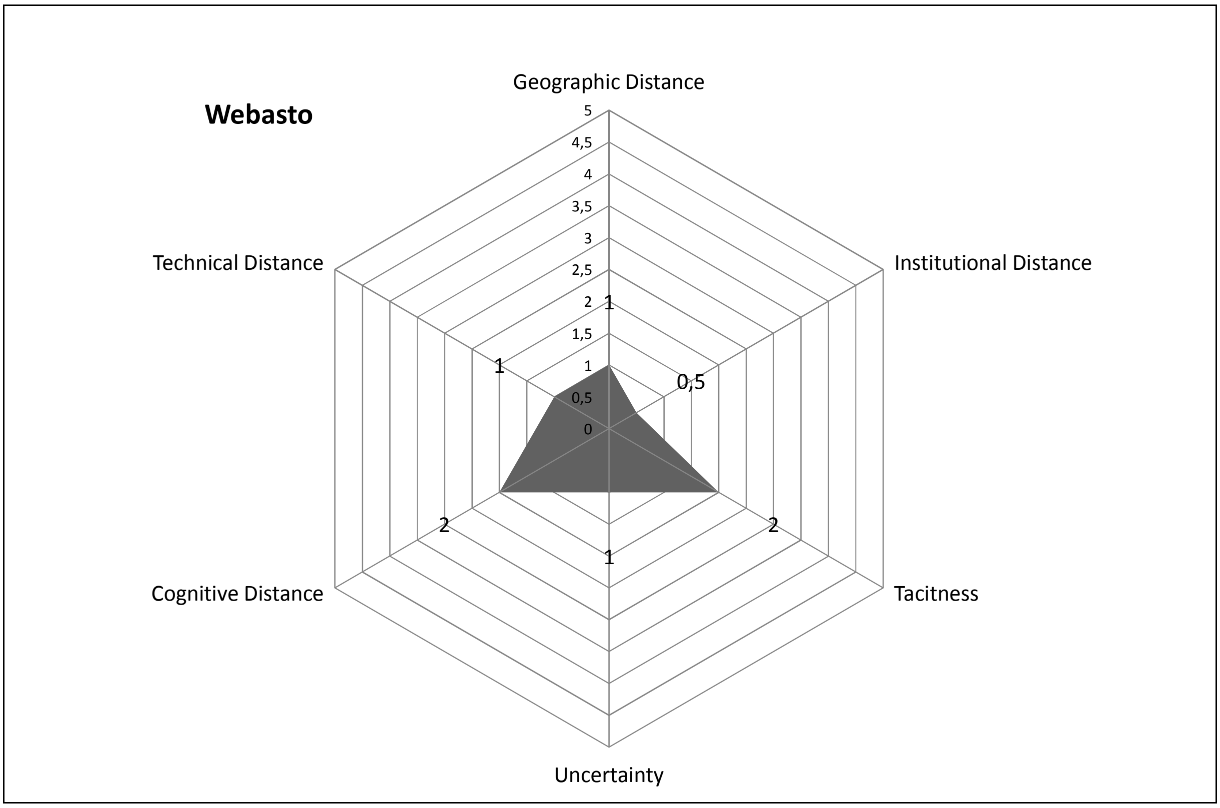


Table - 17 Knowledge Distance Webasto Lead Users

Dimension of Novelty	Value	Explanation
High Uncertainty	1	• Uncertainty is moderate since actual users of Webasto's products are tapped. Market, Technological and Business Model close to existing capabilities and market.
Tacitness	2	• Users may find it difficult to express their needs and ideas in technical terms, otherwise tacitness is moderate.
Technical Distance	1	• Since innovation sources are users of existing products/technology, technological distance is low.
Institutional Distance	0,5	• Both formal and informal institutional distance negligible.
Cognitive Distance	2	• Mental models and approaches to problem solving differs to moderate degree from corporate/engineering mindset.
Geographical Distance	1	• Spatial distance, time difference, travel time very low.

6.5.4 Skill and Task Division

In order to facilitate the workshops, a creativity coach leads participants through different exercises and group sessions. Ideas which sprout up during the workshops, helped by various creativity-enhancing games and techniques, can be captured on site by a designer who produces scribbles and more advanced artwork of any idea the participants come up with. At the end of the workshop, the 100 ideas generated on average are all prepared by designers to high standard, and are edited into a leather-bound book. In addition, they are transferred into the internal idea management system. A maximum number of 5 experts selects the most promising ideas generated in the lead user workshop and develops them further. Thereby, they are turned into a standard format which can then be further disseminated into Webasto's innovation processes. The concept creation entails more concrete drawings and more detailed description of the idea, with a focus on Webasto's product portfolio and customer base. Lang considers this stage as critical since he argues that ideas are otherwise in danger of facing rejection should they fail to convey a certain sense of professionalism:

> *It is crucial that external ideas are of the same quality as internal ideas. Only then can they be processed in the regular way. At Webasto, external ideas are prepared accordingly and then included in the regular process. Ideas, which have come out of lead user workshops will be bound with leather cover and circulated in a professional-looking book within the company. In addition, we generally enhance visually, we create technical drawings and scribbles. In this way, they are of equal quality as internal ideas, if not superior. You can't tell whether ideas have been submitted externally, they follow the same process as internal ideas (Interview, Alexander Lang, Director Marketing and Innovation, March 04, 2008).*

However, none of the Webasto engineers are involved in the lead user workshop, mainly because workshops are conducted on weekends outside of working hours. In addition, Lang stresses,

> *When we tried including our engineers in lead user sessions, they gave the users stage fright since they were not participating but watching very intently and being overly critical of sometimes wild ideas. It didn't exactly improve the creative atmosphere. In addition, the ideas coming out of the interviews are very fragmented, the knowledge of the users can't be transferred one-to-one; it needs to be filtered (Interview, Alexander Lang, Director Marketing and Innovation, March 04 2008).*
>
> .

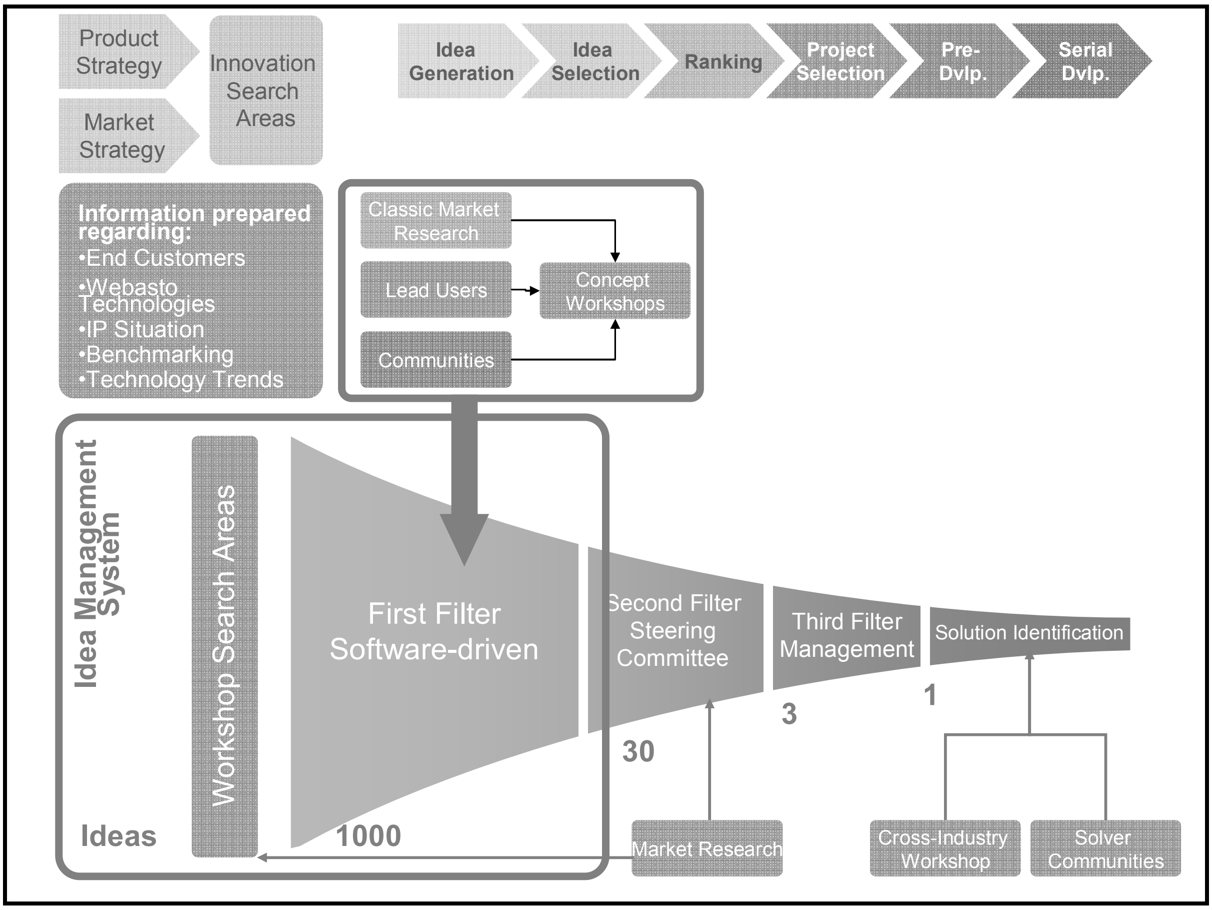
6.5.5 Knowledge Transfer Process

Before ideas which have passed the concept creation stage proceed, a total sample of 400 customers is approached and sent a written evaluation request to validate the ideas. After that, they are entered into the internal idea management system. In addition, the best ideas from lead user workshops are circulated in leather bound books.

The ideas within the digital idea management system can be rated on a scale of one (excellent) to six (poor) by select experts in the corresponding field. From an initial pool of 1000 ideas, including internal as well as lead user ideas, the thirty best ideas proceed to the second stage. An expert steering group assesses those thirty ideas and again rates them on a scale of one to six, which creates several matrices of the dimensions ranked. This second filter leaves three ideas, which are presented to the IMS Board of Innovators. Each of the three ideas receives a small amount of seeding capital of around €1,000. Should there be no engineer actively driving the idea already at this point, it will be assigned to a development engineer with the required competence. The seed capital attached to the idea is intended for him to conduct competitor analysis, market research or feasibility studies.

An idea generated through a lead user workshop which has passed the stage gates of the innovation process successfully, is then turned into hardware for a first, fully functional prototype that can be presented to end users or OEMs. If ideas manage to the stage of a prototype, it is then presented to a panel of lead users, again recruited from the customer database and discussed on-site together with development engineers. Functionalities are tested and another round of ranking confirms the viability of the prototype. Finally, the fully functional prototype is presented to OEMs at the major industry trade shows, such as the Frankfurt Motor Show or the Geneva Motor Show. Sometimes, prototypes are integrated into the show cars Webasto creates specifically for the major automotive events, strengthening its positioning as an innovation leader. The formal process is illustrated in figure 42:

Figure - 42 New Innovation Process at Webasto AG.

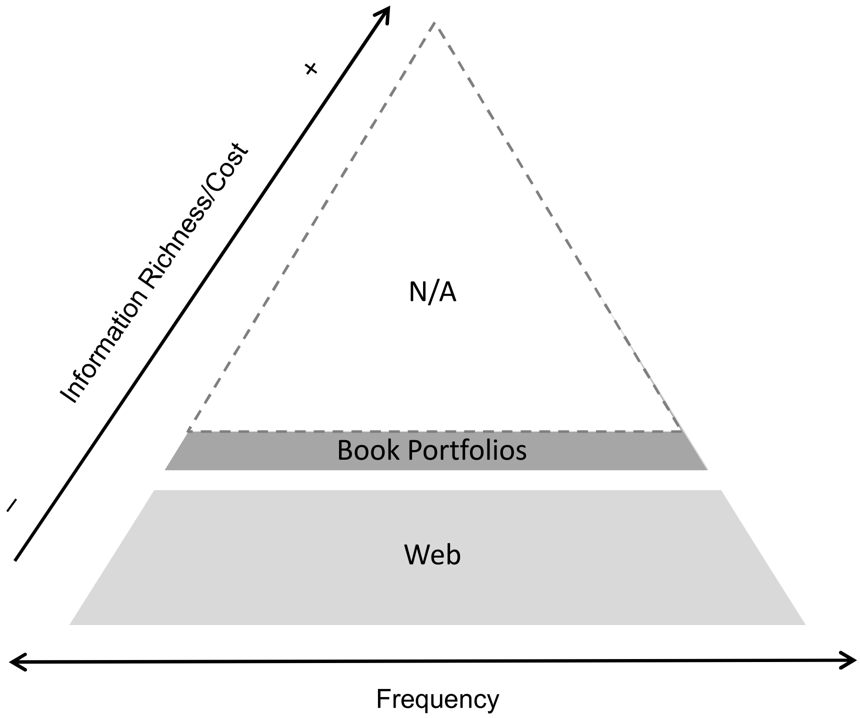


Source: Own interpretation of data provided by Webasto

6.5.1 Communication Channels

In order to facilitate interaction and to reach out to the entire organization, the diffusion of the ideas developed by innovation management relies heavily on the web-base ideas management system. The idea management system is an internal website which allows browsing for new ideas as well as to suggest new ideas. Further, ideas generated in lead user workshops are circulated in leather-bound folios, where ideas are visualized through sketches and graphic interpretations. There is, however little face-to-face interaction and socialization with R&D staff involved. Most critically, engineers do not take part in the lead user workshops. Communication between innovation management and the development units therefore only takes place through intranet and the books. Although the formal process also suggests that, once ideas have passed all stages, engineers are directly approached to drive pre-development further, this had only happened once, as described in the success case below. The use of communication channels for the idea transfer from lead user workshops could thus be illustrated as follows:

Figure - 43 Communication Channels Lead User Ideas Webasto



Source: Own

6.5.1 Motivation and Incentives

"We had five engineers working on a lamella roof for the Mercedes-Benz A-class for seven years, they even worked from home. They were completely convinced of their idea and simply couldn't be stopped, although their solution didn't make any sense from a commercial perspective" (interview, Alexander Lang, director marketing, 04 March 2008).

The account of the lead user process and its diffusion channels already suggested a disconnection between innovation management and the mainstream R&D organization. This disconnection seems to continues when it comes to goal and incentive alignment. Innovation and Marketing is responsible for the successful creation and implementation of innovative ideas with high growth potential. Aside from generating ideas, however, it cannot do this in isolation. Engineers, on the other hand, are motivated by championing their own ideas. Often, engineers tap their personal contact at automotive OEMs in order to bounce back ideas for new development projects with their respective counterparts there. Intrinsic and extrinsic motivation of the development engineers is opposed to the targets set for Innovation and Marketing. Particularly since the development engineers do not at all correlated with the potential risk more radical ideas entail, creating intrinsic motivation among engineers could help the diffusion of ideas. This, however, is hampered by a restricted internal, personal network of innovation management into R&D. Moreover, it is hampered due to the lack of a general lack of legitimacy.

6.5.2 External and Internal Status

As opposed to a wide external network, Lang considers the degree of the innovation and marketing department's internal network as 'poor'. Lang blames this sub-optimal internal connection on the fact that the prophet's teachings are not always appreciated by his peers. Secondly, in his opinion, the R&D organization is inflicted with strong not-invented-here syndrome. Marketing seems to have a generally weak recognition and indistinct reputation in the rest of the organization due to the fact that the sales function had traditionally commanded a monopoly on customer contact and lead generation. Since the innovation management function is located within Marketing, it faces some considerable opposition from the mainly engineering-driven organization.

> *We are a B2B company. This means that the sales department is much more powerful than marketing. It is the sales people who generate new leads; they are in close contact with the customers and identify new ideas. Being a supplier, we are dependent on the input provided by the OEMs. Secondly, we are buffering enormous cost pressures which jeopardizes innovation even more (Interview, Alexander Lang, Director Marketing and Innovation, September 02, 2008).*

6.5.3 Successful Example of Lead User Process

Developing a Multi-Purpose Tailgate from Lead User Idea to Joint OEM Pre-Development Project

Webasto's process for new products is best illustrated with a concrete example. In early 2006, triggered by the suggestion of a developer who had a personal interest in finding new ideas for the functionality of the boot lid, a search area was defined in accordance with lead user process. In alignment with strategy and the internal requirements mentioned, a call for action was formulated which was intended to convey the desire to find new, holistic solutions for transportation. The call for action was labeled "Cargo Management System". This search area was entered into the idea management system in order to stimulate ideas from internal employees. Then, a lead-user workshop was organized in the summer of 2006 to gauge novel ideas from innovative customers. Like other workshops, the summer workshop in 2006 generated around 100 ideas. What became evident during the workshop were the widely diverging demands that the lead-users voiced. These included:

- No storage on the roof.
- No storage inside the car.
- No restriction of boot space.
- No additional parts which might have to be stored in the garage.
- Modular tailgate comprising several opening functions.
- Opening and closing with electrical support – ideally remotely.
- Opening function of the tailgate in fully loaded condition.

