

Martin Fischer

Patent Management in New Product Development

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Erstbetreuer: *Prof. Dr. Holger Ernst*

Zweitbetreuer: *Prof. Dr. Martin Högl*

Martin Fischer

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Martin Fischer

EXTENDED ABSTRACT

This dissertation investigates patent management during new product development (NPD). In the course of three main chapters, a conceptual framework including antecedents and consequences of patent management in NPD is theoretically developed, subsequently refined, and empirically tested. Empirical analyses are based on a cross-functional sample of 101 recently finished NPD projects which are nested within 72 multi-national technology-based firms across various industries. The main focus lies on two theoretically different approaches of patent management in NPD: patent orientation, and cross-functional integration of patenting and R&D.

In the first main chapter, the concept of patent orientation is introduced. It comprises a broad, organizational perception of patent management during NPD and is an addition to other strategic orientations like market or technology orientation. It is derived from the information processing theory and refers to the processes, practices, and decision-making activities that lead to protect the new product and appropriate its value. The effect of patent orientation on new product success is empirically analyzed. Furthermore, antecedents to patent orientation at the program level are included in the analysis. The results show that patent orientation has a positive and significant influence on the outcome of development projects. Additionally, it was found that the program-level antecedents ‘strategic patent emphasis’ and ‘proactiveness of the intellectual property department’ both foster patent orientation at the project-level. These findings have important implications for improving project performance by means of incorporating a patent orientation within the organization. Also, top-managers should establish an organizational awareness for patent-related matters within the company. Furthermore, IP specialists should anticipate NPD needs and deliver support activities.

The second main chapter takes on a narrower, operational perception of patent management in NPD than the patent orientation approach. Based on the resource-

dependency theory, the interface between a company's R&D function and its patent function is examined in the context of NPD. In particular, efforts of integrating these two originally distinct corporate functions on the level of single product development projects and their impact on new product success are analyzed. The results show that the patent function can deliver important contributions during development projects. It is found that this so-called behavioral contribution dimension of patent management integration has a positive and significant impact on the project's success. Also, the so-called attitudinal collaboration dimension of patent management integration has a positive impact on project outcome. Additionally, this seems to be the case for both radical and incremental innovations alike because the degree of innovativeness doesn't seem to play a moderating role in the relationship between collaboration and NPD success. However, the relationship between the behavioral dimension and the project outcome actually is affected by innovativeness. Obviously, patent management contributions become even more important during NPD when the new product gets more innovative. These partly surprising findings have important implications for improving project performance by means of effectively integrating the patent and the R&D functions at the project level.

The third main chapter investigates efforts of fostering patent management integration at the program level and at the project level. In particular, the impact of a set of antecedents on the behavioral and the attitudinal dimension of cross-functional integration is examined. The analysis suggests that patent management integration can be influenced by a company's management through several specific antecedents. It is found that team involvement of patent professionals and strategic patent emphasis within the whole organization both have a positive and significant impact on the two dimensions of cross-functional integration. However, goal incongruity and formalized NPD and patenting processes only affect the attitudinal dimension. Furthermore, formalization is only moderately significant here. These findings have important implications for im-

proving patent management integration into product development by means of effectively supporting and fostering specific organizational actions.

All in all, this thesis contributes to the existing literature on strategic orientations and interface management by introducing patent orientation and patent management integration as new success factors in NPD. Overall, one can conclude that the increased focus on patent management during NPD projects is economically justified.

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Chapter A:
Introduction and Framework

INTRODUCTION

In our globalized environment, firms have to adapt to their customers' ever-changing and wide-ranging demands constantly. At the same time, they are forced to hold current and upcoming competitors from all parts of the world at bay and defend their distinct competitive advantage. In order to persist in this hyper-competitive environment, most companies feel the pressure to come up with new products very frequently (D'Aveni, 1995). These new products must be innovations that absolutely meet the diverse requirements from local and international customers. At the same time, these new products must be far ahead of competitors' offerings from a customer's point of view (Crawford and Di Benedetto, 2003). Consequently, these developments lead to ever shorter product life-cycles which in turn require higher corporate R&D spending.

In order to secure maximum financial returns from these high investments in R&D, more and more companies have turned their attention to the use of intellectual property (IP) rights in general, and patents in particular (Cukier, 2005; Grindley and Teece, 1997; Kortum and Lerner, 1999). Patents allow its holder to exclusively exploit a certain set of inventions, which catapults the patent holder into a very favorable monopolist position for a maximum period of twenty years. Also, patents provide a depth of information, which can be applied not only for technological but also for strategic use. Managing patents can optimize the amount, quality, and effectiveness of a company's patents in order to contribute to the firm's overall success by generating a favorable and superior patent position.

By timely aligning their corporate patent management activities with their new product development (NPD) projects, leading companies in the field can purposefully use patent information for project intelligence and protect their valuable innovations from imitation. Thereby, these companies try to obtain and preserve their competitive advantages, with the overall aim to eventually generate higher profits.

Observations from companies like W.L. Gore and Siemens Healthcare show, that the integration of patent management into new product development can improve the innovation outcome. For materials specialist W.L. Gore – most famous for its waterproof and breathable fabric called ‘Gore-Tex’ – intellectual property has been playing an important role in the company’s culture ever since its founders filed their first patents in the 1950s. The awareness for intellectual property related matters is very high during new product development. As the developers at Gore are used to working in cross-functional teams, the inclusion of patent professionals happens naturally. As soon as the final product concept has been developed, its unique selling proposition is transformed into patent applications immediately. During this process, the most important customer requirements are directly converted into patent claims almost word by word. Nearly all patentable inventions are actually filed for patent application. The result from this genuine cross-functional integration (including R&D, patenting, marketing, and manufacturing) is that the most important inventions resulting from each project are very well protected, making it extremely difficult for competitors to obtain own patents in the field of the new Gore products. Therefore, project teams at Gore are able to build up strong patent portfolios surrounding the most valuable features of their new products.

Another example of patent management integration into NPD comes from the German technology powerhouse Siemens. The company is one of the world’s largest patent holders. Siemens Healthcare makes ample use of formal procedures which explain in written form how to systematically involve relevant patent management tasks into the company-wide standardized development process, the so-called product life-cycle management (PLM) process. This implies clearly defined stages, tasks, responsibilities, and decision gates that require certain patent management activities. By this, Siemens Healthcare effectively synchronizes its IP- and development processes. According to these procedures, the protection of new products and their most important

features already starts during the very early phases in order to subsequently secure so-called freedom to business and freedom to design. This helps to protect own inventions and to timely identify existing intellectual property that could possibly inhibit own development activities. Furthermore, top-management stresses the importance of generating own IP and respecting IP belonging to others. Establishing a profound patent awareness throughout the whole business unit is the long-term goal at Siemens Healthcare.