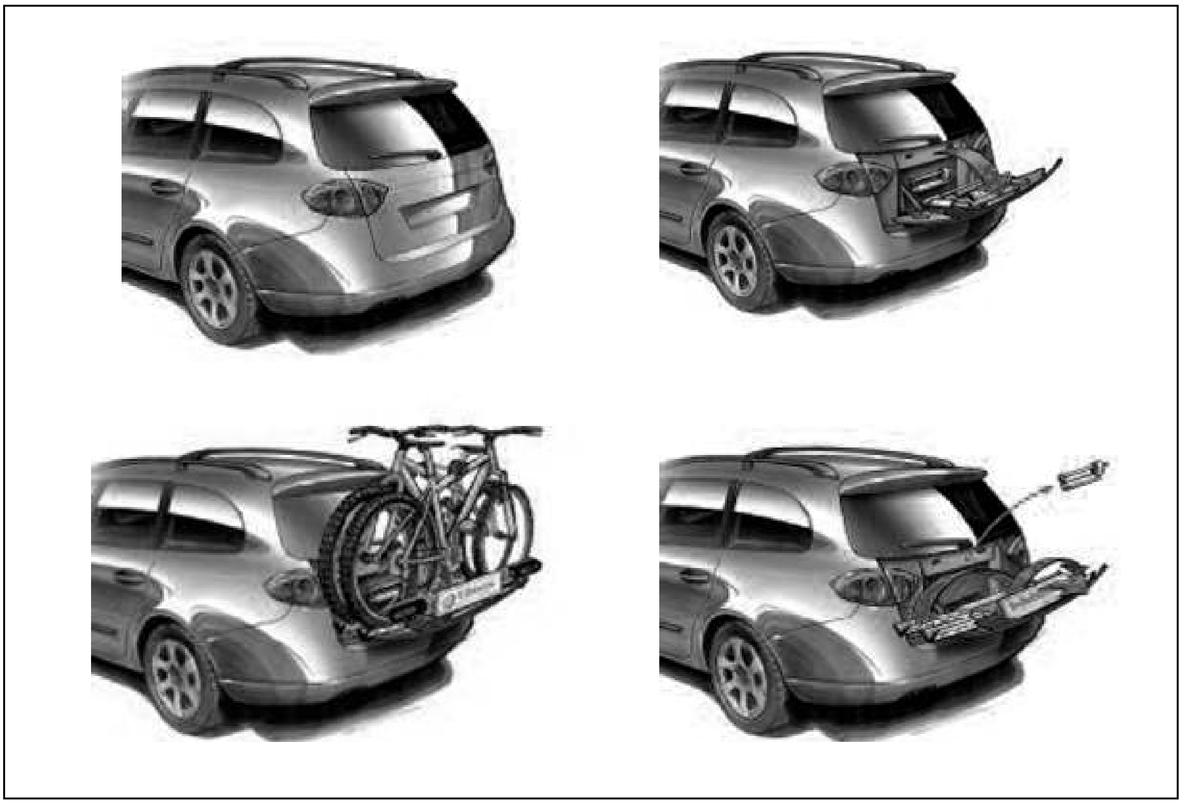
For the subsequent concept workshop, Webasto teamed up with material specialist ThyssenKrupp. The collaboration with ThyssenKrupp provided a good match of complementary competences. Webasto provided sound know-how in system integration and specialist knowledge of doors, roofs and latches, while ThyssenKrupp provided the required know-how in metallurgy necessitated by the sophisticated functionalities that the concept demanded (Sünkel, 2008). Together, Webasto engineers and ThyssenKrupp specialists refined and filtered the ideas. 20 ideas remained after this stage. ThyssenKrupp remained closely involved throughout the remainder of the process. Following the concept workshop, the 20 ideas were presented to 300 people from the customer data base. Three ideas were favored, and one idea finally approved by the innovation review team. As a next step, the final idea was jointly developed into a fully functional prototype, built into a VW Passat car.

Again, a sample of customers was recruited into a product clinic.[38] Webasto and ThyssenKrupp's joint effort was demonstrated alongside competitors' products, such as the tailgate functionality of the Opel Corsa. Customer feedback proved to be highly enthusiastic once more, and it was decided to finally present the solution to the wider public. The Multi-Purpose-Tailgate (MPT) was presented at the international car exhibition IAA in Frankfurt in 2007. And, as Lang recalls, the MPT attracted significantly more attention from representatives of the OEMs as well as the general public than the Ferrari Superamerica displayed nearby. Thanks to the exhibition of the MPT at the Frankfurt Motor Show, a large, premium German OEM signaled interest in the solution and has since started a pre-development project with Webasto to determine feasible ways of integrating the solution to its model range. The customer requirement for the functionality to be able to open the lid even when fully loaded (automatically) has consequences for the stiffness of the car body. This means that in order to provide the full functionality, the OEM would have to create either a new body structure for all models with the lid, or

[38] Product Clinics are a commonly used market research tool in the automotive industry. A representative sample of customers tries out early full-sized prototypes and provides feedback.

develop a second car body structure just for the customer ordering the optional boot lid. This wouldn't make sense from an economic perspective. Thus, the search for solutions at the OEM is still on-going. The illustration below provides an overview of the functionalities offered by the Multi-Purpose-Tailgate. The space required for the hatch is the same that would be required for the tailgate anyway. Hooks and straps to fixate cargo are integrated in the solution:

Figure - 44 Illustration of the Multi-Purpose-Tailgate (MPT)



Source: Sünkel, 2008

Despite this positive example, Lang held reservations as to in how far this 'success story' aids the internal acceptance of the lead-user process. While on the one hand, the process has been perfectly adhered to and executed, Lang points out that the result, i.e. the joint pre-development of the MPT with an OEM, would merely be the first step of other development projects which would otherwise have been generated through sales or personal contacts of Webasto engineers. Many of the development engineers entertain personal contacts into automotive OEMs and are in a good position to informally discuss and suggest new projects to their OEM counterparts which then immediately lead to joint pre-development projects.

His assessment would prove to be accurate. Despite the relative success of the tailgate project, Webasto mothballed the lead user process at the end of 2008, in yet another effort for focus on core business in the face of mounting difficulties in the automotive supplier field.

6.5.4 Barriers to Knowledge Transfer

Gradually, we manage to carve out a mark with our knife, but the mark always heals again. This is Sisyphus work; you roll a stone up a hill and you never reach the top (Interview, Alexander Lang, Director Marketing and Innovation, 04 March 2008).

The major component of creating acceptance for this process is a culture change. This cultural dimension should make up 90 per cent of our work (Interview, Alexander Lang, Director Marketing and Innovation, 02 September 2008).

Lang's doubts about the future of the Webasto's lead user activities were confirmed at the end of 2008, when Webasto decided to axe all lead user activities and dissolve the marketing function. The MPT, despite its apparent success, had given top management the final proof that the existing processes of vetting ideas directly through contacts at the OEMs were both more effective and efficient. Lang blamed the difficulties in realizing ideas and finding general acceptance for the lead user method strongly on the aspect of culture. In addition, he acknowledges that the newly created Innovation function competes with existing processes for conducting R&D. Lang considers the cultural reasons as the most immediate and serious challenge. He argues that addressing these constitutes 90 per cent of his role (Interview, Alexander Lang, Director Marketing and Innovation, September 02, 2008). Table 18 summarizes the barriers to knowledge transfer emerging from interview and secondary data:

Table - 18 Barriers to Knowledge Transfer at Webasto

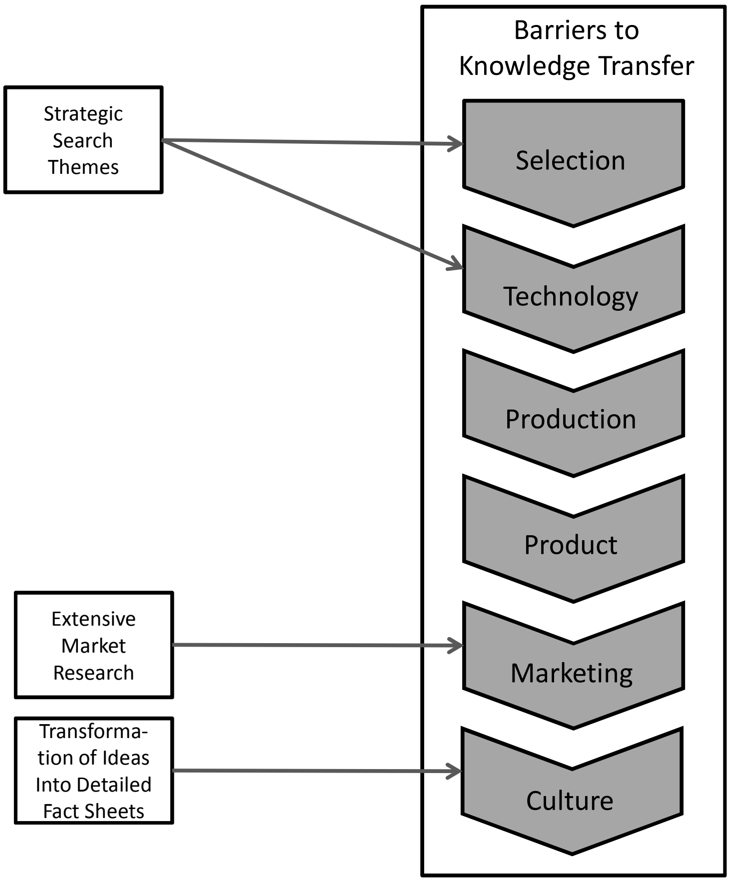
Barriers
Selection
Low-Powered Incentives in R&D: No incentives for engineers to champion ideas coming from Innovation and Marketing department. Champion-based culture. No involvement of engineers in lead user workshops.
Budgeting: Regular budget cut-backs and de-prioritization of longer-term change efforts lead by innovation and marketing.
Anti-Cannibalization Bias: Traditionally, new project ideas initiated by members of sales team and engineers with direct contacts at automotive OEMs.

Business Model: Despite success of tailgate development, innovation and marketing criticized since regular development process starts already with a development agreement with an OEM.
Organizational Culture
Not Invented Here: Long tradition of innovation champions, rejection of external ideas.
Engineering-Driven Culture: Long tradition of purely engineering-driven developments. Marketing has no legitimacy and remains isolated "ivory tower".

6.5.5 Matching Strategies Addressing Knowledge Transfer Barriers

Since Lang considered organizational culture as the most immediate barrier to overcome he focused most of his efforts to positively affect the innovation climate at Webasto. For instance, early on Lang offered employees customizable calendars. Employees were able to choose from a number of pictures that would make up their calendar, and they could also personalize other aspects of the calendars. The idea was received enthusiastically by all staff and continues to be popular until today. Further, in preparation for the Frankfurt motor show in 2005, an idea competition was set up among all Webasto employees. 180 ideas were generated in this process, and the winning idea was implemented in a show car. The idea consisted of an alternative to the sun visor. The sun visor was replaced by inductive foil, which could adapt its shading through touch to prevent blinding from sun rays. Further in a similar vein as the 15 per cent rule championed by 3M, Lang enabled employees to allocate a fraction of their time to exploring new ideas – to brainstorming and green-light thinking. However, this measure was eventually abolished during a cost-cutting initiative. While these measures certainly contributed to improving a general climate conducive to innovation, the fundamental disconnect between the innovation unit and the mainstream R&D organizations were not addressed, as illustrated by figure 45:

Figure - 45 Matching Strategies Employed by Lang



7. Cross-Case Analysis

The three case narratives were structured according to the theoretical framework presented in chapter 4. Inasmuch as the theoretical framework guided data collection, which, as discussed in chapter 3, followed an iterative process between data and theory, it also structured analysis and the narrative write-up. Without such underlying structure, rich, in-depth data becomes overwhelmingly complex. In addition, theoretical generalization from the data is hampered. The case narratives used tables and illustrations to summarize data and aid in the subsequent cross-case analysis and pattern matching. The cross-case analysis adheres to the same structure as the case narratives. However, analysis is more abstract and makes greater use of cross-referencing between data and the theory. Further, it uncovers difference and similarities in the cases and derives generalizable theoretical constructs and propositions.

7.1 Strategic Rationale for Creating Search Function

What all three cases have in common is what Zahra and George (2002) referred to as "activation triggers". In all cases, these consisted of external pressures and internal changes. However, these varied in intensity and consistency. As outlined in the chapter 3, the cases were deliberately picked based on this aspect of variation which is in turn manifest in the choice of knowledge sources being tapped and the mechanisms for doing so. Thereby, the choice of cases allows for some tentative insight into the correlation of these activation triggers and the eventual outcome of the three cases.

In the case of BMW, external pressure consisted of price wars, new entrants to the premium segment and decreasing scope for product differentiation. At Webasto, too, the motivation came from a reaction to the cost pressures exerted by automotive OEMs, the desire to differentiate the product offering from competitors, and to relieve the dependence on OEMs as the sole source of new innovation impulses. In all cases, major external shocks are absent. Therefore, external pressure to produce significant change and thus deviation from thus far successful routines and behavior was still relatively mild. In two cases, PATYO and Webasto, the change effort has been attributed to a particular senior management figure. At BMW, Wolfgang Reitzle was cited in several interviews for his role as architect of BMW's focused innovation search efforts in the context of PATYO. At Webasto, the new externally appointed CEO Kortüm instigated the drive to more marketing orientation and the integration of end customers in the innovation process.

In the case of **PATYO**, the matching process has become closely aligned with the activities of the central R&D organization. Initially, this was fostered by the perceived external competitive pressures. In addition, "isomorphic pressures" exacerbated the willingness for expansion through acquisition and organic growth. The then arch-rival Daimler-Benz AG/DaimlerChrysler had already begun to build a "world-company", merging with Chrysler and already having established a presence in Palo Alto in 1994. The BMW CTO Wolfgang Reitzle was a powerful driving force behind planning and executing the establishment. Some interviewees for instance indicated that the implementation of the first PATYO success story, the iDrive command button, can be attributed by his efforts, which effectively "fast tracked" development and serial production (see also Kiley, 2004). Starting off with such intense management attention also ensured that PATYO remained strategically relevant in the future. Thus, it was embedded into the organizational chart so that access to top management was facilitated. Budgets were allocated accordingly and generously.

VIA, on the other hand, was an effort driven out of middle management, for the same motivation as PATYO; but with significantly less management attention. Using the web as a source of innovation was a pioneering idea, especially considering that the plans for VIA were drawn up at the end of the 1990s. Yet, VIA lacked the integration into R&D, management focus that accompanied PATYO. Resources, too, were restricted. Although the web did potentially contain an unlimited reservoir of new ideas, matching and integrating these ideas could not be organized as effectively as in the case of PATYO.

Webasto's strategic rationale for introducing a lead-user based method for tapping external, distant knowledge shares parallels with both PATYO and VIA. Like PATYO, a senior board member initiated change, in his drive to transform Webasto from mere supplier to a "Total Process Partner". His vision was to become less dependent on automotive OEMs as source for new development projects, and at the same time, leverage existing resources to create new avenues for growth. The industry pressures which led up to this strategy continued to intensify, however, and frequent cost-cutting and efficiency programs soon undermined the innovation efforts. Moreover, the most important engine of innovation, the R&D organization, was not actively involved from the start, leading to inconsistencies in the process for implementing ideas, and in some cases, engendering open resistance to the efforts primarily driven out of Marketing, in itself a newly created function. Interviewees also cited significant difference of opinion of the different board members with a skeptical attitude toward the innovation effort.

In terms of the successful outcome of the innovation efforts, the extent of strategic priority awarded to the matching functions correlates with the outcome. Only PATYO can be regarded as mostly successful in fulfilling its remit of searching and transferring "trends and technology" from outside of the automotive industry. In the case of VIA, there are some success stories, but these were at times difficult to discern from internal ideas which had already been pursued, or one or two "lucky breaks". The adjustments made to VIA as part of its re-launch in the summer of 2008 are also testament to the fact that results had been suboptimal. At Webasto too, the goals initially set have not materialized. The success story of the tailgate did not turn out in favor of the process, since it demonstrated to skeptics of the process that the same result could be achieved by more efficient means, since the overall innovativeness of the project didn't deviate significantly from other projects otherwise coming out of R&D. The discontinuation of the the lead user effort underline this drastically.

7.2 Search Focus and Sources of Innovation

Chapter 4 delineated distant knowledge along six dimensions. The purpose of the theoretical review was to arrive at a finer definition of what constitutes knowledge bridging organizational and other boundaries. In addition to being characterized by a high degree of uncertainty and tacitness, knowledge distance is manifest in terms of geography as well as various contextual factors. In general, knowledge which displays high values in these dimensions entails higher innovation potential. However, high values also make it difficult to reconcile such knowledge with the present context. Conversely, local, close knowledge is easier to understand and utilize yet contains less innovation potential. This may seem like an obvious insight, however, it seems that the degree of distance, the intended innovation outcome, and the present technology/product/market context is rarely considered in combination, neither by academia nor practitioners. Matching the nature of knowledge to be integrated and the mechanism to achieve it seems to be equally neglected. The cases seem to confirm this proposition.

PATYO's search locus is aligned with its mission of finding and transferring key non-automotive trends. Silicon Valley represents an ideal location in the sense that it represents the most progressive area in the fields of IT and electronics. Particularly those fields have already begun to be integrated into cars and represent an area of considerable car-related progress. Due to the fact that some extent of convergence between mechanical engineering, mechatronics and IT applications already exists, technological distance is relatively moderate. Thereby, while still retaining considerable potential for innovation, the search focus allows for integration of the transferred knowledge. PATYO therefore strikes a good balance between knowledge distance and innovative performance, as illustrated in figure 46.