From these case-based observations and other anecdotal evidence reported in the literature, it becomes obvious that patent management seems to play a very relevant role in NPD. Companies with a clear and consistent strategic guidance on patent-related matters and with highly integrated patenting and R&D activities during new product development seem to be more successful in terms of NPD outcome because they create more valuable patents which protect the economically most important products and features.

Despite these apparent implications, in the literature only very little is known about patent management in the context of new product development. Patent management during NPD is neither treated in the field of strategic orientations nor in the field of cross-functional integration. So far, there exist only a few studies on patent management with case-based random observations (e.g. Granstrand, 2000; Pitkethly, 2001, Tsuji, 2002; Bhatia and Carey, 2007) while other patenting-related studies lack a clear NPD perspective and potential performance implications (e.g. Reitzig and Puranam, 2007; Somaya, Williamson, and Zhang, 2007; Arora, Ceccagnoli, and Cohen, 2008). This thesis addresses these research gaps by building a conceptional framework of patent management in new product development. This framework includes antecedents as well as potential outcomes. Furthermore, this framework is empirically tested on the basis of a large scale questionnaire survey. The following subchapter introduces the overall con-

ceptual model, depicts the particular contributions of this research, and eventually explains the structure of the thesis.

OVERALL FRAMEWORK

In this thesis, patent management is examined by means of two fundamentally different approaches which both seem to be relevant in the context of new product development. Hence, we differentiate between strategic patent orientation on the one hand and cross-functional integration of patenting and R&D on the other hand. Figure 1 shows the overall framework for this thesis, which is refined during the three chapters of this thesis. We will introduce and explain the two concepts of patent orientation and cross-functional patent management integration in the following.

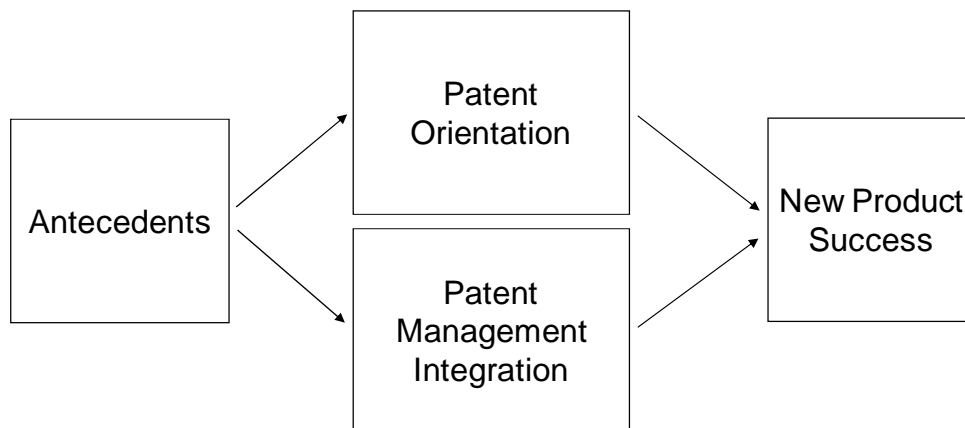


Figure 1: Overall Framework

Patent Orientation

Based on information processing theory, we contribute to the existing research by introducing patent orientation as a new approach within the stream of strategic orien-

tations. Furthermore, we investigate the impact of patent orientation on performance as well as the organizational antecedents to patent orientation.

Strategic orientations reflect different managerial priorities in the company which intend to encourage and support desired behaviors at the operational level (Atuahene-Gima and Ko, 2001; Noble, Sinha, and Kumar, 2002). Several studies in the field of new product development have dealt with market orientation and technology orientation (e.g. Jaworski and Kohli, 1993; Zhou, Yim, and Tse, 2005). However, these two approaches have neglected patenting aspects so far, though patent management seems to be essential for appropriating revenues from R&D.

The processing of patent related information is a key element of patent orientation. It is of both strategic and tactical value for new product development. Patent information can be processed through three iterative steps: Gathering information from patents, internally disseminating and interpreting this information, and eventually responding to this information. Patent information processing happens across functional borders and is independent from the different functional backgrounds of the individual NPD team members involved. It affects the intentions and actions of key players such as R&D managers, patent managers, marketing/product managers, and new business development managers. Consequently, in this thesis, patent orientation and its influence on single NPD projects are assessed at the micro-level. But because patent orientation has its roots within the broader organizational context, its potential antecedents are investigated at the macro-level.

Cross-functional Integration

Cross-functional integration is a much narrower and very different perspective than the rather broad patent orientation approach. Instead of disregarding functional borders like in the orientation approach, cross-functional integration focuses very

much on the attitudes and behaviors of different functions when working jointly during new product development projects. Consequently, it must be considered separately from patent orientation.

Many companies have established the intellectual property or patenting function as a new corporate department within their organization because the awareness for intellectual property matters has increased during the last two decades. Building up a separate functional department with IP specialists can help bundling resources and improve productivity. This is especially the case when IP professionals are engaged in their primary tasks within their subject area. Typical tasks for patent professionals include filing patent applications, prosecuting patent infringements, conducting patent searches and analyses, and managing the corporate patent portfolio.

On the one hand specialization has the potential to improve efficiency, especially when carrying out routine tasks. On the other hand, companies might run the risk of nurturing functional silos with fundamentally different attitudes and behaviors (Dougherty, 1992). Therefore, when members from organizationally distant departments are forced to collaborate during new product development, different expectations and priorities concerning time and outcome are likely to occur (Griffin and Hauser, 1996). In the case of the patenting function, cost- and time pressure along with ad-hoc decision making on the project side (often dominated by R&D and marketing managers) might collide with long-term oriented, formalized, and procedural safety thinking on the patenting side. Often, both sides lack a mutual understanding for one another.

Members from many different corporate functions can contribute relevant and substantial activities during new product development. Integrating these functions can be considered as just the opposite to functional specialization. Undoubtedly, functional specialization generally allows many organizational benefits (first of all gains in efficiency and productivity), but opening up departmental barriers for a given time and for

a selected circle of people conducting relevant proprietary activities allows for immediate cooperation between otherwise separated specialists. Consequently, cross-functional integration during NPD projects becomes critical.

Based on resource dependency theory, we contribute to the existing research in the field of cross-functional integration and interface management in NPD by considering the patenting function for the first time. In particular, we examine attitudinal and behavioral integration between the patenting function and the R&D function during new product development projects. Furthermore, we investigate performance implications under different conditions of product innovativeness. Additionally, we take into account multi-level organizational antecedents to integration.

OUTLINE OF THE THESIS

Chapter B deals with the broader and strategic aspects of patent management by introducing the new concept of patent orientation. Antecedents and consequences of patent orientation are investigated.

Chapter C takes on a narrower, more detailed perspective on patent management by considering attitudinal and behavioral integration simultaneously. The attitudinal dimension of integration reflects the rather inexplicit relationship between the functions considered (i.e. the patent function and the R&D function here). The behavioral perspective allows for a close look on new NPD-relevant activities from functions yet rather unexplored (such as the patent function) at the project level. In particular, it is explored, if these two dimensions of patent management integration have an impact on the commercial success of the new product, and if the degree of innovativeness somehow influences this relationship.

Chapter D builds up on the results of chapter C by exploring potential antecedents to the contribution and collaboration dimensions of patent management integra-

tion into new product development. As these two dimensions of integration are supposedly affected by factors from the broader organizational context and the narrower project environment alike, macro- and micro-level antecedents are considered simultaneously.

Finally, chapter E summarizes the theoretical and managerial implications derived from the three previous chapters.

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Chapter B:
**Patent Orientation in New Product Development:
Antecedents and Outcome**

This chapter has been accepted for presentation at the 18th International Product Development Management Conference (IPDMC) at the Delft University of Technology, June 5-7, 2011, in Delft (The Netherlands).

ABSTRACT

This chapter extends the research on strategic orientations by introducing the whole new concept of patent orientation in the context of new product development. Patent orientation is derived from the information processing theory and refers to the processes, practices, and decision-making activities that lead to protect the new product and to appropriate its value. The effect of patent orientation on new product success is empirically analyzed. Furthermore, antecedents to patent orientation at the organizational level are included in the analysis. Empirical analyses are based on a cross-functional sample of 101 recently finished new product development projects which are nested within 72 multi-national technology-based firms or strategic business units across various industries. The results show that patent orientation has a positive and significant influence on the outcome of development projects. Additionally, we found that the program-level antecedents ‘strategic patent emphasis’ and ‘proactiveness of the intellectual property department’ both foster patent orientation at the project-level. These findings have important implications for improving project performance by means of incorporating a patent orientation within the organization. Also, top-managers should establish an organizational awareness for patent-related matters within the company. Furthermore, IP specialists should anticipate NPD needs and deliver support activities.

Key Words: Strategic Orientations, New Product Development, Patent Orientation, Information Processing Theory, Project Performance, Mediation, Cross-level Analysis.

INTRODUCTION

Today's volatile and globalizing markets along with rapid technological advances lead to highly uncertain business environments. In order to timely sense the relevant environmental changes and to adequately react to these changes, many companies are aiming to set up certain strategic orientations within their organization.

Strategic orientations reflect different managerial priorities within the firm (Noble, Sinha, and Kumar, 2002). They can be seen as selection mechanisms that try to establish coherence between the management's strategic intent and operational activities as they create internal environments in which desired behaviors are encouraged and supported (Atuahene-Gima and Ko, 2001). Thus, they provide guidance for organizational members when processing different sorts of information and reacting to the external environment (Atuahene-Gima and Ko, 2001).

Effectively and efficiently processing relevant environmental information at different organizational levels and reacting accordingly to this information is vital for new product development (NPD). Several studies have identified the processing of different NPD relevant information as an important success factor (e. g. Keller, 1994; Tatikonda and Montoya-Weiss, 2001). During new product development, project teams can draw on multiple sources of information in order to facilitate decision making during the development process. For example, when it comes down to defining the target customers, to formulating product requirements, and to eventually introducing the new product successfully in the market place, it is commonly perceived that detailed information on relevant markets, customers, and competitors must be thoroughly considered during new product development (e. g. Moorman, 1995). This processing of market and customer information throughout the whole company and across functional borders has been described as a market orientation (Kohli and Jaworski, 1990). Several studies have

confirmed the positive effects of market orientation on business and new product performance (e. g. Jaworski and Kohli, 1993; Ottum and Moore, 1997).

Next to market orientation, technology orientation has been considered relevant in the context of new product development. In contrast to the ‘customer-pull’ approach of market orientation, technology orientation represents a ‘technology-push’ attitude (Zhou, Yim, and Tse, 2005). Technology orientation encompasses the internal and external acquisition of new, sophisticated technologies and the ample use of these technologies during the development of new products (Gatignon and Xuereb, 1997). A technology-oriented firm therefore uses its technical knowledge to answer and meet new needs of the users. Because a technology-oriented firm always strives for the use of the latest technologies in its new products, it is forced to process and to incorporate new technical information immediately.

An important source of information for new product development can be found in patents. Patents not only provide a multitude of technical details. They can also be used to derive other important information which might be of high value during strategic and tactical decision making (Cukier, 2005; Rivette and Kline, 2000). For instance, analyses of competitors’ patent applications might reveal their entrance into new markets and new technology fields which forces the organization to react accordingly. Also, sound patent search can reveal white spots in own and third parties’ patent portfolios. Therefore, patents must be acknowledged as an important source for intelligence purposes.

Although the search for patent information seems to be included in the concepts of technology orientation and partly also in market orientation, these two orientations fall short of protection and appropriation matters. Neither market orientation nor technology orientation consider, that technical knowledge, which was developed during the course of a NPD project, must be protected from imitation. Patents count among the

most important and strategically significant intellectual assets (Cohen, Nelson, and Walsh, 2000). A patent provides an inventor with the opportunity to exclusively appropriate the value of his invention by prohibiting or at least delaying its use and imitation by competitors (Chisum, Nard, Schwartz, Newman, and Kieff, 1998). By protecting their inventions with patents, companies can create temporary and geographic monopolies and thereby appropriate the returns from their initial investments in R&D. When used thoughtfully, patents can offer effective protection and thereby help securing the financial returns from the new product.

However, these virtual monopolies also bring along an important downside for the inventor since every patent application (and not just the eventually granted patent) must be published. In most countries, publication happens within 18 months after first filing (the so-called priority date). Therefore, an inventing company has to decide very carefully which inventions or components of the invention it wants to have included and eventually published in a patent application. In general, applicants choose to disclose just as much technical information as is needed for the examiner at the respective patent office to recognize an inventive step. If the examiner can recognize a significant departure from the current state of the art he can ultimately grant the patent. If the examiner rejects the application – for whatever reason that might be – the technical details of the application will be published anyway. The result is that third parties, like competitors, can easily get access to an organization's patent applications which contain a lot of technological information, some of it even unprotected.