VIA, on the other hand, opens a channel to virtually anyone with the means of submitting ideas electronically or through ordinary mail. Although an initial search focus was limited to small- and medium sized companies from outside the industry, the choice of search mechanisms, a universally accessible website, there is little scope for enforcing this search focus[39]. There is thus, a lack of alignment with

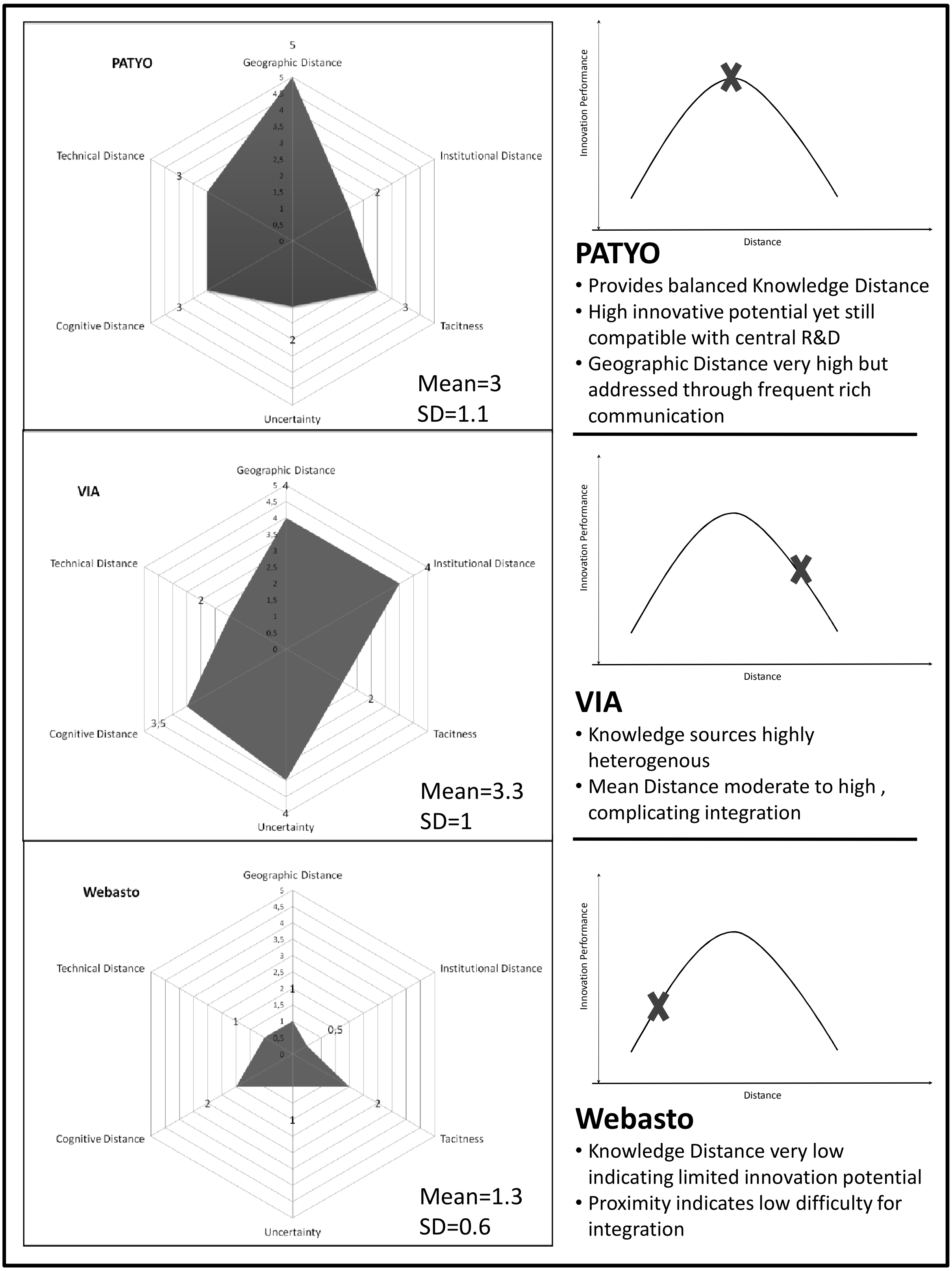
[39] The intention of attracting primarily small and medium sized companies was stated on the start page of the portal. Formal proof of such status, however, was not required.

corporate and innovation strategy with the ideas entering through VIA. In addition, the content of ideas is highly heterogeneous in terms of content, creating challenges for the limited resources of the impulses team to translate, transform, and match ideas with internal centers of competence. With regard to the position on the inverted-U of optimum knowledge distance and innovation performance, VIA would therefore be located on the descending slope of the inverted U characterizing the relationship between knowledge distance and innovative performance.

Whereas VIA may have reached out considerably beyond its ability for matching and integration of distant knowledge, the opposite seems to be the case for **Webasto.** It reaches out to the least distant and novel sources in the case sample. The greatest deviation from the current knowledge base consists of cognitive distance, since the individuals tapped for ideas have a high product usage/customer-centric perspective. This also means that these lead users may find it difficult to articulate their ideas, a problem prominently discussed in the lead user literature (e.g. von Hippel, 2005). In order to articulate those tacit ideas, intensive workshops become necessary. However, due to the otherwise low knowledge distance, the yield in terms of innovative potential seems to be rather small. Therefore, the knowledge distance fails to correspond to the strategic goals and expectations vested in the lead-user process. This finding would lend support to Ron Boschma's (2005) assertion that too little distance may inhibit innovation due to lock-in, conversely, too much distance may prohibit incorporation of novel knowledge. Both extremes can be seen in the VIA and Webasto case, respectively, whereas PATYO seems to have managed to strike a balance between distance and matching ability. Figure 46 illustrates the aspects discussed[40]:

[40] Figure 46 shows means and standard deviation of the different subjectively assigned values in the different knowledge dimensions. This is not intended to ascribe the values any statistical significance. Rather, it is intended to illustrate the overall degree of distance as an average of all dimensions included in the radar chart as well as the variance between the different values assigned to the dimensions.

Figure - 46 Cross-Case Comparison of Knowledge Distance



SD= Standard Deviation

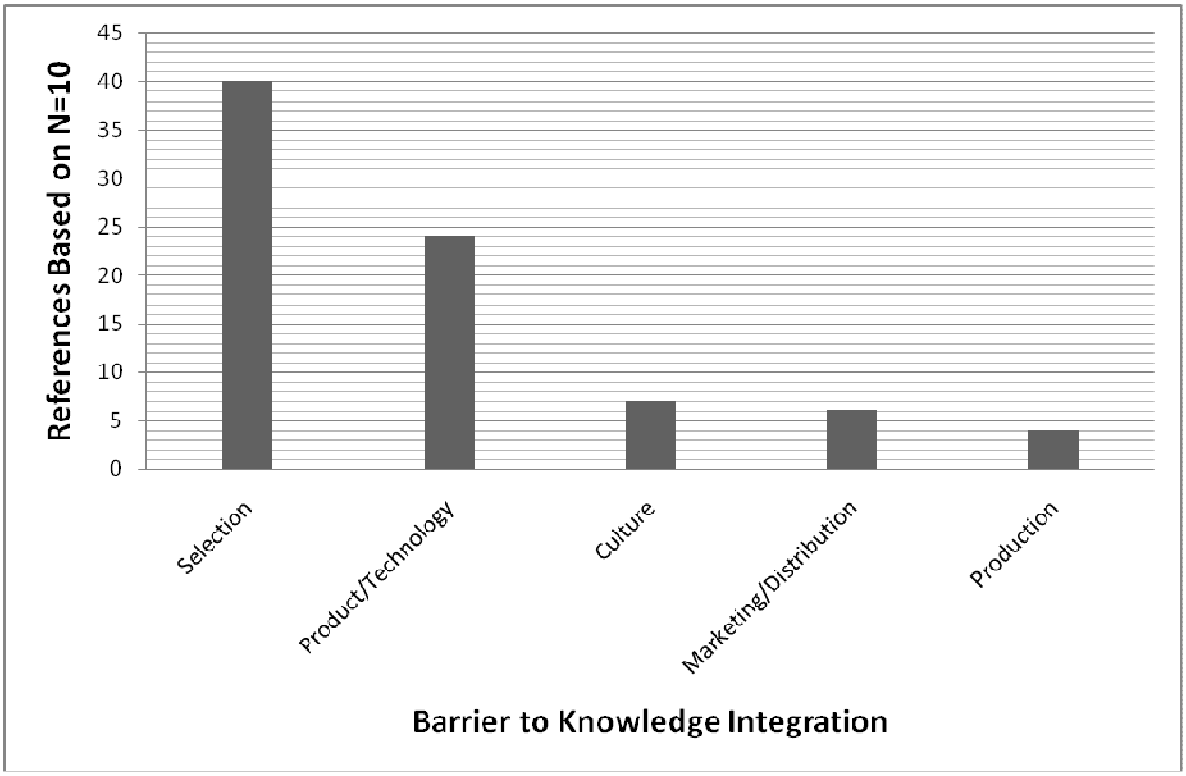
Based on this snapshot of the three cases, one might deduce that the knowledge to be tapped in distant knowledge search and transfer processes needs to be aligned with the strategic intent behind it, as well as with the mechanisms and processes enabling this transfer. Only in the case of PATYO strategic goals which are translated into concrete search criteria are aligned with the search focus and the mechanisms for accessing it. Moreover, the nature of knowledge tapped needs to strike the right balance in terms of providing novelty and enabling matching with existing capabilities. Interestingly, in the case of VIA, there is an "overload" of distant knowledge, whereas at Webasto, search is too close-by the existing context, therefore allowing for little scope for innovation.

7.3 Barriers to Knowledge Transfer

The second part of the theoretical framework addressed the nature of organizational routines, processes, systems and structures. These, in combination, constitute a firm's capabilities (Teece et al., 1997). Existing capabilities are a source for local search bias and organizational path dependence. Some of the most relevant aspects of these constraints were presented following a generic innovation process. As part of the selection criteria for this research project, the cases were selected with a view to hold constant organizational characteristics impacting on organizational capability to absorb and utilize novel knowledge. However, while the barriers faced by the matching function seem to be highly similar across all cases, there seems to be some inconsistency in how these are prioritized by different interviewees. For instance, more experienced engineers with longer tenure and better knowledge of the R&D organization at BMW stress problems of incentive alignments and budgeting and control issues as primary barriers in implementing scouted ideas. Interviewees with less experience of their respective R&D organizations across all cases seem to stress "cultural" reasons as the predominant barriers to knowledge transfer. The discrepancy may also be explained by differential learning curves among the different cases. PATYO, for instance has been able to adjust and fine-tune its process for over ten years, whereas there has been less adjustment and improvement and less time in the other cases. These inconsistencies could also stem from reflectivity and desirability biases among interviewees.

Data triangulation helped shed more light on this issue. Particularly participatory observation suggested that the discrepancies were a result of differential experience and knowledge among interviewees of organizational processes and routines. When for instance ideas were rejected by development engineers, experienced PATYO engineers were aware of a potential lack of budget or clash with individual/team goals and incentives. Interviewees who lacked a deep understanding of the needs and goals of the development units blamed rejection on generic reasons derived from popular technology management concepts, such as not-invented-here syndrome. In addition to participatory observation, coding of a sub-sample of the interview data based on ten individuals from all cases confirmed a strong predominance of resource allocation/technological compatibility reasons as the actual underlying reasons for rejecting ideas[41]:

Figure - 47 Barriers to Knowledge Integration as Cited by Interviewees (N=10)



N=10 based on 3 interview transcripts from VIA, 3 from Webasto, 4 from PATYO.

Particularly at Webasto, cultural reasons for lack of innovation were cited, with little mention of the potential rational self-optimizing behavior of individuals and processes. At VIA, the responses were more differentiated, and respondents with intimate knowledge of the R&D organization and longer tenure tended to emphasize barriers stemming from routines and processes geared toward efficiency optimization. PATYO engineers predominantly cited budgeting and control mechanisms as primary barriers. A possible explanation of this divergence is that inexperienced actors, the reasons for rejections of ideas are relatively opaque, and the reasons given, for instance lack of time may seem unqualified from a more strategic perspective. In turn, not-invented-here provides a convenient explanation for the behavior of internal engineers who need to reject ideas simply because they are not aligned with their incentives and goals.

[41] A sub-sample of 3 interview transcripts from VIA and Webasto and 4 from PATYO were coded using the qualitative analysis software package NVivo. Statements in response to interview questions based on the theoretical framework (see appendix 10.1) were assigned to a category of barrier to knowledge transfer.

Based on data triangulation, however, a tentative hierarchy of barriers can be derived. Selection and resource allocation appear to be the most prominent barriers. This finding supports the emerging "business model" view, which focuses on renewal of the firm's business model in order to create innovation. Since selection criteria are based on the current business model, radical innovation would naturally require a different business model. The complexity of the current technology and product were another major barrier and seem reasonable given the complexity of a car. Culture was often cited, but as discussed disentangling non-rational from rational decisions in this context is difficult. Marketing and distribution mainly related to the lack of a business model for a radical idea. Production was less emphasized, however, compatibility with existing production processes could be another factor for dismissing ideas.

Thus far, the cross-case analysis centered on strategic intent behind the creation of the search mechanisms. The degree of strategic urgency was the main source of variation in the cases, which otherwise followed a replication logic aimed at holding constant other factors affecting the outcome of the processes studied. Analyzing the source of distant knowledge the different functions tapped, and the mechanisms employed, several instances of misalignment with the strategic intent could be identified. Further, the barriers to successfully matching, transferring and implementing distant knowledge were delineated. These were shown to be predominantly influenced by resource allocation which favored developments aligned with the current business models. The next section looks at the particular, micro-level matching strategies employed aimed at reconciling the knowledge identified with existing routines and processes.

7.4 Matching Strategies

The previous comparison of the cases in terms of knowledge they are intended to search and transfer would suggest that the VIA case would be characterized by greater task division and more complex process, in order to adapt the highly heterogeneous knowledge inputs, and subsequently transfer them to an equally heterogeneous set of stakeholders inside the organization. As per the case write-ups, it emerged that the PATYO case displays the most resource-intensive and complex process in the sample. In order to access the predominantly IT-focused cluster in Silicon Valley, BMW committed a fairly high investment, consisting of setting up operations, permanently manning it with 15 full-time employees (FTEs), providing sufficient funds for regular travel and enabling the pre-development of prototypes which requires local workshop, tools, and development time. On the contrary, in the case of VIA there may have been an implicit assumptions that the knowledge accessed via the internet could be readily transmitted from outside sources to internal engineers. Besides minor programming costs and one FTE working as an administrator, VIA was very low-cost. Webasto, on the other hand, also uses a fairly resource intensive and sophisticated process, despite the degree of novelty and the distance of the knowledge to be integrated being relatively low. This section will cross-analyze the characteristics of the functions analyzed in more detail along the dimensions developed in the theoretical framework.

7.4.1 Task and Skill Division

Given internal lack of deep knowledge in all technical and scientific areas, the theory chapter questioned the degree of division of labor inside a function responsible for the search and transfer of distant knowledge. The technological gatekeeper suggested that boundary spanners require an understanding of both external and internal context in order to successfully understand, transform, and transfer boundary-spanning knowledge. The case revealed that such especially PATYO had instituted mechanisms of ensuring that knowledge of the relevant external knowledge are combined in communities of practice. At VIA and Webasto, on the other hand, such targeted division of skills and tasks was largely absent.

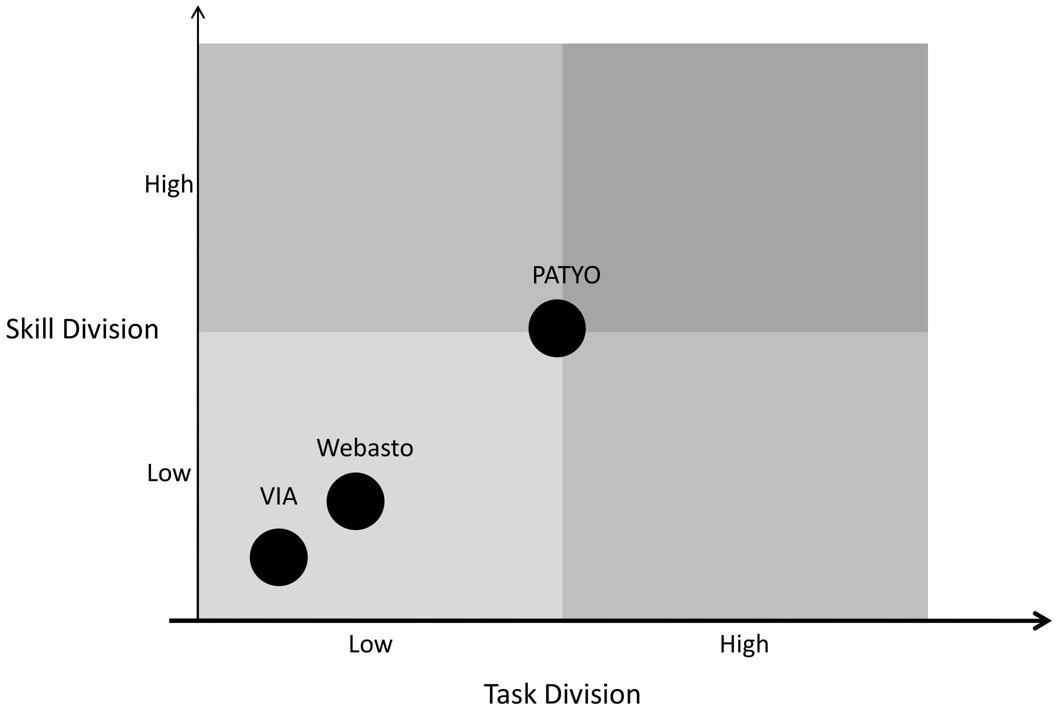
PATYO has the highest degree of task and skill division. In the tech office, local hires primarily maintain the local network and deal with matters pertaining to their respective skill specialization. Long-term expats work on longer term projects, act as nodes for pull requests by central R&D, and are a bridgehead for the network back into central R&D. The short-term expats focus on projects they have brought with them from central R&D. The alumni and the project managers collaborating back in Munich could be regarded as the fourth component of the PATYO task division. Interviewees highlighted that the diversity of BMW engineers, representing a variety of different development units back in Munich, combined a miniature sample of BMW central R&D organization with a representative sample of typical Silicon Valley specialists. This ensures that the Tech Office has the capacity to appraise a wide variety of new ideas that are sourced locally. The diversity in skill and task also enables PATYO to transform the knowledge scouted into early prototypes, making ideas more tangible and shaping them into a format which will be understood and recognized by central R&D. Such a task and skill division enables integrating distant knowledge, what the classical technological gatekeeper achieves, on a larger scale. PATYO understands the local knowledge context and the central context at the same time. By mutually exchanging tacit knowledge in "mutual adjustment" (Brown and Duguid, 1991) knowledge is transformed and transferred to close personal contacts or the rotation of individual engineers.