Against this background, patenting turns into a managerial task with implications reaching far beyond the judicial realms of patent attorneys (Grindley and Teece, 1997; Rivette and Kline, 2000). Also, some recent studies suggest that the processing of certain patent information – such as technological, legal, or strategic data – might be very critical to innovation (Markman, Espina, and Phan, 2004; Leiponen, 2008). It be-

comes evident that market orientation and technology orientation are not sufficient to fully capture the importance of patent management during NPD. We therefore see the need to extend the literature on strategic orientations by introducing the concept of patent orientation. Patent orientation refers to the processes, practices, and decision-making activities that lead to extend an organization's intellectual assets. Drawing on the information processing theory, we understand patent information as the gathering, the distribution, and the use of patent information during new product development projects.

This research contributes to the existing literature in several ways. It builds up and empirically tests a whole new conceptual model that accounts for patent orientation in NPD projects. Also, it explores possible outcomes of patent orientation. Most other related studies on patent management lack a clear NPD perspective and don't explicitly address information processing elements (e. g. Reitzig and Puranam, 2007; Somaya, Williamson, and Zhang, 2007; Arora, Ceccagnoli, and Cohen, 2008; Markman et al., 2004; Artz, Norman, Hatfield, and Cardinal, 2010). The strategic and systematic use of patent information during new product development processes – including appropriation and protection matters – has not been investigated so far. Our research intends to fill this gap.

Furthermore, we include program-level antecedents in order to display the organizational background where the individual projects are nested in. As described above, it is in the very nature of strategic orientations to bridge the program-level strategies with the project-level operations. Previous studies and review articles have confirmed that the project level is very suitable for observing information processing and communication phenomena, especially in NPD (e. g. Brown and Eisenhardt, 1995; Keller, 1994; Ottum and Moore, 1997). Moreover, Leiponen (2008, p. 1377) acknowledges that “property-rights theoretic predictions should be analyzed at the level of projects”.

Therefore, individual project groups are the focal unit for orientation and performance whereas the antecedents are perceived on a higher level. With combining two hierarchical levels in a mediation analysis we might shed more light on cross-level relationships in organizations, as proposed by several recent articles (e.g. Hitt, Beamish, Jackson, & Mathieu, 2007; Salvato and Rerup, 2011).

THEORY AND HYPOTHESES

Overview

This paper basically draws on the research conducted in the field of information processing and strategic orientations. Because information processing is considered to be a strategic organizational task (Tushman and Nadler, 1978; Daft and Weick, 1984), existing studies on different strategic or organizational orientations such as market orientation, technology orientation, or entrepreneurial orientation are relevant here (e.g. Jaworski and Kohli, 1993; Gatignon and Xuereb, 1997; Noble et al., 2002; Paladino, 2007; etc.). As we derive our concept of patent orientation from Jaworski and Kohli (1993), we very much focus on their behavioral market orientation approach.

Organizational Information Processing Theory

Originally developed at the individual level in the field of psychology, Galbraith (1973) and Tushman and Nadler (1978) were among the first to establish information processing theory in the context of organizational research. Their point of departure was that companies can be considered as information processing systems which are facing a largely unstable environment and a high degree of uncertainty. Under these conditions, organizations are forced to quickly adapt to their changing environment and to reduce uncertainty by acquiring, interpreting, and responding to all sorts of information available, internally and externally. For instance, in order to discover what consumers want

that other companies cannot provide, organizations have to actively search for and response to various external and internal sources of information relevant in their fields (Daft and Weick, 1984). Organizations that adopt their information processing capacities adequately to their information processing needs are supposed to be more successful than those with an inadequate fit (Tushman and Nadler, 1978).

Given environmental uncertainty along with internal resource constraints when trying to take an entrepreneurial opportunity, information processing becomes a highly important managerial task. Customers' choices might change quickly, competitors might be faster or come up with superior offers, or other innovation opportunities suddenly might seem more compelling (Daft and Weick, 1984). Management has to decide where to allocate its resources efficiently. Timely and accurate information therefore becomes a very critical component of strategic and operational decision making (Egelhoff, 1991; Daft and Lengel, 1986; Tushman and Nadler, 1978).

The following three conceptual steps of organizational information processing were developed in the literature and have been prevailing ever since, although their labels might change slightly (e.g. Tushman and Nadler, 1978; Daft and Weick, 1984):

- 1) Gathering information (synonymously: acquiring, collecting, scanning, perceiving, generating, searching, creating, etc.)
- 2) Sharing information (synonymously: interpreting, disseminating, distributing, etc.)
- 3) Using information (synonymously: responding, applying, etc.)

When exploring information processing, Egelhoff (1991) requests to differentiate between the macro and the micro levels of organizations. Accordingly, instead of only considering phenomena at the program level some studies have turned to analyzing

the project level (e.g. Moorman, 1995; Ottum and Moore, 1997). However, until now no study on information processing has ever included multiple organizational levels simultaneously.

These basic concepts of information processing were established at a very high, abstract level and can be applied generically. From the beginning on there have been calls for further refinement (Tushman and Nadler, 1978). Accordingly, the approach has been applied to many different organizational settings (e.g. Keller, 1994; Sherman and Keller, 2011). A special focus has been laid on the processing of market information, which has been widely acknowledged as the so-called market orientation (Kohli and Jaworski, 1990; Moorman, 1995).

Strategic Orientations

Along with the concepts of market orientation and technology orientation, many other types of strategic or organizational orientations have been developed in the literature, for example entrepreneurial orientation, production orientation, resource orientation, etc. (Lumpkin and Dess, 1996; Gatignon and Xuereb, 1997; Noble et al., 2002; Jayachandran et al. 2005; Zhou et al., 2005; Paladino, 2007). There are several definitions of the term 'strategic orientation', which vary only slightly. A comprehensive definition is provided by Atuahene-Gima and Ko (2001), who describe strategic orientations as "social learning and selection mechanisms that aim to maintain a coherence between management's strategic intent and operational activities" (p. 55). Accordingly, an internal orientation determines "how organizational members process information and react to the environment through the nature of control systems and rewards they engender" (p. 55). Therefore, an organizational orientation refers to the processes, practices, and decision-making activities that are induced by certain strategic guidelines. These guidelines are usually set up and implemented by an organization's top-

management, but diffuse throughout the whole organization. For example, Lumpkin and Dess (1996) describe the key elements of an entrepreneurial orientation to include “a propensity to act autonomously, a willingness to innovate and take risks, and a tendency to be aggressive towards competitors and proactive relative to marketplace opportunities” (p. 137). Therefore, it becomes evident, that strategic orientations are a multi-level phenomenon. Also, orientations are characterized to take on broader, cross-functional approaches. They typically require the involvement of different corporate functions as well as the processing of very different sorts of information from multiple internal and external sources.