In the case of **VIA**, most tasks and skills required center around the internet platform and the administrator, usually a mechanical engineer. Although the innovation field managers are intended to provide a representative forum for the 7 most central innovation fields in R&D, covering all development units, often the administrator uses his or her own initiative to appraise and transfer ideas coming in through VIA, since the innovation field managers regard the steering of their innovation councils as their primary task. At **Webasto**, the Head of Marketing collaborates with senior managers and designers in order to transform the ideas generated in the lead user workshops to a high standard. Finally, ideas are submitted into a web idea platform, which engineers are expected to use for their idea generation process. There is no immediate representative of R&D present at the lead user workshop and also in the subsequent filtering; the process seems to take place at the exclusion of members from R&D. Therefore, PATYO's diverse skill task division concentrates a wide scope of expertise in a small team, enabling fast and qualified search, appraisal, transformation, and transfer of knowledge. At VIA and Webasto, on the contrary, lack of scope of resources and skill severely restricts their ability to appraise and transfer identified knowledge:

Table - 19 Comparison of Skill and Task Division

	PATYO	VIA	Webasto
Skill Division	High diversity of BMW technical competence represented, equally high diversity of Silicon Valley skill profiles inside PATYO	Most search and transfer activity relegated to website and administrator.	Majority of activities marketing centered, no R&D competences included
Task Division	Four-step task division (overlapping) between local hires, long-term expats, short-term expats, central R&D stakeholders	Mostly admin, some involvement of Innovation Field Managers	Mainly marketing centered

Figure - 48 Task and Skill Division Matrix

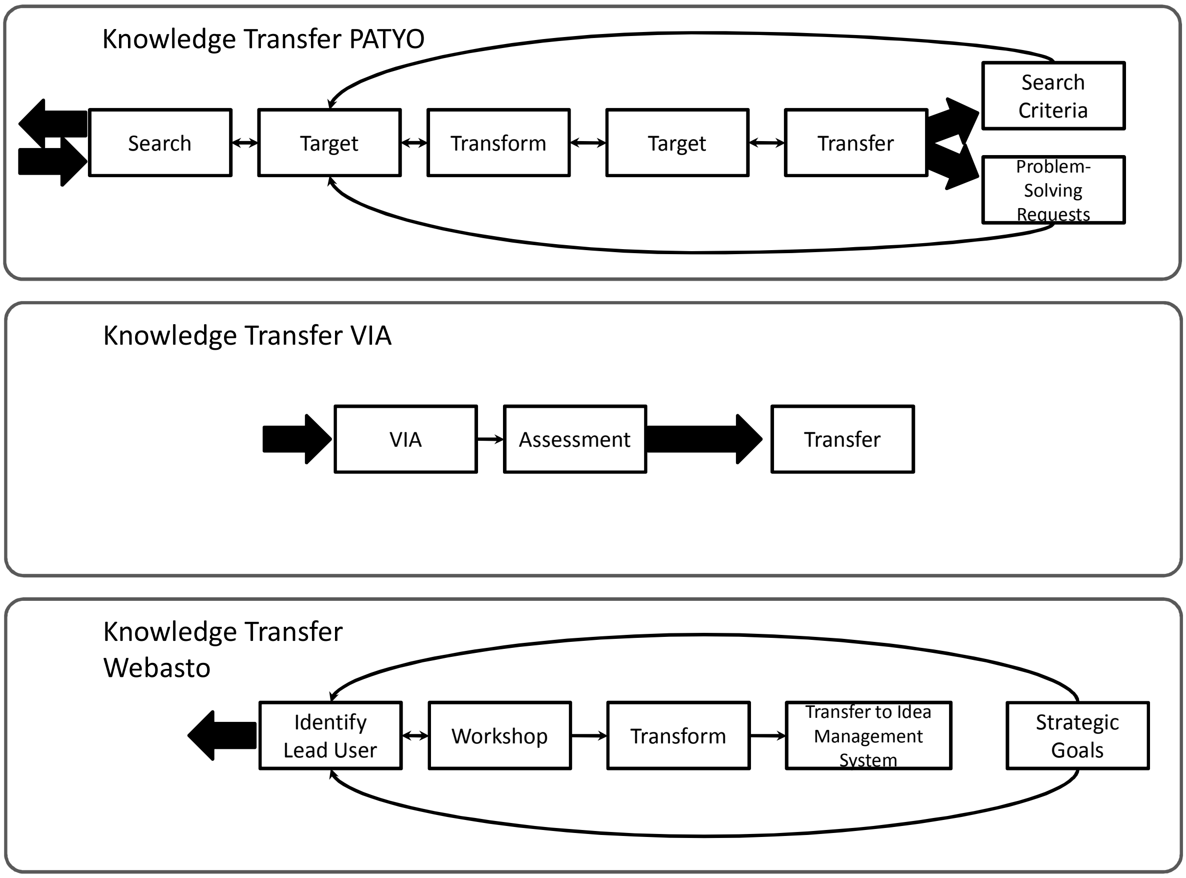


Based on the three cases, it seems that the knowledge complexity and distance to existing routines requires appropriate competence to identify, assess, transform, and match it. Given the knowledge distance and barriers explored in the different cases, a lack of such cross-functionality may offer one explanation of the failure of VIA and Webasto.

7.4.1 Knowledge Transfer Process

In the case of VIA the search and transfer process operates solely on the basis of a push mechanism. Feedback loops or prior search criteria are absent. Webasto formulates long-term strategic search criteria as the basis for identifying lead users and for creating the themes for the lead user workshops. These search criteria do not reflect problems within R&D. PATYO uses search criteria to guide search on its own initiative. Concrete requests for help with problem solving are provided for 50 % or all projects. In the case of PATYO, the process includes multi-level feedback loops, creating an "intelligent" learning process:

Figure - 49 Cross-Case Comparison Knowledge Transfer Processes:



7.4.2 Communication Channels

As indicated in the discussion of the knowledge transfer process, the cases deviate significantly in their choice of communication channels along the entire search and matching process.

PATYO uses rich communication channels along the entire process of identifying, matching, and transferring of knowledge. By co-locating local engineers in the Tech Office, interpersonal relationships are tapped, which in turn enable informal face-to-face communication with relevant sources of knowledge in the Silicon Valley region. Inside the Tech Office, mutual socialization ensures that the local context is matched with the BMW context in Munich. Equally, frequent rotation of staff from central R&D and personal visits ensure that the idiosyncratic knowledge is appropriately addressed and communicated. Moreover, face-to-face contact instills the trust necessary for PATYO engineers to be accepted by their counterparts from central R&D. With great spatial distance and divergence of goals and incentives among innovative functions and mainstream R&D, biases, distrust and non-rational biases would develop otherwise (Taylor and Osland, 2003; Kanter, 2006). Other, less rich communication channels such as emails, blogs and teleconferences effectively complement face-to-face.

Both VIA and Webasto, on the other hand, rely much less on face-to-face. Due to the high volume of ideas, **VIA** relies almost exclusively on email to disseminate ideas. This leaves little scope for building understanding for the needs and problems of recipients. Also, it prevents mutual understanding among the Innovation Management team members responsible for transferring radical ideas into the organization and development engineers with closely defined goals, milestones, and restricted resources. Webasto uses rich interaction with the lead users to extract ideas which might otherwise be tacit and difficult to articulate by the end customers. On the other hand, diffusion of these ideas into R&D relies to a great extent on the intranet-based internal idea management system. Since innovation marketing at Webasto does not form part of R&D, and to some extent, is in competition with the "champion-based" innovation culture, this communication channels seriously hampers transfer and implementation of the ideas identified. Rich communication channels seem therefore necessary, first to make knowledge from distant knowledge sources explicit. Second, they need to ensure that this knowledge is adequately transformed to be understood by the coding schemes and processes of the target inside the organization. Communicating with relevant target receivers in turn requires rich communication to convey the knowledge, instill trust so as to mediate the uncertainty of the knowledge, and to pre-empt social rejection by the mainstream organization.

7.4.3 Motivation and Incentives

A central theme in the technological gatekeeper literature pertained to designing appropriate incentives for gatekeepers. The technological gatekeeper literature suggested that organizations need to encourage gatekeeping activity by avoiding career trade-offs for gatekeepers, as well as by providing appropriate positive incentives for gatekeeping activity. The review of organizational barriers to innovation confirmed this challenge. It found that activities which require excessive risk-taking by agents and which might compromise career progression are generally avoided and lower-risk options explored instead. The cross-case analysis reveals similar findings of the extent of incentivization in each case, pointing to first, a lack of high-powered incentives and a general lack of consistency of incentives moving from search, transfer, and implementation:

In the case of **PATYO**, interviewees report a significant trade-off between a stay at PATYO and their career progression. At the same time interviewees also highlighted that due to the relocation and relative strong incision to their personal lives, only individuals with a high degree of flexibility, open-mindedness and entrepreneurial spirit were attracted to go and work in Silicon Valley. Most importantly, those candidates willing to move to California had a strong *intrinsic motivation* to work in an entrepreneurial environment and to drive innovation. Expatriates at PATYO are aware of the potential risks to their career progression and can reconcile the trade-off with their intrinsic motivation to work on innovation in an entrepreneurial manner. When it comes to counterparts at the central R&D organization, incentive structures are different. Pull projects, i.e. projects commissioned by development units in central R&D, fulfill a concrete demand by development units. For push projects, initiated by the Tech Office, a significant amount of work consists of stimulating demand at the home organization. This is generally done by convincing project managers at home of the value of the project for their work. After all, development engineers can make a name for themselves by project managing a high-profile, high-impact project. Moreover, Tech Office engineers can sometimes convince their counterparts that their solution is superior to one currently used, resulting, for instance, in efficiency gains. However, should this soft touch approach fail, it becomes very difficult for Tech Office engineers to convince engineers of the value of their project, particularly those with a higher degree of novelty. In such cases, PATYO engineers take their projects back to R&D with them once they have finished their stay in Palo Alto. There are then, limits to the novelty of projects that can be reconciled with the central R&D organization. But specifically these more radical projects could have the highest impact, yet there is no mechanism present in the home organization to exploit these high-value, high-risk projects, other than championing it personally.

For **VIA**, the incentives dilemma shows a similar pattern. The Innovation Impulses team is measured according to radical and incremental ideas being implemented per year. Yet, already the innovation field managers in the same department have no tangible incentives to invest effort in pushing ideas coming in from VIA. The same applies to development engineers, who benefit from ideas they receive only in the event that it provides them with an immediate benefit for the projects they are currently working on. This is endorsed by the nature of the successful VIA ideas cited by interviewees. Implemented ideas, in a process of "random luck" found a problem they were able to solve.

At **Webasto**, incentives structures are opposed to the lead user ideas generated in several ways. First, engineers are by no means incentivized to use the ideas generated by marketing since they lose the prestige awarded to them by pursuing their own ideas. Second, a legacy internal idea management system competes with the web-based idea platform created by marketing for ideas and for users. Third, marketing is in direct competition with sales. The sales function is the traditional source of new project ideas, in combination with the personal contacts of individual development engineers. When marketing organized a lead user workshop based on a concrete problem formulated by a development engineer, the ideas generated culminated in a pre-development project – the exception to the otherwise isolated process proving the rule.

Table - 20 Comparing Cross-Case Incentive Structure for Matching Function and R&D

Group	PATYO	VIA	Webasto
Orchestration Function	Members trading-off career progression for intrinsic motivation to work entrepreneurially	Innovation Impulses measured according to ideas implemented	Goals and targets reflect implementation of new ideas
Main R&D organization	High provided transferred ideas meet respective demand	High provided transferred ideas meet respective demand	Low

Based on the cross-comparison of the three cases, it follows then that by design, the members of the orchestration function are incentivized to pursue their remit of searching and transferring novel knowledge from the outside. There is, however, considerable discrepancy with the orchestration unit's remit and the strategic and individual targets and goals.In order to reconcile the conflicting targets, only PATYO succeeds in creating motivation for implementation of a large part of their projects, either by defining demand ex ante, or by subsequently targeting potentially interested stakeholders inside R&D.

7.4.4 External and Internal Status

Prior research on the transfer of technological information, such as Thomas Allen's (e.g. 1977) seminal work, as well as several authors in the organizational learning space (e.g. Davenport and Prusak, 1998) have stressed the role of status and reputation in the facilitation of knowledge transfer. In all cases, external status is high, a function of active external networking and the general image and reputation of the organization as a whole. However, only PATYO commands high status internally, most likely due to its active integration into R&D, regular job rotation, its alumni network, and the benefits that have accrued to central R&D from pull projects and other problem-oriented searches for solutions. The most significant factor in determining internal status seems not be mere social integration, but economic benefits derived from the Tech Office. This benefit is the highest in the case of PATYO.

7.4.5 Summary and Comparison Matching Strategies

The analysis of the different matching strategies employed further highlights differing levels of understanding and ability to address the needs and structures of the organization. The case of PATYO presents the most sophisticated and effective combination of mechanisms to match distant knowledge with existing capabilities. VIA and Webasto highlight potential pitfalls, thereby providing complementary insights into appropriate matching strategies. It also highlights that none of the cases sufficiently addresses the most serious barrier. Since selection and resource allocation is determined by the current business model, ideas which do not conform to this business model need to be matched with alternative functions in order to be realized. The summary chapter explores the implication of the findings, especially managerial recommendations, in more detail.

8. Summary and Conclusion

8.1 Summary

"Never a fad, but always in or out of fashion, innovation gets rediscovered as a growth enabler every half-dozen years (about the length of a managerial generation). Too often, however, grand declarations about innovation are followed by mediocre execution that produces anemic results, and innovation groups are quietly disbanded in cost-cutting drives." (Kanter, 2006:73)

This quote by Rosabeth Kanter is a forthright assessment of the theme explored in this thesis. It encapsulates a central problem in innovation theory and practice, which seems to persist despite the changes in the organization of R&D in the field and the new concepts describing these changes. Despite their dependence on innovation for sustainable growth and competitive fitness, business firms too often fail in identifying, applying and ultimately, profiting from novel knowledge. Current innovation management concepts reflect the growing efficiency in the market for technological and other forms of knowledge. This thesis highlights how concepts such as open innovation espouse the "opening up" of the innovation process as a proactive approach to embracing the opportunities inherent in the market for technology. These concepts focus on avoiding the spiraling costs of building up R&D internally, and on identifying new avenues of growth through new revenue streams for unused R&D spillovers. Further, this thesis proposes that the growing efficiency in the markets for knowledge does not automatically enable firms to improve their capacity for innovation and adaptability. The most critical factor to take into account is the path-dependence of a firm's existing capabilities. These consist of current routines, processes, structures and systems and are aligned to efficiently exploit the current knowledge base, thereby constraining the search and application of knowledge which is outside of the current technology/product/market combination. In this context, this thesis fundamentally explores whether some firms have been able to develop processes which enable them to take advantage of the growing markets for technology in improving their capacity for innovation and change.

The theoretical framework is intended to provide a finer conceptualization of the nature of novel knowledge which is distant from the current organizational context than the crude radical/incremental distinction offered in extant literature. In addition, the theoretical framework describes how the different constituent parts of the innovation process at large industrial firms are aligned and shape the way firms choose and implement sources of new knowledge. Since existing processes aim at efficient exploitation of narrowly defined areas of knowledge, they constrain the distance of knowledge utilized to areas close-by to the current context. A third part of the theoretical framework uncovers the central insights of the technological gatekeeper literature. This literature stream has been little addressed in the past 30 years. For the purpose of this thesis it nevertheless provides useful insights as to how organization can span boundaries and access and apply distant knowledge. Since technological gatekeepers, too, search and transfer knowledge external to the organization, yet within the current technological trajectory, the insights of the gatekeeper literature were contrasted with the nature of distant knowledge and organizational constraints to distant knowledge. Based on this comparison, tentative proposition were made, which explicitly and implicitly structured and guided empirical analysis.

The scientific method, relying on rich, context-dependent data, was chosen in order to uncover the micro-foundations of emerging processes for searching, transferring, and matching knowledge distant from the current technology/product/market combination with the existing capabilities of the firm. Using a multiple-case study research design, three examples of such processes were selected. These three cases came from a population which displayed high levels of maturity, a strong focus on efficiency and high complexity in most factors pertaining to innovation. The rationale for this choice of population was to derive highly information-rich cases. The sampled cases promised above average success in matching distant knowledge with existing capabilities, although this assumption was refuted in two cases by the data during the research process.

BMW's Virtual Innovation Agency addressed the growing need for distant knowledge. In addition, having launched the platform in 2001, BMW pioneered the use of online innovation portals, drawing on "the wisdom of the crowds" and incorporating worldwide internet users into development processes. Yet, the ideas received generally failed to address the needs of current business. At the same time, the organization lacked the capacity to utilize potentially meaningful ideas outside of mainstream processes. At Webasto, too, the new CEO recognized the need for differentiation and the exploration of new sources for innovation and growth. Webasto pioneered the integration of end customers into the early phase of development in the automotive supplier field. However, also in this case, the lead user process was disconnected from existing processes and routines and lacked the resources to realize them in a separate organizational arrangement.

The case of BMW's Palo Alto Technology Office, conversely, revealed a process which proved largely successful in fulfilling its remit of matching distant knowledge with existing capabilities. Not only is much of PATYO's work devoted to identifying challenges and needs at the central R&D unit. It further proactively searches for novel ideas, however, in close alignment with pre-defined search criteria. By ensuring task division between locals and expats, knowledge is transferred along rich communication, through communities of practice. Moreover, staff rotation from central R&D unit to PATYO emulates mobile inventors. Finally, former PATYO engineers inoculate the organizations back home with ideas and a different, more entrepreneurial outlook.

The cross-case analysis analyzed common and divergent themes across the cases. Based on the limited "snapshot" provided by the three cases, a fundamental issue determining the outcome of matching strategies was found to consist of consequently aligning strategic focus with search locus, search mechanisms, and finally, systems for exploiting distant knowledge. Inconsistencies in any of the aspects of the process significantly jeopardize success. Such matching mechanisms are therefore only as strong as their weakest link, from strategic intent, to identifying relevant and meaningful search focus, organization of a search function, to ensuring processes are in place which exploit the knowledge tapped within the mainstream processes or outside of them.

8.2 Conclusion

Naturally, the insights derived from a limited data set do not lend themselves to universal generalization. The purpose of using a smaller number of cases in order to derive rich and in-depth data for highlighting a complex problem, has, however, been achieved. The cases poignantly stress that too easily, practitioners misunderstand the scope and implication of innovation for the business. Innovation cannot happen in isolation, but pertains to all aspects of the organization. The cases also highlighted that the old question of managing the trade-off between efficient exploitation and exploration for longer-term growth is still highly relevant, also in the context of new innovation management concepts.

Returning to the questions posed at the outset of this thesis, the central conclusions based on the theoretical and empirical analysis presented here are as follows. The central research question enquired, "How do technology-intensive firms match external knowledge distant from their current technology/product/market context with their existing routines and processes?" As two of the cases highlighted, the answer is that often – they don't. The fundamental reason for the failure of such matching processes seems to be, based on the cases, an inconsequential matching of strategic intent and the processes supporting the sourcing and subsequent application of distant knowledge. Only in one case, there was a high level of consistency of intention, willingness and ability to match and utilize distant knowledge. This leads to the first sub-question, which asked "Which levels of organization need to be coordinated to ensure successful matching of distant knowledge with existing routines?" As indicated, such matching efforts entail the successful orchestration of all levels of organization. Isolated efforts seldom lead to success, and the cases of VIA and Webasto illustrated this poignantly. The second sub-question pertained to the aspect which ensures a consistent alignment across the entire organization to enable success of matching processes. The questions asked: "How does the extent of internal or external stimulus for change affect the outcome of the matching strategy employed?" This question was reflected in the research design by selecting cases in which this factor showed some variation. The extent of perceived shock and the level of action in response to it may the most significant factor influencing the ability of firms to innovate, as extensively discussed in the relevant literature. In the cases analyzed, too, it correlated with successful outcome. Only sufficiently acute sense of threat released the resources required to set up the resource-intensive listening post in Palo Alto, and ensured continuous resources for the rich communication required for knowledge transfer. Absent such strategic priority, the innovation efforts of VIA and Webasto were stuck in their respective silos, inhibited in their ability to disseminate and implement the knowledge tapped. In addition to these conclusions, additional insights have been gained yielding some implications for theory.

8.3 Implications for Theory

Based on this assessment, several implications can be drawn for theory. This study started off with the implicit assumption that the increasing efficiency of markets for technology had led to significant improvements in the way technology-intensive firms access and utilize external knowledge, in particular knowledge distant from their current context in order to create radical innovation for new growth and adaptation. Not surprisingly, however, this study confirmed incumbent literature which stresses the path-dependent nature of innovation and the constraints on innovation within the firm. As long as firms rely solely on market dynamics and neglect the internal flexibility of their capabilities, market efficiency may be necessary but not sufficient for growth through innovation. Moreover, the data suggested a hierarchy of internal constraints to innovation. The early selection procedures for R&D projects were found to be the most inhibiting barrier for utilizing external, distant knowledge. Although this finding, too, may not be surprising it should be stressed that at times, among managers but also in more practitioner-oriented publications, the informal organization and therefore problems such as "culture" or not-invented-here syndrome are considered the most serious constraints on innovation. Selection, i.e. early innovation investment decisions, is determined by what is now often referred to as the firm's business model. In this sense, the dominant role of selection as a barrier to innovation found in this study confirms the emergent stream of literature stressing the role of the business model and its centrality to supporting innovation by appropriately innovating the business model in conjunction with introducing technological change (i.e. Chesbrough and Rosenbloom, 2002; Chesbrough, 2006; Teece, 2009a).

In addition to confirming incumbent as well as emerging theory, other findings are relevant for theory. An interesting finding emerging from the interview was the discrepancy in what respondents considered an innovation barrier which seemed to have some correlation with the length of tenure at their respective companies. Engineers and managers with longer experience, and in particularly, with prior experience within R&D business units had an apparently more astute and accurate understanding of why radical ideas were rejected. This issue may be tested further by for instance through unprompted survey-based research which could investigate the extent of understanding of and ability to overcome innovation constraints and its correlation with seniority.

An important aspect of the methodology was following replication logic across multiple cases. While holding other potentially significant variables constant, the significance of strategic intent behind the decision to create a technology orchestration function varied across the cases. The limited sample suggests that the intensity of the perceived need for change and innovation at the very top level of the organization is an important determinant for the success of innovation endeavors. At the same time, the cases suggest that willingness does not equal ability. In the case of Webasto, a high strategic intent, at least at the outset, could be implied. However, there seem to exist some profound misunderstanding of the implications and considerable organizational adaptation required for the successful implementation of innovation. This was evident in the choice of search locus at VIA and Webasto. At Webasto, for instance, ambitions for radical innovation and change ran high. Yet, by turning to end customers, the degree of novelty of knowledge gathered turned out to be low, thus falling short of the goals set at the outset. At VIA, on the other hand, the choice of medium and the process employed to attract ideas from outside of the automotive industry which could be applied in an automotive context meant that a high number of extremely heterogeneous ideas were captured, which could not be reconciled with existing routines. An important insight for theory therefore may consist of the importance of closely determining a matching of innovation source with ambition – and ability. Both the correlation between strategic intent as a corollary of external turbulence/threat as well as the discrepancy between strategic intent and awareness of the implications on adapting the current organization in order to realize innovation may warrant further research, perhaps also through large-scale surveys.

The data also provided important insights with regard to effective boundary-spanning/orchestration between distant knowledge and internal organization. A review of the technological gatekeeper literature provided some basic insights and led to some tentative propositions. An important additional insight based on the data suggests that the complexity of the matching endeavor is a function of the complexity of knowledge accessed and subsequent complexity surrounding the receiving organization. Thus, in accordance with associated complexity, a matching function requires considerable skill and task division in order to be able to assess and transform accessed knowledge accurately, as well as a corresponding depth of knowledge transfer process, consisting of targeted search, transformation, targeted dissemination, as well as feedback loops constantly re-calibrating search with receivers. Further, rich communication channels are necessary in order to facilitate face-to-face contact and external as well as internal socialization. The findings concerning the matching process which emerged from individual cases and the cross-case analysis thus expand on the classic technological gatekeeper literature and, in addition provide important insights for theory dealing with related concepts, such as boundary-spanning.

8.4 Managerial Recommendations

From a managerial perspective, important lessons are to be drawn from this thesis. First of all, managers need a better understanding of the scope and consequences of innovation. As long as innovation is regarded as a process of incremental improvement of products and gradual process improvement in the interest of efficiency, innovation management activities should be organized accordingly. The fundamental issue underlying the discrepancies between supposed managerial intention and the outcomes in the three cases discussed seems to lie in the "loose-coupling" of corporate strategy and ensuing tactics and individual actions. In other words, innovation has, in some way, turned into an idea which means everything and nothing. Managers pay lip service to innovation without desiring radical organizational changes. On the other hand, even if change through new growth is desired, there seems to be little understanding of the implications and consequences. For instance, in the case of VIA and Webasto, the strategic aim of integrating impulses from arenas which had previously not been tapped were executed in isolation from the overall operational context of the organization. When looking at the cases in the context of incompatibility of efficient processes such as described in the theoretical chapter, the measures taken to transfer and integrate these impulses prove to be entirely inadequate.

In the case of PATYO, which can be regarded as a mostly successful case, strategic intent is backed up by a resource-intensive process. However, the limitations experienced by the interviewees are the result of a potential misunderstanding of the repercussions of radical knowledge for existing routines. Where ideas and projects lie outside of the existing organizational or technological trajectory, in this case, too, transfer and matching fails. However, if innovation is understood as the process of reconfiguring the existing knowledge base, finding and implementing new applications of existing resources with novel knowledge in order to generate entirely new sources of growth and tap new avenues for revenue generation, managers must install an enterprise-wide infrastructure to support this process. "You cannot innovate a little bit", innovation is a comprehensive commitment which needs to pervade all aspects of operations, organization and culture. As the theory, empirical findings, and analysis shows, managers need to be aware of how urgently the organization needs innovation. The extent of internal or external "activation trigger" (Zahra and George, 2002) or sense of shock determines how devoted to innovation the organization really is. Commitment to innovation must be comprehensive in order to create truly radical change. If such commitment is not particularly pronounced, the inertia of current routines and processes is likely to preempt truly radical innovation. In the cases, the strategic rationale underlying the creation of the innovating "matching" units was evident in the historical events leading up to their creation. The strategic intent was also evident in the resource-intensity of the measure taken. However, in the case of VIA, for instance, the degree of distance, or radicalness was not aligned with the strategic commitment. Although some rather incremental ideas had been realized, more outlandish ideas didn't stand a chance. In the case of PATYO, the alignment seems to be more accurate, with moderate knowledge distance matched with comprehensive mechanisms to transfer and match that knowledge. Therefore, if we treat the radicalness or distance as a continuum, as attempted in this thesis, processes for matching distant knowledge with existing capabilities should aligned accordingly. Stage 1 would entail finding solutions for internal problems and thus remain firmly within the current trajectory. Stage 2 would entail creating organizational capabilities for exploiting radical innovation. The measures suggested here deviate from the order they were presented in earlier sections because they have here been arranged in priority according to the extent of distance or radicalness of knowledge to be matched.

Identifying Ex-Ante Search Criteria and Choosing Appropriate Search Locus and Mechanism

The sheer breadth of search opportunities is likely to overwhelm any function concerned with search and transferring distant knowledge. The scope of search focus may vary according to the extent of innovation required. The case of VIA illustrated how a lack of search criteria resulted in purely coincidental successful idea transfer. The case of PATYO shows a mix of varying degrees of search focus, from highly specific to broader criteria. The choice of search focus has important repercussions for the search locus and the accessing mechanism. It is debatable whether in the case of VIA or Webasto, the search locus and accessing mechanism was appropriate for the strategic intent of the innovation endeavor. The choice of locating PATYO in Silicon Valley, on the other hand, resulted from a clear desire to access knowledge in the field of IT and electronics.

Combining Radical Ideas with Problem-Solving Search for the Current Business

The case of PATYO has demonstrated how soon after the launch of the office, BMW introduced search criteria and so-called "pull" projects, problems in central R&D to be solved locally in the Tech Office. By both serving the mainstream business while pursuing more radical projects, PAYTO achieves several effects. First, it creates legitimacy for the activities of the office within mainstream R&D. By helping colleagues with concrete problems it prevents being perceived as an engineering playground. Conversely, by predominantly focusing on truly novel and radical ideas, VIA and Webasto's lead user process failed to attain legitimacy inside R&D. This lack of legitimacy often led to ridicule and outright rejection. Second, by catering both to existing business and radical ideas will expand the interpersonal network of the matching function with potentially relevant specialists in R&D. Knowing individuals with the relevant complementary knowledge may be critical when introducing more radical ideas. Both at VIA and Webasto this aspect too, was severely lacking. At PATYO, the ability to serve concrete needs of the mainstream R&D was achieved by several mechanisms.

Choosing Intrinsically Motivated Individuals with Solid Experience of the Business

When choosing members of units dedicated to innovation, they need to first and foremost have a very good understanding of the business, the intricacies of the formal routines, processes and structures. In addition, they need a good knowledge of the informal structures of the organization. This knowledge will on the one hand ensure that they understand the needs of the formal organization, how they can meet those needs, or how they can match the innovations they have identified with those needs. A solid informal network and experience facilitates communication with those individuals who will ultimately take on the ideas they are transferring. This pre-empts biases such as not-invented-here, and it mediates the uncertainty of those ideas since members of the matching function vouch for ideas with their own status, reputation, and prestige. Since there is a potential career trade-off associated with joining the innovating unit, individuals need to be highly intrinsically motivated. Particularly because they are bound to encounter various forms of opposition, regardless of how well they know the business. Creating separate extrinsic incentives for the innovating unit may alienate members of other units, making sure that individuals have high intrinsic motivation is key. PATYO, for instance, by virtue of demanding re-location, potential stagnation of career progression back home, among other incisive changes, thereby ensures that those engineers that do choose to go to Palo Alto do so because they truly want to make a difference.

Creating Cross-Functional Matching Team

Depending on the extent of search activities, i.e. the distance of knowledge to be integrated, the innovating unit needs a broad set of skills in order to identify and understand ideas from various backgrounds. PATYO includes specialists in the areas specific to Silicon Valley. Local specialists work closely together with representatives of the most important technical function of central R&D. As one PATYO engineers put it, "we have a miniature version of central R&D here". VIA's process, to some extent, followed the same principle. However, here the collaboration between "Impulses Team" and the rest of Innovation Management had not yet fully taken off, due to the newness of the Impulses Team. In addition to having a team with broad technical competence, more radical ideas may require strategists or marketers who can create a potential business model around an idea scouted. Should an idea not fit with the current business, alternative ways to market could thus be identified.

Transforming Ideas Identified to Facilitate Understanding and Acceptance

The case of VIA shows how a high quantity of highly heterogeneous ideas was disseminated into R&D largely unfiltered. This caused misunderstandings, and in the extreme, irritation among those engineers who received such ideas. At PATYO, on the other hand, the same procedures for creating a project suggestion were followed as in the rest of R&D, after the ideas scouted locally were put into a context which could be understood by central R&D. Frequent face-to-face communication ensured that some of the uncertainty associated with the more radical ideas was mediated by status and reputation of the PATYO engineer proposing the idea.

Identifying Key Relevant Partners in R&D and Using Rich Communication Channels

In order for matching and transferring of distant knowledge scouted to succeed, the matching unit needs to identify the relevant function or individuals inside the organization holding complementary competence. These stakeholders ultimately need to continue projects ideas once matched and transferred. Targets should be segmented according to the strategic impact of the ideas transferred. These could vary from technical specialists, political/technical opinion leaders and top management. The ideas most likely to succeed will be of relevance for all these stakeholders and should be communicated accordingly. This form of segmentation could be described as one aspect of the "marketing" of ideas internally. This has been described by PATYO engineers as one of the most critical aspects of their task. Such marketing of ideas also depends on frequent rich, ideally face-to-face communication with the mainstream organization. Rich communication is essential, as it instills the trust necessary for both parties to accept each other. It also provides both parties with opportunities to learn from each other. As a PATYO noted, ceasing frequent travelling between Munich and Palo Alto and reducing staff rotation would mean the end of the Tech Office.

As the distance of the knowledge sought by the matching function increases, it ceases to be sustained by the current routines and processes. The experiences reported from interviewees in all three cases attest to this. Most notably, the budgeting, controlling and selection process prevents the more radical ideas to be realized. This prevents, in all cases, the foundation of new business to emerge. In order to remedy this, the frontloading with new ideas needs to have a counterpart inside the organization which enables the creation of radical innovation. Managers need to be aware that new sources of growth need not exclusively come from their technology basis. Conversely, it can be a combination of novel knowledge with other knowledge assets the organization possesses. Edith Penrose (1959) viewed the firm as a bundle of resources which could be recombined in various ways. Innovative companies currently leverage diverse aspects of their competences in novel ways in order to create innovation. This entails not only lifting the controls applied to regular innovation processes, but ensuring that, particularly in technology-intensive firms, radical innovation is not driven out of R&D, but from a more strategic function. This notion is congruent with O'Reilly and Tushman's (2004) ambidexterity concept.

Accessing Complementary Knowledge from External Partners

Both in the case of Webasto and in the case of VIA, external partners with complementary knowledge were involved in areas where the companies did not possess previous experience. Webasto collaborated with ThyssenKrupp in order to further the development of the Multi-Purpose-Tailgate. ThyssenKrupp provided critical expertise in material sciences. PATYO engineers teamed up with Google to realize the Google-to-Car functionalities. Therefore, rather than relying on a particular development competence internally, the critical stages of pre-development prone to the highest degree of uncertainty can be conducted in collaboration with external partners. Naturally, this implies choosing an appropriate legal form of governance of this collaboration, management of exclusivity and requires a mutual win-win situation with the partner. By teaming up with highly reputable partners such as Google, such projects benefit from an additional boost in legitimacy and credibility, enhancing the chances of success.