In the orientation literature, market orientation is one of the most elaborated concepts. Two different streams have emerged over the years that can be loosely grouped into a cultural (e. g. Narver and Slater, 1990) and a behavioral (e. g. Kohli and Jaworski, 1990) market orientation (Kirca, Jayachandran, and Bearden, 2005). However, it seems that both views convene as many behavioral market orientation studies consider cultural antecedents (Kirca et al., 2005; Moorman, 1995; Ottum and Moore, 1997; Noble et al., 2002). According to Kohli and Jaworski (1990), market orientation implies the following three stages of information processing: Organizationwide generation of market intelligence pertaining to current and future customer needs, dissemination of the intelligence across departments, and organizationwide responsiveness to it. Market orientation thereby focuses on specific activities or concrete behaviors rather than on philosophical or cultural perceptions. Several studies have proven that market orientation has a positive and significant outcome for the organization (e.g. Kirca et al., 2005; Han et al., 1998; Kumar et al., 2011). Atuahene-Gima and Ko (2001), Moorman (1995), and Ottum and Moore (1997) also applied this concept at the level of individual new product development projects. They confirmed the positive effects of market orientation on the (project) outcome.

Market information processing actually is a broad organizational task and not just a functional task of the marketing department alone (Jaworski and Kohli, 1993). Also, market information is not restricted to the customers but does also include other factors like competition, regulation, technology, and industry (Jaworski and Kohli, 1993). These aspects become even more important in new product development, where project members with very different functional backgrounds have to work jointly on making the new product a success in the market place (Song and Parry, 2009).

We draw on the behavioral market orientation in order to develop our concept of patent orientation in new product development for two main reasons. First, patent information processing is a managerial task analogue to market information processing that affords the participation of multiple functional departments who have high stakes in new product development. Second, it provides a comprehensive framework for summarizing relevant patent management activities across the three stages: gathering information, internally disseminating this information, and eventually responding to this information.

Patent Orientation

Patents have become an increasingly important source of information. Patent information can be used for technological, strategic, or market planning purposes (Rivette and Kline, 2000; Ernst, 2003). Systematic patent information processing throughout the whole company allows for identifying important business opportunities in new technology fields. This can ultimately lead to occupying the most promising of these fields by triggering own R&D accompanied by patent information and protection activities. In this broader context, patent management also implies the upfront decision if a certain technology should be internally developed and patented in the first place, in order to extend a company's own intellectual assets. Alternatives to filing for own patents are to

keep inventions secret, to file for other prohibition rights (like for example copyrights, utility models, or trade dresses), or to issue defensive publications so that the invention becomes public domain and no one else can get a patent on this specific invention. This is often done in open source developments like the Linux and Google Android operating systems. Also, patent-oriented management can be very useful during the make-or-buy decision making process as in some cases it might be beneficial to source certain technologies externally.

It becomes evident, that patent-oriented management is a complex organizational task with far-reaching consequences. By continuously and purposefully extending its intellectual assets, a patent-oriented company can adequately adapt its resource base to current and future needs, and thereby generate a sustainable competitive advantage. Patent orientation therefore refers to the processes, practices, and decision-making activities that lead to extend an organization's intellectual assets. It implies the intentions and actions of key players such as R&D managers, patent managers, marketing/product managers, and new business development managers when working together in dynamic processes aimed at creating new intellectual assets, most notably during new product development processes.

Patent orientation is established, if project managers and developers recognize the importance of patent data for their work during new product development and act accordingly. In alignment with the information processing approach and analogue to the concept of behavioral market orientation (see above), patent orientation can be considered as the underlying common cause for patent information processing through three iterative steps:

- Gathering patent information,
- Disseminating and interpreting patent information,
- Responding to patent information.

These three steps of patent-oriented behavior can be observed best at the group level of an organization. Here, the key players inevitably reveal their true intentions and interact accordingly within their project group. Also, individual project groups are very likely to vary in their tasks and in their communication patterns. In addition, the impact of the project group's behavior can be directly traced to the project outcome.

Patent Orientation and New Product Performance

Gathering: The starting point of a patent orientation is technology intelligence. This can be accomplished through intensive scanning of the patent situation in technology fields, which are related to the actual new product development project. Famous litigation cases (like for example Kodak vs. Polaroid or the Blackberry case) and previous observations stated that many products actually violated existing patents from third parties (e. g. Bhatia and Carey, 2007; Pitkethly, 2001). The main reason for this is a failure in executing upfront patent intelligence activities such as carrying out regular patent searches, doing in-depth patent analyses in specific technology fields, or scanning patenting activities of major competitors. It is also important to start with these intelligence activities already at an early project phase and not to look too narrowly. Gathering patent information in later stages for the first time is very critical, because then much of the costly engineering work has already been done and might turn out to be useless when it infringes existing intellectual property by others. Also, patent searches should be conducted frequently as the project evolves, thereby subsequently refining the search results. Another important intelligence activity is to thoroughly and consistently retrieve the state of the art relevant to the project from patent information. All of these activities are subsumed under patent intelligence generation or patent information gathering. It becomes obvious that these activities require the interaction between the developers, the patent professionals, and the marketing/product managers in

order to perfectly align the gathering of patent information with the actual information demand in the core NPD team. Also, strategic planning and new business development should be involved here.

Disseminating: Once the gathering of patent information has been put into action, mechanisms for this information to be effectively disseminated to other parts of the organization must be implemented. Anecdotal evidence reports that communication flows between the project's stakeholders are often insufficient or incomplete. On the one hand, the IP department might have derived helpful technical or strategic information on the basis of patent searches, but the NPD team doesn't know about it. On the other hand, it might occur that developers are identifying the current state of the art in a new technology field they are recently embarking on without communicating these activities to the patent department and thus not sharing their results. Therefore, information may flow in several directions, depending on where it is generated. However, patent data as such is not readily applicable for NPD. Instead, it requires purposeful aggregation, interpretation, and visualization. In order to make patent data understandable for strategic and tactical decision making, several tools have been developed over the years, which allow for effective dissemination and interpretation of patent information (e. g. Ernst, 2003). This is essential because it provides an accurate and timely common basis for concerted actions by the NPD project team.