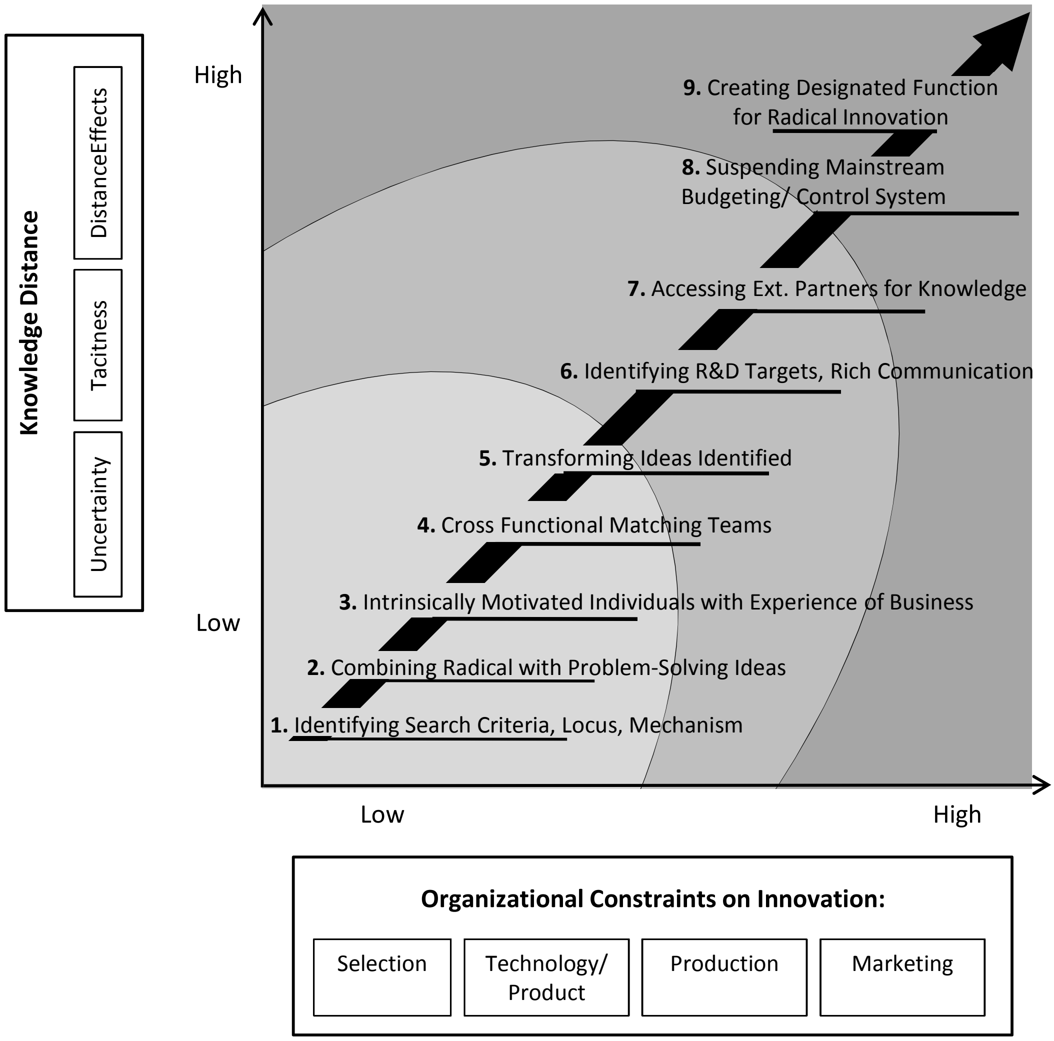
Suspending Selection and Control System for More Radical Ideas

Budgeting, selection and control processes are usually aimed at combating uncertainty and risk. In order to realize more radical and therefore higher risk projects, alternatives sources of financing must be made available. At BMW, R&D budget slack is "built-in" on the level of the development units. After prioritization of development projects across all of R&D, development units are assigned a percentage of the budget of all of their projects for projects as they see fit. PATYO engineers take advantage of this budget slack and suggest to development units to take on board their ideas, financed by their spare budgets. While this is one way of offering alternative sources of funding, it is prone to the technical and strategic myopia of the individual development units, which mostly favor projects with a high relevance for them. Other options include making finance available through more strategic and centralized channels. Some organizations use internal venturing, IBM's InnovationJam is a well-known example of such an approach. Creating an alternative source for resource allocation, however, entails the creation of a function overseeing the budget allocation.

Creating Designated Function Responsible for Driving New Growth Opportunities

Where externally accessed knowledge fails to be matched with internal competence, organizations need a function dedicated to driving it further. PATYO engineers reported several cases, where they simply couldn't identify the appropriate center of competence inside the organization. They sometimes resorted to approaching several points of contacts or at other times, took matters into their own hands upon return to central R&D. For highly radical innovations, a central staff function could be created which identifies synergies with existing capabilities and creates a business model around radical ideas. Daimler, for instance has created such a function in order to develop new business models or complementary services to create growth. Open Innovation research suggests that any innovation which cannot be utilized internally could be commercialized through alternative channels externally. Particularly radical ideas which are not realized could be spun-off or licensed out. Identifying such alternative ways to market could also form part of the responsibilities of this function. Figure 50 illustrates the hierarchy of orchestration mechanisms as a function of the extent of organizational constraints and knowledge distance:

Figure - 50 Hierarchy of Matching Mechanisms



8.5 Limitations and Direction for Further Research

The approach pursued in addressing a recurring theme in strategy and innovation management literature has delivered insightful and relevant results. The logic implicit in this thesis, embedded in the theoretical framework and complemented by empirical findings, provides a meaningful addition to current dialogue in the relevant literature. With regard to the choice of scientific method, interpretive analysis using multiple-case studies was deliberately chosen due to gaps in the previous literature which largely favored large-scale data sets. A natural limitation is therefore the limited external validity and generalizabilty. Therefore, generalizing from cases to the German premium automotive industry in general, to the automotive industry at large, or technology-intensive firms on the whole, is not desirable. However, as also highlighted, an in-depth, case study-based approach was selected first and foremost to get a snapshot providing highly rich data illuminating the micro-foundations of how firms match distant knowledge with existing capabilities. The aim was thus to achieve theoretical generalization on which to base further discovery through more multiple case studies or through deductive quantitative testing. Taking this limitation into account, however, great care has been taken to design and conduct the case-based study as rigorously and reliably as possible. For instance, diligent triangulation of different data sources, particularly participant observation and the inclusion of "dissident voices" shed some light on the "loose coupling" between managerial intentions with regard to innovation processes and their actual outcomes. As discussed in methodology section, the tightly scoped theoretical framework helped to guide data collection in a meaningful way, yet it somewhat restricted the scope for analysis to narrowly pre-defined categories. There was therefore a trade-off between level of detail and scope for new theoretical categories to emerge. However, it was decided that early data gathered had remained superficial and that only by creating a more tightly scoped theoretical framework, meaningful and relevant data could be elicited from respondents. Despite this limitation, the data provided a great level of detail, and in addition to confirming incumbent and emerging theory, some theoretical implications were drawn which had emerged from the cases and cross-case analysis.

Another potential limitation of this thesis may stem from a lack of conceptual and analytical parsimony. The theoretical framework is eclectic, combining a multitude of variables and levels of analysis. While such an eclectic approach may hinder exact delineation of causal relationships among the multiple variables analyzed, such an approach was also chosen deliberately based on previous research which stressed the multi-level and multi-variable nature of learning and innovation. It therefore followed that the research method addressed this aspect, favoring a case-study based approach whose strength consists of enabling the study of phenomena in the natural context. Another limitation evident in this thesis is the uneven distribution of data across the cases. While the first two cases are comparable in data richness, the third case relies strongly on one source. This is due to the smaller size of the function studied and equally, due to limited access. However, this data imbalance was addressed by supplying a larger number of secondary sources, which were more readily available than in the first two cases. In addition, transcripts from other researchers were used to complement the interview data gathered by me and additionally provided a source of "dissident voices". Finally, the focus of this research centers on firm-level process. While external factors influencing the rate and direction of innovation are addressed by introducing a "strategic rationale" for the creation and continuation of these processes, other external factors have been assumed away. Particularly in forcing organizations into novel combinations, the extent of external pressures and shocks may play a much more significant role. As an object of study, "after-the-fact" responsiveness to external pressures and shocks may therefore be of more relevance in investigating differential innovation and change capability among firms than "before-the-fact" measures.

With regard to further research, applying this framework to a higher number of cases initially would help to sharpen the results further and lend it a broader basis for the development of a parsimonious set of hypotheses suitable for yet larger scale testing in order to derive universally generalizable theory. This thesis has uncovered that the opening of up innovation processes and the ensuing need for greater distance in innovation search is recognized and reacted upon. However, it also revealed that little clarity about the implications of innovation on organizations exists among practitioners. Intentions for innovation and change were only matched evenly and consistently along the entire process in one case studied. This discrepancy could form the core of further research on this matter. The focus here should be in further disentangling the causal relationships among the variable identified in this thesis. In addition, there should be a clearer delineation of units of analysis.

9. References

Abernathy, W. J., & Clark, K. B. (1984). Innovation: mapping the winds of creative destruction. *Research Policy, 14*, 3–22

Abernathy, W. J., & Utterback, J. M. (1978). Patterns of industrial revolution. *Technology Review*, 41–47

Allen, T. J. (1964). *The use of information channels in r&d proposal preparation.* Cambridge, MA: MIT, Sloan School of Management

Allen, T. J. (1966). Performance of communication channels in the transfer of technology. *Industrial Management Review, 8*, 87–98

Allen, T. J. (1970). Communication networks in r&d labs. *R&D Management, 1*, 14–21

Allen, T. J. (1977). *Managing the Flow of Technology.* Cambridge, MA: The MIT Press

Allen, T. J., & Cohen, S. I. (1969). Information flow in research and development laboratories. *Administrative Science Quarterly, 14*(1), 12–19

Allen, T. J., Piepmeier, J. M., & Cooney, S. (1971). Technology transfer to developing countries: the international technological gatekeeper. *Working Paper,* MIT, Sloan School of Management

Allen, T. J., Tushman, M. L., & Lee, D. M. S. (1979). Technology transfer as a function of position in the spectrum from research through development to technical services. *Academy of Management Journal, 22*(4), 694–708

Almeida, P., Phene, A., & Grant, R. (2003). Innovation and knowledge management: scanning, sourcing, and integration. In M. Easterby-Smith, & M. A. Lyles (Eds.). The Blackwell Handbook of Organizational Learning and Knowledge Management (pp. 356–371). UK: Blackwell Publishing

Altshuler, L., & Stern, A. (2006). *Emerging Forms of Collaboration in the Context of Networked Innovation – an Exploration of New Product Development in Complex Technology Industries.* Unpublished Master Thesis, Baltic Business School, Kalmar, Sweden

Amour, H. Ogden, & Teece, D. J. (1980). Vertical integration and technological innovation. *The Review of Economics and Statistics, 62*(3), 470–475

Anonymous (2004). *Automotive Industry Structure (FAST) 2015 – die neue Arbeitsteilung in der Automobilindustrie.* Mercer Management Consulting

Anonymous (2005). *Top 20 innovative companies in the world.* Retrieved September 06, 2009, from Business Week: http://www.businessweek.com/magazine/content/05_31/b3945407.htm

Anonymous (January 2006). *Auto industry consolidation: is there a new model on the horizon?* PricewaterhouseCoopers, from www.pwcautomotiveinstitute.com

Anonymous (2006). *The top 100 most innovative companies ranking.* Retrieved September 06, 2009, from Business Week: http://www.businessweek.com/magazine/content/06_17/b3981401.htm

Anonymous (June 2008). *2008 Global Market Data Book.* Automotive News Europe

Anonymous (2008). *A rough road: the effects of today's financial crisis on the global automotive industry.* KPMG.

Anonymous (December 2008). *The BMW Group Skunkworks in Silicon Valley.* BMW Group. Retrieved January 20, 2009, from www.bmwgroup.com

Anonymous (2009). The end of the free lunch - again. *The Economist, 390*(March 21)

Antonelli, C. (1999). *The Microdynamics of Technological Change.* London: Routledge

Argyris, C., & Schon, D. (1996). *Die Lernende Organisation: Grundlagen, Methoden, Praxis*. Stuttgart: Klett-Cotta

Arora, A., Fosfuri, A., & Gambardella, A. (2002). Markets for technology in the knowledge economy. *Unesco*, 115–128

Arrow, K. (1962). Economic welfare and the allocation of resources for invention. *NBER*, 609–625

Arrow, K. (1969). Classificatory notes on the production and transmission of technological knowledge. *American Economic Review: Papers and Proceedings, 52*, 29–35

Banbury, C. M., & Mitchell, W. (1995). The effect of introducing important incremental innovations on market share and business survival. *Strategic Management Journal, 16*(Special Issue Summer), 161–182

Barney, J. B. (1991). Firm resources and sustained competitive advantage. *Journal of Management and Governance, 17*(1), 99–120

Becker, H. (2007). *Auf Crashkurs: Automobilindustrie im globalen Verdrängungswettbewerb* (2nd ed.). Heidelberg: Springer Verlag.

Benner, M. J., & Tushman, M. L. (2003). Exploitation, exploration and process management: the productivity dilemma revisited. *Academy of Management Review, 28*(2), 238–256

Bettis R., & Prahalad, C. (1995). The dominant logic: retrospective and extension. *Strategic Management Journal, 16*(1), 5–14

Birkinshaw, J., Bessant, J., & Delbridge, R. (2007). Finding, forming, and performing: creating networks for discontinuous innovation. *California Management Review, 49*(3), 67–83

BMW Group (21. 03. 2003). *BMW Group Science Portal.* Retrieved 04 April 2009, from www.bmwgroup.com

BMW Group (2008). *BMW Group Palo Alto Technology Office: Presentation*

Booz Allen Hamilton (2005) Global Offshoring Survey 2005

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

Boston Consulting Group (2006). *Innovation 2006*

Brown, J., & Duguid, P. (1991). Organizational learning and communities of practice: towards a unified view of working, learning, and innovation. *Organization Science, 2*(1), 40–55

Brown, J., & Duguid, P. (2000). *The Social Life of Information:* Harvard Business School Press

Brown, J. W. (1979). The technological gatekeeper: evidence in three industries. *Journal of Technology Transfer, 3*(2), 23–36

Brown, J. W., & Utterback, J. M. (1985). Uncertainty and technical communication patterns. *Management Science, 31*(2), 301–311

Brown, J. S., & Duguid, P. (1998). Organizing knowledge. *California Management Review, 40*(3), 90–111

Burns, T., & Stalker, G. (1961). *The Management of Innovation.* London: Tavistock

Cantwell, J. (1995): The globalisation of technology: what remains of the product cycle model? *Cambridge Journal of Economy*, 19, 155-174

Carlile, P. R. (2004). Transferring, translating, and transforming: an integrative framework for managing knowledge across boundaries. *Organization Science*, 15(5), 555-568

Chandler, A. (1977). *The Visible Hand.* Cambridge, MA: Harvard University Press.

Chesbrough, H. W. (2002). Making sense of corporate venture capital. *Harvard Business Review*, (March), 4–11

Chesbrough, H. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology.* Boston, Massachusetts: Harvard Business School Press

Chesbrough, H. W. (2006). Open innovation: a new paradigm for understanding industrial innovation. In H. Chesbrough, W. Vanhaverbeke, & J. West (Eds.). *Open Innovation: Researching a new Paradigm* (pp. 1–14). Oxford University Press

Chesbrough, H. W. (2009). Business model innovation: opportunities and barriers. Long Range Planning, doi:10.1016/j.lrp.2009.07.010

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

Chesbrough, H. W., & 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*, 529–555

Christensen, C. (1997). *The Innovator's Dilemma.* Boston, MA: Harvard Business School Press

Christensen, J. Froslev, Olesen, M. Holm, & Kjaer, J. Sorth (2005). The industrial dynamics of open innovation - evidence from the transformation of consumer electronics. *Research Policy*, (34), 1533–1549

Clark, K. B., & Fujimoto, T. (1991). *Product Development Performance.* Boston, MA: Harvard Business School Press

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly, 35*(1), 128–152

Cohen, W. M., & Levinthal, D. A. (1994). Fortune favors the prepared firm. *Management Science, 40*(2), 227–251

Coleman, J., Katz, E., & Menzel, H. (1966). *Medical Innovation: A Diffusion Process.* New York: Bobbs Merrill

Contractor, F., & Lorange, P. (1988). Why should firms cooperate? In F. Contractor, & P. Lorange (Eds.). *Cooperative Strategies in International Business* (pp. 3–30). Lexington, MA: Lexington Books

Cooney, S., & Allen, T. J. (1974). The technological gatekeeper and policies for national and international transfer of information. *R&D Management, 5*(1), 29–33

Cooper, R., & Kleinschmidt, E. (1986). An investigation into the new product process: steps, deficiencies, and impact. *Journal of Product Innovation Management, 3*(2), 71–85

Cranefield, J. Yoong P. (2007). The role of the translator/interpreter in knowledge transfer environments'. *Knowledge and Process Management, 14*(2), 95–103

Cyert, R. M., & March, J. G. (1963). *A Behavioral Theory of the Firm.* New Jersey: Prentice-Hall

Czarnitzki, D., & Kraft, K. (2004). Firm leadership and economic performance: evidence from german firms. *Economics Letters, 22*(5), 325–332

Davenport, T. H., & Prusak, L. (2000). *Working Knowledge: How Organization Manage What They Know* (2nd ed.): Harvard Business School Press

De Lussanet, M., & Radjou, N. (December 2006). *The Forrester Wave: National Innovation Networks, Q4 2006.* Forrester

DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: institutional isomorphism and collective isomorphism in organizational fields. *American Sociological Review*, 48(April), 147–160

Dosi, G. (1988). Sources, procedures, and microeconomic effects of innovation. *Journal of Economic Literature, 26*(September), 1120–1171

Doz, Y., Foss, N. J., & Santos, J. (2009). *A knowledge system approach to the multinational company: conceptual grounding and implications for research.* Working Paper, Copenhagen Business School

Dubois, A., & Gadde, L. (2002). Systematic combining: an abductive approach to case research. *Journal of Business Research*, 55, 553–560

Dunning, J. (1993). *Multinational Enterprises and the Global Economy.* Wokingham: Addison-Wesley

Dushnitsky, G., & Shapira, Z. B. (2008). Entrepreneurial finance meet organizational reality: comparing investment practices by corporate and independent venture capitalists. *Working Paper, Wharton School of Business*

Dyer, J. H., & Singh, H. (1998). The relational view: cooperative strategy and sources of interorganizational competitive advantage. *Academy of Management Review, 23*(4), 660–679

Easterby-Smith, M., & Lyles, M. A. (2003). Watersheds of organizational learning and knowledge management. In M. Easterby-Smith, & M. A. Lyles (Eds.). *The Blackwell Handbook of Organizational Learning and Knowledge Management* (pp. 1–15). UK: Blackwell Publishing

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

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: opportunities and challenges. *Academy of Management Journal*, 50(1), 25–32

Eisenhardt, K. M., & Schoonhoven, C. (1996). Resource-based view of strategic alliance formation: strategic and social effects in entrepreneurial firms. *Organization Science, 7*, 136–150

Engardio, P., & Einhorn, B. (2005). Outsourcing innovation. *Business Week*, (March), 84–94

Ettlie, J. E., & Elsenbach, J. M. (2007). The changing role of r&d gatekeepers. *Research Technology Management*, (September-October), 59–66

European Commission (2005a). *Annual Digest of Industrial Research*, Background Document.