Responding: However, unless patent information is not actually used in every day NPD work, very little is achieved. NPD project teams have to adequately respond to the patent situation they are working in and take concerted action. For example, NPD project teams could use information that was retrieved from patents to support the process of defining the strategic goals and content of the project. These goals might be taking the lead in certain strategic technology fields, or trying to constrain competitors. Also, patent information can be very helpful when generating and selecting product

ideas. White spots in technology fields might offer great business opportunities for highly innovative new products, while mature technologies in turn might allow for developing me-too-products or – in the case of the pharmaceutical industry – generics. Furthermore, when NPD teams have to decide for or against filing a patent application to protect own inventions from the project, a sound knowledge of the respective patent situation becomes very crucial.

In sum, it can be assumed that patent orientation in new product development projects as described above seems to positively influence on the project outcome. Not considering patent information or processing it in an inadequate manner supposedly leads to new product failures. Next to the effects described above, this is because these new products more often infringe on existing patents belonging to others, or they are easily being copied because they lack sufficient protection, or their patents don't cover the really important product features with superior customer value. Therefore, patent data should be thoroughly and frequently gathered, disseminated, and used during any NPD project. Accordingly, hypothesis 1 can be formulated as follows:

Hypothesis 1: Patent orientation through gathering, disseminating, and using patent information during the NPD project has a positive impact on the new product's success.

Antecedents to Patent Orientation

Well documented product failures with very little or no patent protection as well as the rising number of litigation cases provide evidence, that many firms still don't always process patent information well enough during their NPD projects (Cukier, 2005; Rivette and Kline, 2000). This brings up the question, how to foster patent orientation in an organization. Previous works on information processing and strategic orien-

tations (e. g. Kirca et al., 2005; Jaworski and Kohli, 1993; Lumpkin and Dess; 1996; Moorman, 1995) have identified two significant antecedents, which also seem to play an important role here in the context of patent orientation: Pro-activeness and top-management emphasis. In the following, we will explain these two antecedents and theoretically derive their potential influence on patent orientation. In advance it must be stated, that these phenomena are inherent to the program level of an organization but they affect all of the single projects nested within the organization. Therefore, in accordance with Egelhoff (1991), Hitt et al. (2007), and Salvato and Rerup (2011), a joint analysis of macro- and micro-levels of organizations becomes necessary here.

Strategic patent emphasis: Top-management can emphasize the strategic importance of patent management for the organization by putting it on its agenda (Cukier, 2005; Grindley and Teece, 1997). This starts with formulating a detailed IP and patent strategy which is aligned with the general company strategy (Rivette and Kline, 2000). Also, top-management can foster a high awareness for patent related tasks among all employees in the company (Granstrand, 2000). It must be made visible, that the protection of own intellectual assets and the respect for third party IP both should be major company-wide concerns. Furthermore, inventors and holders of outstanding patents should enjoy a high reputation throughout the company so that the importance of their patents is actively communicated among all employees, even among those who are seemingly remote to the topic. All of this is likely to create an organizational environment where patent orientation in new product development can thrive. Hence, we formulate:

Hypothesis 2a: The higher the level of strategic patent emphasis in the organization, the higher the level of patent orientation in NPD projects.

Proactiveness: Traditionally, patent work is conducted in specialized intellectual property or patent departments within a firm. These departments have been working rather isolated in the background and didn't interact much with other functions (Granstrand, 2000). However, for patent orientation to be achieved, it requires a much more active role of the IP department. The IP department must anticipate the specific needs of the NPD teams. Appropriate patent information should be filtered and shared with the relevant team members, most notably with the developers and the product manager. During some projects, this is not the case because on the one hand the patent department doesn't actively transfer it to the team, and on the other hand the managers and team members don't ask for it as they might consider patent work to be irrelevant and a nuisance. By means of frequently offering patent-related trainings for researchers and developers, these managers and team members might become aware of the usefulness of patent management for their day to day work. Also, the patent department should offer joint workshops with the development teams, for example in order to support idea generation, or to turn ideas directly into applications ('patenting-on-demand'). Furthermore, the patent department could offer comprehensive basic information (e.g. access to data bases, forms, contact persons, etc.). In general, a highly service-oriented and proactive IP department seems to be a prerequisite for patent orientation. Thus, we posit:

Hypothesis 3a: The higher the level of the patent department's proactiveness, the higher the level of patent orientation in NPD projects.

Because strategic patent emphasis and proactiveness of the IP department take effects throughout the whole organization, they might also directly influence project-level new product development outcome. However, we assume that these effects are considerably mediated by patent orientation. As defined above, patent orientation mani-

fest itself in the processes, practices, and decision-making activities that lead to extend an organization's intellectual assets. Therefore, patent orientation can be seen as enabler or facilitator for program-level strategic patent emphasis and proactiveness to actually happen at the operational project-level during new product development. We thus hypothesize:

Hypothesis 2b: Patent orientation mediates the relationship between strategic patent emphasis and new product success.

Hypothesis 3b: Patent orientation mediates the relationship between proactiveness of the patent department and new product success.

Figure 2 summarizes the conceptual model.

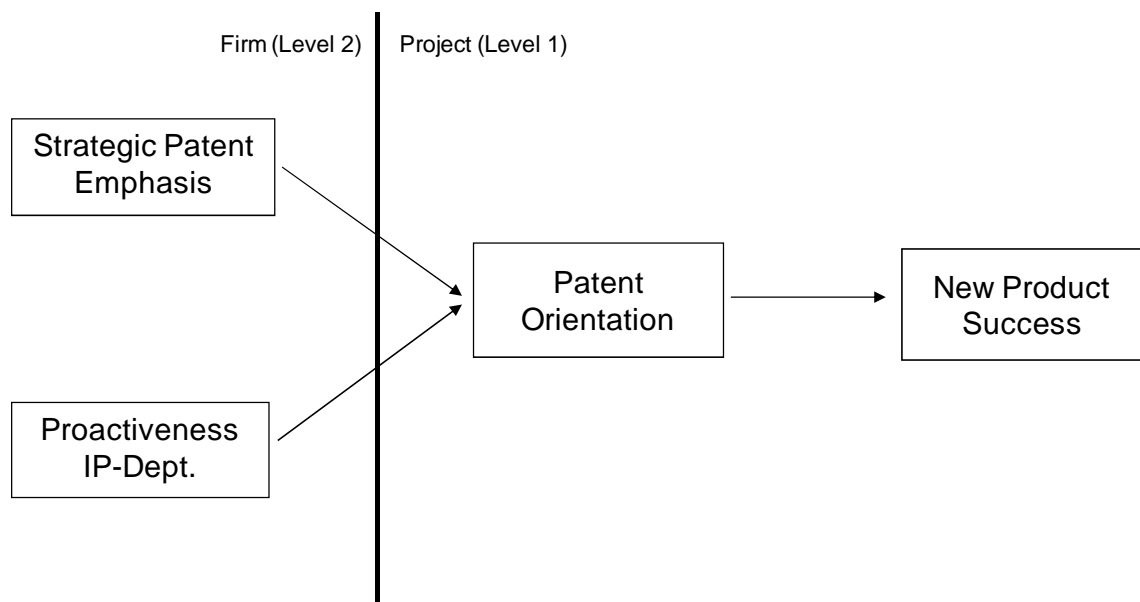


Figure 2: Conceptual Model

METHODS

Sample and Data Collection

We developed our framework based on extensive search of the literature in the fields of information processing, strategic orientations, new product development and patent management. This analysis was accompanied by several exploratory interviews with R&D and patent managers. Furthermore, we conducted in-depth case studies on the topic. In a subsequent step, we empirically tested our model with data from a large-scale questionnaire survey. The questionnaire was thoroughly pretested. The survey includes medium-sized and large multi-national technology-based firms or strategic business units across various industries. We focused on the following five industry clusters: Automotive / Aerospace / Aviation, Chemicals / Pharmaceuticals, Electronics / Information & Communication Technologies (ICT), Mechanics / Metal, and Medical.

The study was conducted in Germany with a list of the top 318 patent applicants at the German Patent and Trademark Office, all filing at least 13 patent applications per year. The applicants include technology-based German companies as well as German branches of international companies. We made sure that all of these firms had major R&D facilities within Germany and that they conducted a substantial amount of developing and patenting work on these sites. This means that companies from other countries, which file patent applications at the German Patent and Trademark Office but that don't actually perform any R&D activities within the country, are not part of the population. Also, we did not include public entities like universities and research organizations (e.g. Fraunhofer Society).

Due to time and cost restraints we randomly selected 200 companies from the 318 in our list. These 200 companies were contacted in three subsequent steps: via postal mail, email, and later on by phone. We offered a customized benchmarking report and an exclusive management summary as incentives for firms to participate. The ques-

tionnaire was available in English and German. Translation was provided by a professional translation office specialized on patents, and was subsequently tested with native speakers.

The companies were asked to choose one or more recently finished NPD projects for the study. As this is a very cross-functional topic, each project should have been evaluated by two persons in two separate yet identical questionnaires: The project leader and the patent manager assigned to each project are arguably the persons serving this purpose best. For the first project of each company, both of the respondents were asked to answer an additional set of firm-level questions. Our respondents in general had vast project experience (35 projects assigned on average) and were very familiar with the specific projects they evaluated for our study with an average of 5.7 on a 7-point-Likert scale ranging from “1” (= no knowledge on the project) to “7” (= expert knowledge).

For this study, we received usable questionnaires from 72 companies, which leads to a response rate of 23 percent (related to the total of 318 companies in our list). We conducted a t-test for non-response bias which showed no significant differences between the responding and the non-responding firms on several variables. Also, early and late respondents did not differ. At the company level, 37 firms delivered dyadic responses from the patent professional and the project leader. As we have a multi-level research setting, the second unit of analysis is the project level. In total, we received 101 projects from these 72 companies, which is an average of 1.4 projects per company. 62 projects were complete with questionnaires from the two respondents. Another 39 projects were filled in only by the corresponding patent professional. In total, we used responses from 163 questionnaires for this study. Taking into account the ambitious research design, the sensitive information contained, and the difficult economic back-

ground – the survey was initiated during in plain global financial crisis and German economic recession – the effective response rate can be considered as very satisfactory.

Measures

All constructs are measured on a 7-point-Likert scale ranging from “1” (= strongly disagree) to “7” (= strongly agree). The appendix shows details on the measurement scales and the respective construct reliabilities. Cronbach’s alpha coefficients ranged from .71 to .94 for all of the constructs and therefore lie above the cut-off criterion recommended by Cohen, Cohen, West, and Aiken (2003).

Product Success: The scale for product success was adopted from various other NPDP studies and comprises four items (e. g. Moorman, 1995; Song et al., 1997; Song and Parry, 1997; Schulze and Hoegl, 2006).

Patent Orientation: As described above, patent orientation refers to the company’s ability to adequately process information retrieved from patents during new product development. Drawing on the behavioral market orientation approach which was originally developed by Jaworski and Kohli (1990 and 1993) and then applied for example by Ottum and Moore (1997) at the project level, we adopt a second-order conceptualization of patent orientation with the following three stages of information processing: gathering, disseminating, and using patent information. Because this is the very first study to examine patent orientation we had to develop completely new scales for patent information acquisition, patent information dissemination, and patent information responsiveness/use. The execution of these three stages is the result of a certain underlying organizational way of thinking and working which we describe above as patent orientation. Because patent orientation can be considered as the common cause for patent information processing, we conceptualize patent orientation as a second order construct. Therefore, patent information acquisition, dissemination, and use were in-

cluded as item parcels into the super-ordinate construct of patent orientation (Bagozzi and Edwards, 1998; Coffman and MacCallum, 2005, Law et al., 1998). Similar to Jaworski and Kohli (1993), Moorman (1995), Baker and Sinkula (2007) and others, we identified important information processing behaviors during each of the three patent orientation stages. After very extensive and thorough investigation through literature search, in-depth case studies, expert interviews, and pretests, the final constructs for each stage consisted of three items each. Sample items include “During the innovation project patent searches were conducted frequently” and “Information retrieved from patents was considered when generating and selecting product ideas”.

Proactiveness of the IP Department and Strategic Patent Emphasis: These two company level scales have been newly developed for this study. Again, the items were derived from an extensive literature review, case studies, and expert interviews. Also, they were pretested thoroughly. The final constructs consist of three items each (see appendix). Sample items include “The organizational unit formally responsible for patents offers joint workshops to the development teams” (for proactiveness) or “Protection of intellectual property is a major company-wide concern” (for strategic patent emphasis).