Flyvbjerg, B. (2006). Five misunderstandings of case study research. *Qualitative Inquiry, 12*(2), 219–245

Foss, N. J., Laursen, K., & Pedersen, T. (2007). *Linking customer interaction and innovation: The mediating role of new organizational practices.* Copenhagen Business School

Freeman, C. (1991). Networks of innovators: a synthesis of research issues. *Research Policy, 20*(5), 499–514

Freeman, J., & Engel, J. (2007). Models of innovation: start-ups and mature corporations. *California Management Review,* 50(1), 94–119

Friedman, T. L. (2006). *The World is Flat: The Globalized World in the Twenty-First Century* (3rd ed.). London: Penguin Books

Frishammer, J., & Floren, H. Where new product development begins: success factors, contingencies and balancing acts in the fuzzy front end. *IAMOT Conference, Dubai, 2008*

Galbraith, J. (1977). *Organization Design.* Reading, MA: Addison-Wesley Publishing.

Garcia-Osma, M. L. (June 2009). *An evaluation of innovation rankings published in the business press.* PRIME Conference, Manchester Business School

Gaso, B. (2005). *Management of Technological Listening Posts in Decentralized Firms.* Unpublished PhD Dissertation, University of St. Gallen

Gassmann, O., & Gaso, B. (2004). Insourcing creativity with listening posts in decentralized firms. *Creativity and Innovation Management, 13*(1), 3–14

Gassmann, O., & Zedtwitz, M. von (1999). New concepts and trends in international r&d organization. *Research Policy*, (28), 231–250

Gemunden, H. Georg, Salomo, S., & Holzle, K. (2007). Role models for radical innovations in times of open innovation. *Creativity and Innovation Management, 16*(4), 408–421

Gephart, R. (2004). From the editors: qualitative research and the academy of management journal. *Academy of Management Journal, 47*(4), 454–462

Gilsing, V., & Nooteboom, B. (2006). Eploration and exploitation in innovation systems: the case of pharmaceutical biotechnology. *Research Policy, 35*(1), 1–23

Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal, 17*, 109–122

Grant, R. M. (2005). *Contemporary Strategy Analysis* (5th ed.). UK: Blackwell Publishing

Grant, R. M., & Baden-Fuller, C. (2004). A knowledge accessing theory of strategic alliances. *Journal of Management Studies, 41*(1), 61–83

Hagedoorn, J. (2002). Inter-firm R&D partnerships: an overview of major trends and patterns since 1960. *Research Policy, 31*, 477–492

Hagedoorn, J., Link, A. N., & Vonortas, N. S. (2000). Research partnerships. *Research Policy, 29*, 567–586

Hall, K. R., & Ritchie, E. (1975). A study of communication behaviour in an r&d laboratory. *R&D Management, 5*(3), 243–245

Hamel, G., & Getz, G. (2004). Funding growth in an age of austerity. *Harvard Business Review*, (July-August), 76–84

Hannan, M. T., & Freeman, J. (1977). The population ecology of organizations. *American Journal of Sociology, 82*(5), 929–964

Harada, T. (2003). Three steps in knowledge communication: the emergence of knowledge transformers. *Research Policy, 32*(1), 1737–1751

Harryson, S. J. (1998). *Japanese Technology and Innovation Management.* Cheltenham, UK: Edward Elgar

Harryson, S. J. (2006). *Know-Who Based Entrepreneurship: From Knowledge Creation to Business Implementation.* Cheltenham, UK: Edward Elgar

Harryson, S. J., Dudkowski, R., & Stern, A. (2008). Transformation networks in innovation alliances - the development of volvo C70. *Journal of Management Studies, 45*(4), 730–758

Hartig, J. (2009). International cooperation in r&d: How can a firm cope with distance effects? Evidence from the German Life Sciences Sector. Paper presented at PRIME - PhD and Early Career Researcher Conference; Challenges in Research and Innovation Policy Studies Manchester, July, 2009

Hauschildt, J. (2004). *Innovationsmanagement* (3, Auflage). München: Verlag Franz Vahlen GmbH

Hauschildt, J., & Schewe, G. (2000). Gatekeepers and process promotors: key persons in agile and innovative organizations. *International Journal of Agile Management Systems, 2*(2), 96–103

Henderson, R. M., & Clark, K. B. (1990). Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms. *Administrative Science Quarterly, 35*(1), 9–30

Henderson, R. M., & Cockburn, I. (1994). Measuring competence? exploring firm effects in pharmaceutical research. *Strategic Management Journal*, 15(Winter: Special Issue), 63–84

Hensley, R., Knupfer, S., & Pinner, D. (2009). *Electrifying cars: how three industries will evolve*. Retrieved August 25, 2009, from McKinsey Quarterly: www.mckinseyquarterly.com

Howells, J., 1990. The location and organisation of research and development: new horizons. *Research Policy* 19, 133–146

Howells, J. (2008). New directions in R&D: current and prospective challenges. *R&D Management, 38*(3), 241–252

Iansiti, M. and Clark K. B. (1994). Integration and dynamic capability: evidence from product development in automobiles and mainframe computers. *Industrial and Corporate Change,* 3(3), 557–605

Internet World Stats. *Internet Usage Statistics.* Retrieved July 25, 2008, from www.internetworldstats.com

Jansen, J., van den Bosch, F. A. J., & Volberda, H. W. (2005). managing potential and realized absorptive capacity: how do organizational antecedents matter? *Academy of Management Journal, 48*(6), 999–1015

Kanter, R. Moss (2007). Innovation: the classic traps. *Harvard Business Review*, 73–83

Katz, E., & Lazarsfeld, P. (1955). *Personal Influence.* New York: Free Press

Katz, R., & Tushman, M. L. (1979). Communication patterns, project performance, and task characteristics: an empirical evaluation and integration in an R&D setting. *Organizational Behaviour & Human Performance, 23*, 139–162

Katz, R., & Allen, T. (1982). Investigating the not invented here (nih) syndrome: a look at the performance, tenure, and communication patterns of 50 r&d project groups. *R&D Management*, 7–19

Katz, R., & Tushman, M. L. (1983). A longitudinal study of the effects of boundary spanning supervision on turnover and promotion in research and development. *Academy of Management Journal, 26*(3), 437–456

Kellogg, K. C., W. J. Orlikowski and J. Yates (2006). Life in the trading zone: structuring coordination across boundaries in postbureaucratic organizations. *Organization Science*, 17(1), 22-44

Kiley, D. (2004). *Driven: Inside BMW, the Most Admired Car Company in the World.* New Jersey: John Wiley & Sons ltd.

Kim, C. W., & Mauborgne, R. (2005). *Blue Ocean Strategy: How to Create Uncontested Market Space and Make Competition Irrelevant.* Boston, Massachusetts: Harvard Business School Press

Kline, D. (2003). Sharing the corporate crown jewels. *MIT Sloan Management Review, 44*(3), 89–93

Knudsen, L. G. (2009). *Collaborative R&D Capabilities: In Search for Microfoundations.* Dissertation, Copenhagen Business School, Copenhagen

Kodama, F. (1986). Japanese innovation in mechatronics technology. *Science and Public Policy, 13*(1), 44–52

Kodama, F. (1992). Technology fusion and the new r&s. *Harvard Business Review, 70*(4), 70–78

Kogut, B., & Zander, U. (1992). Knowledge of the firm, combinative capabilities and the replication of technology. *Organization Science, 3*(3), 383–396

Lampikoski, T. (March 2009). *Nintendo - yes wii can.* MBA Case Study*,* Haas School of Business

Langer, K. (2003). Dem Himmel so nah. Retrieved September 12, 2008, from http://www.manager-magazin.de/koepfe/unternehmerarchiv/0,2828,258511-2,00.html

Langlois, R. N. (2003). The vanishing hand: the changing dynamics of industrial capitalism. *Industrial and Corporate Change, 12*(2), 351–385

Laursen, K., Salter A. (2006). Open for innovation: the role of openness in explaining innovation performance among u.k. manufacturing firms. *Strategic Management Journal, 27*, 131–150

Lazarsfeld, P., Berelson, B., & Gaudet, H. (1948). *The People's Choice.* New York: Duell, Sloan, and Pierce.

Leonard-Barton, D. A. (1992). Core capabilities and core rigidities: a paradox in managing new product development. *Strategic Management Journal*, (13), 111–125

Levitt, B., & March, J. G. (1988). Organizational learning. *Ann. Review of Sociology*, (14), 319–340

Lewin, K. (1947). Channels of group life. *Human Relations, 1*

Lichtenthaler, U. (2008). Open innovation in practice: an analysis of strategic approaches to technology transactions. *IEEE Transactions on Engineering Management*, 55(1), 148–157

Lichtenthaler, U., & Ernst, H. (2006). Attitudes to externally organising knowledge management tasks: a review, reconsideration and extension of the nih syndrome. *R&D Management,* 36(4), 367–386

Lichtenthaler, U., & Ernst, H. (2007). Developing reputation to overcome the imperfections in the markets for knowledge. *Research Policy, 36*(1), 1–156

Lindner, R. (2009, December 23). Volvo wird Chinesisch. *Frankfurter Allgemeine Zeitung.* Retrieved January 17, 2010, from www.faz.net

MacDonald, S., Williams, C. (1993). Beyond the boundary: an information perspective on the role of the gatekeeper in organizations. *Journal of Product Innovation Management*, 10, 417-427

March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science, 2*(1), 71–87

March, J. G., & Simon, H. A. (1958). *Organizations*. New York: Wiley

Marshall, A. (1920). *Principles of Economics*. London: Macmillan

Martin, X. Mitchell W. (1998). The influence of local search and performance heuristics on new design introduction in a new product market. *Research Policy*, 26(7, 8), 753–771

Maxton, G. P., & Wormald, J. (2004). *Time for a Model Change: Re-Engineering the Global Automotive Industry.* Cambridge: Cambridge University Press

McEvily, B. & Marcus, A. (2005) Embedded ties and the acquisition of competitive capabilities. *Strategic Management Journal*, 26(11):1033-1055

Meyer, A. de (1984). A technological lifecycle approach to the organisational factors determining gatekeeper activities. *R&D Management, 14*(4), 239–246

Miles, M. B., & Huberman, A. (1994). An Expanded Sourcebook: Qualitative Data Analysis. London: Sage Publications

Mowery, D. C. (1983). The relationship between intrafirm and contractual forms of industrial research in American manufacturing. *Explorations in Economic History, 20*, 351–374

Mowery, D. C. (2009). Plus ca change: industrial r&d in the "third industrial revolution". *Working Paper*, Haas School of Business, UC Berkeley

Narula, R. (2001). Choosing between internal and non-internal r&d activities: some technological and economic factors. *Technology Analysis & Strategic Management*, 13(3), 365–387

Narula, R., & Duysters, G. (2004). Globalisation and trends in international r&d alliances. *Journal of International Management, 10*, 199–218

Nelson, R. R., & Winter, S. G. (1982). *An Evolutionary Theory of the Firm:* Harvard University Press

Nochur, K. S., & Allen, T. J. (1992). Do nominated boundary spanners become effective technological gatekeepers? *IEEE Transactions on Engineering Management, 39*(3), 265–269

Nonaka, I. (1991). The knowledge-creating company. *Harvard Business Review, 69*(November-December), 96–104

Nonaka, I., & Takeuchi, H. (1995). *The Knowledge Creating Company.* New York: Oxford University Press

Nooteboom, B. (1999). *Inter-Firm Alliances - Analysis and Design.* London: Routledge

Nooteboom, B. (2000). Learning by interaction: absorptive capacity, cognitive distance and governance. *Journal of Management and Governance*, (4), 69–92

Nooteboom, B., van Haverbeke, W., Duysters, G., Gilsing, V., & van den Oord, A. (2007). Optimal cognitive distance and absorptive capacity. *Research Policy, 36*, 1016–1034

North, D. C. (1990). *Institutions, Institutional Change and Economic Performance:* Cambridge University Press

O'Reilly III, C. A., & Tushman, M. L. (2004). The ambidextrous organization. *Harvard Business Review*, 74–81

Pavitt, K. (1998). Technologies, products and organization in the innovating firm: what adam smith tells and joseph schumpeter doesn't. *Industrial and Corporate Change, 7*(3), 433–452

Penrose, E. T. (1959). *The Theory of the Growth of the Firm.* New York: Wiley

Perez, C., & Soete, L. (1988). Catching up in technology: entry barriers and windows. In G. Dosi, J. Freeman, R. Nelson, G. Silverberg, & L. Soete (Eds.). *Technical Change and Economic Theory* (pp. 458–479). London: Pinter

Pettigrew, A. (1974). *The Politics of Organizational Decision Making*. London: Tavistock

Phene, A., Fladmoe-Lindquist, K., & Marsh, L. (2006). Breakthrough innovations in the u.s. biotechnology industry: the effects of technological space and geographic origin. *Strategic Management Journal*, 27, 369–388

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

Pisano, G. (1990). The R&D boundaries of the firm: an empirical analysis. *Administrative Science Quarterly*, 35(1), 153–176

Polanyi, M. (1967). *The Tacit Dimension*. Garden City, NY: Doubleday Anchor.

Porter, M. (1985). *Competitive Advantage*. New York: Free Press

Porter, M. (1998). Clusters and the new economics of competition. *Harvard Business Review*, 76(6), 77–90

Prahalad, R., & Bettis R. (1986). The dominant logic: a new linkage between diversity and performance. *Strategic Management Journal*, (7), 485–501

Prahalad, C. K., & Hamel, G. (1990). The core competence of the corporation. *Harvard Business Review*, (May/June), 79–91

PricewaterhouseCoopers (2008). *Will You Handle the Curve? Global Automotive Perspectives 2008*

Quinn, J. B. (2000). Outsourcing innovation: the new engine of growth. *Sloan Management Review, 41*(4), 13–28

Reed, J. (2008, March 04). Challenges open up new paths to profit. *Financial Times,* Special Report Motor Industry

Rybczynski, T. (1993). Innovative activity and venture financing: access to markets and opportunities in japan, the u.s. and europe. In Day et al. (Eds.). *The Markets for Innovation, Ownership and Control.* Amsterdam, New York: North-Holland

Rigby, D., & Zook, C. (2002). Open-market innovation. *Harvard Business Review, 80*(10), 80–89

Roberts, J. (2000). From know-how to show-how? questioning the role of information and communication technologies in knowledge transfer. *Technology Analysis & Strategic Management, 12*(4), 429–443

Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). New York: Free Press

Rosenkopf, L., & Almeida, P. (2003). Overcoming local search through alliances and mobility. *Management Science, 49*(6), 751–766

Rosenkopf, L., & Nerkar, A. (2001). Beyond local search: boundary-spanning, exploration and impact in the optical disc industry. *Strategic Management Journal, 22*, 287–306

Saxenian, A. (1994). *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Cambridge, MA: Harvard University Press

Schon, D. A. (1963). Champions for radical new inventions. *Harvard Business Review, 41*(2), 77–86

Schumpeter, J. A. (1911). *Theorie der wirtschaftlichen Entwicklung*. Berlin

Schumpeter, J. A. (1942). *Capitalism, Socialism, and Democracy*. New York: Harper

Schwartz, H., & Davis, S. (1981). Matching corporate culture and business strategy. *Organizational Dynamics*, 30–48

Senge, P. (1990). *The Fifth Discipline: The art and practice of the learning organization*. New York: Doubleday

Shannon, C., & Weaver, W. (1949). *The Mathematical Theory of Communication*. Urbana: University of Illinois Press

Singh, J., & Agrawal, A. (2008). Recruiting for ideas: a difference-in-differences approach for estimating the effect of mobility on access to an inventor's prior knowledge. *Working Paper*, 1–41

Spender, J.-C. (1989). *Industry Recipes: An Inquiry into the Nature and Sources of Managerial Inquiry*. Oxford: Blackwell Publishing

Storper, M., & Venables, A. J. (2004). Buzz: face-to-face contact and the urban economy. *Journal of Economic Geography*, 4(4), 351–370

Stuart, T., & Podolny, J. (1996). Local search and the evolution of technological capabilities. *Strategic Management Journal, 17*, 21–38

Sünkel, R. (2008). *Multi Purpose Tailgate MPT – ein flexibles Heckklappenmodul mit integriertem Trägersystem*. Retrieved September 12, 2008, from ThyssenKrupp Steel AG: http://www.thyssenkrupp.de/documents/Publikationen/Techforum/techforum_1_2008_de.pdf

Szulanski, G. (1996). Exploring internal stickiness: impediments to the transfer of best practice within the firm. *Strategic Management Journal*, 17(Winter Special Issue), 27–43

Taleb, N. Nicholas (2007). *The Black Swan*. London: Penguin Books

Tallman, S., & Phene, A. (2007). Leveraging knowledge across geographic boundaries. *Organization Science,* 18(2), 252–260

Tapscott, D., & Williams, A. D. (2008). *Wikinomics: How Mass Collaboration Changes Everything* (2nd ed.). UK: Atlantic Books

Taylor, R. L. (1972). *An Analysis of the Two-Step Process of Scientific and Technical Communication in a Military Research and Development Laboratory*. Bloomington: unpublished D.B.A. dissertation

Taylor, R. L. (1975). The technological gatekeeper. *R&D Management, 5*(3), 239–242

Taylor, R. L. (1982). The influence of organizational dynamics on the technological gatekeeper role. *Academy of Management Proceedings*, 384–388

Taylor, S., & Osland, J. S. (2003). The impact of intercultural communication on global organizational learning. In M. Easterby-Smith, & M. A. Lyles (Eds.). *The Blackwell Handbook of Organizational Learning and Knowledge Management* (pp. 212–232). UK: Blackwell Publishing

Taylor, R. L., & Utterback, J. M. (1975). A longitudinal study of communication in research. *IEEE Transactions on Engineering Management, 22*, 80–87

Teece, D. J. (1986). Profiting from technological innovation: implications for integration, collaboration, licensing and public policy. *Research Policy*, 15(6), 285–305

Teece, D. J. (1996). Firm organization, industrial structure, and technological innovation. *Journal of Economic Behavior and Organization*, (31), 193–224

Teece, D. J. (2000). *Managing Intellectual Capital.* Oxford: Oxford University Press

Teece, D. J. (2003). Industrial Research. In S. I. Kutler (Ed.). *Dictionary of American History* (pp. 338–342). Charles Scribner's Sons

Teece, D. J. (2009a). Business models, business strategy, and innovation. *Long Range Planning*, doi:10.1016/j.lrp.2009.07.003

Teece, D. J. (2009b). *Dynamic Capabilities.* New York: Oxford University Press

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509–533

Tidd, J., & Bessant, J. (2009). *Managing Innovation: Integrating Technological and Organizational Change* (4th ed.). Chichester: John Wiley & Sons ltd.

Tushman, M. L. (1977). Special boundary roles in the innovation process. *Administrative Science Quarterly, 22*(4), 587–605

Tushman, M. L., & Katz, R. (1980). External communication and project performance: An investigation into the role of gatekeepers. *Management Science, 26*(11), 1071–1085

Tushman, M., & Scanlan, T (1981a). Characteristics and external orientation of boundary spanning individuals. *Academy of Management Journal, 24*(1), 83-98

Tushman, M. L., & Scanlan (1981b). Boundary spanning individuals: their role in information transfer and their antecedents. *Academy of Management Journal, 24*(2), 289–305

Utterback, J. M. (1994). *Mastering the Dynamics of Innovation*. Boston: Harvard Business School Press

Utterback, J. M., & Abernathy, W. J. (1975). A dynamic model of process and product innovation. *Omega, 3*(6), 69–656

van de Ven, A. (1999). *The Innovation Journey*. Oxford: Oxford University Press

van den Bosch, F. A. J., Volberda, H. W., & de Boer (1999). Coevolution of firm absorptive capacity and knowledge environment: organizational forms and combinative capabilities. *Organization Science*, 10(5), 551–568

Vera, D., & Crossan, M. (2003). Organizational learning and knowledge management: toward an integrative framework. In M. Easterby-Smith, & M. A. Lyles (Eds.). *The Blackwell Handbook of Organizational Learning and Knowledge Management* (pp. 122–142). UK: Blackwell Publishing

Verband der Automobilindustrie (2008). *Jahresbericht 2008*. VDA. Retrieved December 07, 2008, from http://www.vda.de/de/publikationen/jahresberichte/index.html

von Hippel, E. (1988). *The Sources of Innovation*. New York, Oxford: Oxford University Press

von Hippel, E. (1994). "Sticky information" and the locus of problem solving: implications for innovation. *Management Science, 40*(4), 429–439

von Hippel, E. (2005). *Democratizing Innovation*. Cambridge: The MIT Press

Webasto AG (July 18, 2006). *Company Presentation*

Webasto AG (2008). *Company Brochure*. Retrieved June 25, 2008, from www.webasto.de

Webasto AG (July 31, 2008). *Company Presentation*

West, J., & Gallagher, S. (2006). Patterns of open innovation in open source software. In H. Chesbrough, W. Vanhaverbeke, & J. West (Eds.). *Open Innovation: Researching a new Paradigm* (pp. 82–108). Oxford University Press

Wikipedia (2009). *BMW*. Retrieved September 22, 2009, from www.wikipedia.de/wiki/bmw

Williamson, O. E. (1985). *The Economic Institutions of Capitalism*. New York: Free Press

Witte, E. (1973). *Organisation für Innovationsentscheidungen - Das Promotorenmodell*. Göttingen: Schwart.

www.fiskerautomotive.com, last accessed May 07 2009

www.teslamotors.com, last accessed May 07 2009

Yin, R. K. (2003). *Case Study Research: Design and Methods*. London: Sage Publications

Zahra, S. A., & George, G. (2002). Absorptive Capacity: A review, reconceptualization, and extension. *Academy of Management Review, 27*(2), 185–203

Zaltman, G., Duncan, R., & Holbeck, J. (1984). *Innovations and Organizations:* Malabar

10. Appendix

10.1 Interview Guideline

Theme	Question*	Possible Further Questions
Personal Information/ Background	- What is your educational background? - Could you please outline the main positions in your career so far? - How long have you been with this company? - What roles have you had at this company? - How would you describe your network outside and inside the company?	- How would you describe the skill set required for your current role?
History and Strategic Context of the Search Function	- When was this function created? - What were the strategic reasons behind creating this function?	- What was top management's involvement in this decision?
Purpose of the Function	- How would you describe the purpose of this function? - How would you assess the extent to which this purpose has been fulfilled?	
Search and Transfer Process	- How would you describe the process by which you search and transfer knowledge? - Could you provide an estimate of the extent of external vs. internal networking required?	- Would you describe the projects/ideas as radical?
Process Barriers	- Could you give an overview of some of the problems you face when searching and transferring ideas/projects?	
Process Enablers	- Could you describe how these barriers have been addressed?	- What seems to work particularly well?
Project Example	- Could you please provide one or more concrete project examples?	- What went well/What did not go so well? - What were the key success factors?

Theme	Question*	Possible Further Questions
Ideal Process	- In your opinion, if you could create the ideal process, what would it look like?	

*Both German and English interview guidelines were used.

10.2 Full List of Interviewees

Name	Position	Company	Date(s)
Anonymous	Project Manager, Palo Alto Technology Office	BMW AG	March 27, 2009+
Achim Böckelt	Project Leader, Public Research Consortia	BMW AG	July 01, 2008+
Dr. Claus Dorrer	Head of Innovation Transfer	BMW AG	June 27, 2008+
Stephan Durach	Head of Palo Alto Technology Office	BMW AG	March 27, 2009+
Simon Ellwanger	Project Manager, Palo Alto	BMW AG	May 15, 2008+*
Martin Ertl	Head of Innovation Impulses	BMW AG	June 15, 2006; October 18, 2006 November 21, 2006; June 6, 2008+
Dr. Marc Jokisch	Innovation Manager, Marketing	BMW AG	November 20, 2006+
Max Kicherer	Palo Alto Alumnus	BMW AG	May 07, 2008+*
Marc Lengning	Palo Alto Alumnus	BMW AG	July 15, 2008+*
Dr. Bernardo Alvarez-Lopez	Former Head of Palo Alto Technology Office	BMW AG	January 20, 2009+
Ronny Martin	Innovation Field Manager	BMW AG	January 15, 2009 September 30, 2009
Jeff Ota	Project Manager Palo Alto Technology Office	BMW AG	April 24, 2008+*
Horst Reichl	Head of Innovation Management	BMW AG	July 03, 2007
Rico Schütz	Innovation Manager, Supply Chain Management	BMW AG	April 22, 2008+
Torsten Winter	Manager, Supply Chain Management	BMW AG	July 12, 2007
Thomas Würtenberger	VIA Administrator	BMW AG	December 12, 2006; March 21, 2007; February 13, 2008
Jeff Zabel	Project Manager PATYO	BMW AG	April 24, 2008+*
Anonymous	Project Manager Product Design	Webasto AG	September18, 2008+**
Anonymous	Head R&D	Webasto AG	September 18, 2008+**
Alexander Lang	Director Marketing and Innovation	Webasto AG	04 March 2008+; 31 July 2008; 02 September 2008+ September 18,

Name	Position	Company	Date(s)
			2008+**
Gero Schling	Marketing Manager	Webasto AG	July 31, 2008
Michael Dimitrov	General Manager Advanced Engineering and Weight Management	Porsche AG	July 25, 2007
Serhan Ili	Industrial PhD Student	Porsche AG	July 25, 2007; November 21, 2007+; March 28, 2008
Dr. Eric Larsen	Director STRNA	Daimler AG	April 20, 2009+
Dr. John Suh	Researcher GM Palo Alto Office	GM	April 17, 2009+
Rich Friedrich	Director Open Innovation Office	HP	May 04, 2009
Bruce Ackman	Vice President Sales	Innocentive	February 20, 2008; November 19, 2008
Jon Frederickson	Vice President Sales	Innocentive	August 11, 2009
Anne-Mette Lilleøre	Team Leader	Novo Nordisk	September 25, 2008
Dr. Kaarlo Heiskanen	Consultant	Tekes (formerly)	April 01, 2009+
Marco ten Vaanholt	VP	SAP AG	April 17, 2009+
Anonymous	Project Manager	VW AG	April 03, 2009
Anonymous	Development Engineer	VW AG	April 03, 2009
Stefan Gabriel	VP Corporate Ventures (Former Innovation Field Manager, BMW)	3M	June 07, 2008+
Dr. Sven Beiker	Executive Director, Car Lab (Formerly Project Manager, BMW PATYO)	Stanford University	April 17, 2009+
Prof. Henry Chesbrough	Director, Center for Open Innovation	Haas School of Business, UC Berkeley	March 11, 2009; March 18, 2009; April 1, 2009
Prof. Frank Piller	Professor	MIT, RWTH Aachen	April 13, 2009
Prof. Marko Torkkeli	Professor	Lappeenranta University of Technology	March 17, 2009
Total		**16**	**52**

+Structured interview, mostly audio recorded and transcribed

* Interviews conducted by a Master Thesis student according to interview guide designed as part of this study.

**Interviews conducted by an independent academic

10.3 Abstract in English

This thesis pursues the question of how technology-intensive firms can match knowledge from outside of the organization which is distant from their current technology/product/market context with their existing routines and capabilities. The focus of the study is motivated both by theoretical and phenomenological ambiguity and uncertainty. From a phenomenological point of view on the one hand, innovation processes have been opening up, moving from hierarchy-based forms of organizing R&D to more market-based forms. This disaggregation demands of technology-intensive firms to search and apply knowledge from outside of the boundaries of the firm. In addition, technology convergence and divergence dynamics entail that the knowledge sourced is increasingly distant from the current technology/product/market context of the firm. However, technology-intensive firms are facing severe difficulties to reconcile such distant knowledge with their existing routines and processes. Failure to appropriate distant knowledge, in the extreme, can lead to firm failure. The speed of such failure, in the last decades, has increased considerably. From a theoretical perspective, on the other hand, strategy, organizational economics and innovation management literature has long recognized the path dependence and inertia in the face of change imposed by a firm's current routines. This is caused by a focus on exploitation and efficiency in order to protect current revenue streams from competitive forces. The question of how the constraints on innovation due to current routines can be overcome has been neglected relative to other question in the relevant literature. Thus, the question of how distant, novel knowledge can be effectively matched is warranted both from a phenomenological and theoretical perspective.

Many studies in strategy, organizational economics, organization theory and innovation management deal with mechanisms for accessing external knowledge, including firm motivation for using such mechanisms as well as forms of governance. Further, a large body of research also deals with the question of how organizations mature and routines ossify. Mostly, such analysis is based on large-scale data. In-depth data of how distant knowledge is accessed and matched with existing routines is scarce. Therefore, this thesis uses an in-depth, multiple case study design, exploring micro-foundations of how firms have organized processes designed to match distant knowledge with existing capabilities. Empirically, this thesis uses data from the German automotive industry. Two cases from BMW group explore how two separate organizational functions search, transfer, and match distant knowledge. One case from an automotive supplier explores an equivalent function. All three cases feature functions located at the fuzzy front end of innovation. The data largely confirms that current routines preclude the appropriation of distant and more radical knowledge. However, there is also some indication that certain process design *can* enable the

successful matching of distant knowledge provided the strategic focus of the matching activity is sufficiently acute.

10.4 Abstract in Danish

Denne afhandling undersøger spørgsmålet om, hvordan teknologitunge virksomheder kan anvende viden udenfor organisationen; en viden som er fjern fra dennes nuværende teknologi, produkter og marked samt virksomhedens eksisterende rutiner og kapacitet. Studiets fokus er motiveret af både en teoretisk og en fænomenologisk uklarhed og usikkerhed.

Fra et fænomenologisk perspektiv, er innovationsprocesser blevet mere tydelige; i forskning og udvikling er innovationsprocesserne flyttet fra at have været organiseret hierarkisk internt til at have antaget en mere markedsbaseret form. Denne disaggregering kræver, at teknologitunge virksomheder må søge efter og anvende viden uden for virksomheden. Derudover medfører dynamikken omkring teknologi-konvergens og divergens, at indhentet viden i højere grad er længere væk fra virksomhedens nuværende kontekst i forhold til teknologi, produkter og marked. Imidlertid står teknologitunge virksomheder over for alvorlige vanskeligheder i forhold til at forene en sådan ekstern viden med virksomhedens eksisterende rutiner og processer. I ekstreme situationer kan fejlslagen integration af ekstern viden føre til virksomhedens kollaps.
I de sidste årtier er hastigheden for sådanne fejlslagne satsninger steget markant. Fra et teoretisk perspektiv har litteraturen inden for strategi, virksomhedsøkonomi og innovationsledelse i lang tid anerkendt, at virksomhedens nuværende rutiner skaber afhængighed og inerti i en forandringssituation. Dette skyldes et fokus på udnyttelse og effektivitet med henblik på at beskytte nuværende indtægtsstrømme fra konkurrerende kræfter. Spørgsmålet om hvordan begrænsningerne i forhold til innovation, der er betinget af nuværende rutiner, kan blive overvundet, er blevet overset i den relevante litteratur. Retfærdiggjort både fra et fænomenologisk og et teoretisk perspektiv er spørgsmålet derfor, hvordan ny, ekstern viden effektivt kan forenes med virksomhedens nuværende rutiner og kapacitet.

Mange studier i strategi, virksomhedsøkonomi, organisationsteori og innovationsledelse vedrører mekanismer, der kan give adgang til ekstern viden, herunder virksomhedens motivation for at anvende sådanne mekanismer såvel som virksomhedens ledelse. Derudover behandler megen forskning også spørgsmålet om, hvordan virksomheder modnes, og rutiner forstærkes. Denne forskning er overvejende baseret på data fra store undersøgelser. Dybdegående undersøgelser, om hvordan ekstern viden tilgås og tilpasses de eksisterende rutiner i virksomheder, er sjældne. Denne afhandling er derfor baseret på et multiple casestudiedesign for at undersøge, hvordan virksomheder har organiseret processer med henblik på at forene deres nuværende kapacitet med ekstern viden. De empiriske data i denne afhandling stammer fra den tyske automobilindustri. To cases fra BMW Group undersøger, hvordan to separate organisatoriske funktioner søger efter, overfører og forener ekstern viden. En case fra en automobilleverandør undersøger en tilsvarende organisatorisk funktion. Alle tre cases vedrører enheder i

organisationen, som arbejder med det tidlige stadie af innovation. Data bekræfter i stor udstrækning, at nuværende rutiner umuliggør anvendelsen af ekstern og mere radikal viden. Imidlertid er der også nogle indikationer af, at specifikke proces-design *kan* fremme den succesfulde tilpasning af ekstern viden forudsat, at det strategiske fokus har været gjort tilstrækkeligt præcis.