Control Variables: Our case studies and the feedback from the pretests revealed several variables that can potentially impact the predicted relationships. We used these as control variables in the regression models. At the project level, we included project length, resources, and product newness to the firm (which corresponds to a lack of experience in a certain technology field). The measures for resources and newness were adapted from previous project-level studies (e.g. Song and Montoya-Weiss (2001) for resources; Garcia and Calantone (2002) for newness) and were slightly modified. In particular, we included an item on the existing patent portfolio into the newness scale. At the program level, we included company size in terms of number of employees. Al-

so, we controlled for industry effects on both levels of analysis, as there might exist different approaches to patenting depending on the type of industry, e. g. discrete like pharmaceuticals and chemicals vs. continuous like electronics and ICT (Cohen et al., 2000). Industry variables were included as dummy variables.

Analysis

Interrater Agreement: In order to avoid potential single informant bias our study was designed to include dyadic responses on each observation in every construct (see above). We received dyadic responses on 62 projects from 37 companies and checked for the ratio of agreement between the judgments of the respective patent manager and the project leader assigned to each of these. To this end we calculated the within-group interrater agreement r_{wg} according to the proceedings established by James, Demaree, and Wolf (1984) and James, Demaree, and Wolf (1993). The results show high values of interrater agreement with each r_{wg} exceeding the proposed threshold of 0.7 for every item in every dyad. These results strongly indicate that patent professionals and project managers in our sample generally agree on their evaluations. We therefore also included the remaining projects and companies with only one informant into our further analysis. Moreover, we merged the dyadic assessments into one combined evaluation by calculating the mean in order to adequately include both functions' point of view. All in all it seems that we have minimized the possibility of having a key informant bias in our data.

Confirmatory Factor Analysis: We conducted confirmatory factor analyses (CFA) on both levels of our model using the AMOS software package. Additionally, CFA was necessary for validating the second-order construct patent orientation. All items for the antecedents, independent variables, and dependent variables loaded to the constructs reasonably well, lying above the cut-off criterion of 0.5 (Hair, Black, Babin,

Anderson, & Tatham, 2006). The fit-indices for the model at the project level are χ^2 (CMIN) = 207.67 with DF = 126, CFI = 0.92, TLI = 0.90, and RMSEA = 0.08, suggesting adequate fit (Hair et al., 2006). The model at the program level has the following fit-indices: χ^2 (CMIN) = 11.60 with DF = 8, CFI = 0.98, TLI = 0.97, and RMSEA = 0.08, again showing a satisfactory model fit, especially when considering the relatively small sample size at the program level.

Furthermore, we used CFA to check for discriminant validity according to Fornell and Larcker (1981). Discriminant validity is given when the square root of the average variance extracted (\sqrt{AVE}) for each factor exceeds the correlations with all other factors. The results show that discriminant validity was observed for all constructs (see table 1). Also, further proof of construct reliability is given since all \sqrt{AVE} s lie above 0.70 (Hair et al., 2006).

Common Method Bias: As we use data for the independent and the dependent variable from one common source, we used several techniques to check our data for potential common method bias. First, Harman's one factor test at both levels of analysis was negative, which means that no single factor accounted for the majority of the covariance in the independent and dependent variables (Podsakoff and Organ, 1986). This can be interpreted as a first indication that common method bias is not an issue here. Additionally, we assessed method bias using the approach recommended by Lindell and Whitney (2001). We used the construct "newness to the firm" as an ex-post marker variable. Partial correlation analysis then showed that the partial correlations between the independent and the dependent variables were high and significant, very similar to the values from the original bivariate correlation analysis. This suggests that the relationship between these variables is not caused by common method bias. Finally, we took a closer look at the 62 dyads by separating the two sets of answers. We calculated correlation between product success rated by informant one and patent orientation rated by

informant two, therefore using different sources. The resulting Bravais-Pearson correlation coefficient was relatively high ($r = 0.23$) and significant ($p < 0.08$), which again is similar to the correlations obtained from the full data (see table 1). All in all, these analyses offer strong evidence that common method bias can be ruled out in our study.

Multi-Level Regression Analyses: In order to test the hypothesized relationships between the variables at the project level we conducted multiple regression analyses with ordinary least squares estimations. Since we included higher-level organizational antecedents for patent orientation in our theoretical framework, a multi-level modeling approach was required additionally. Project level is regarded as level 1, program level as level 2, assuming that level-1-units are nested within level-2-units. Hierarchical Linear Modeling (HLM) is applicable in this context as it allows for identifying variance between program- and project-level variables (Hofmann, 1997; Bryk and Raudenbush, 2002).

According to our research setting we chose the random effects “intercept-as-outcome” approach which tests for the influence of the level 2 units when explaining level 1 variance (Hofmann, 1997). Level 1 and level 2 variables were grand-mean centered (Hofmann and Gavin, 1998). We used the HLM 6 software package for our analyses.

We calculated the intra-class correlations (ICCs) for the level 1 variables (see table 1). The results show that 45 % of patent orientation variance is caused by the organizational context the projects are nested in. This result delivers very strong support for our multi-level setting and thus for applying HLM (Kreft and de Leeuw, 1998).

Multi-Level Mediation: In order to test for mediation with hierarchical data we draw on the proceedings developed by Krull and MacKinnon (2001) which are based on the single-level approach established by Baron and Kenny (1986). Our framework corresponds to the $2 \rightarrow 1 \rightarrow 1$ model described by Krull and MacKinnon (2001). Accor-

dingly, we investigated the effects between strategic patent emphasis and pro-activity of the IP department (level 2 predictors), patent orientation (level 1 mediator), and new product success (level 1 outcome). Mediation is proven if the following four conditions are fulfilled. First, the predictor variables significantly influence the outcome variable. Second, the predictors significantly influence the mediator variable. Third, the mediator significantly influences the outcome. Fourth, the relationship between the predictors and the outcome gets insignificant (full mediation) or less significant (partial mediation) when the mediator variable is included into the regression.

	Mean	SD	\sqrt{AVE}	ICC	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Level 1 (Project)															
(1) Product Success	2,12	1,20	0,89	0,25	1										
(2) Automotive / Aviation	0,25	0,43	-		-0,06	1									
(3) Chemicals / Pharmaceutical	0,20	0,40	-		-0,07	-0,29**	1								
(4) Electronics / ICT	0,15	0,36	-		-0,13	-0,24*	-0,21*	1							
(5) Mechanics / Metal	0,29	0,46	-		0,10	-0,36***	-0,32**	-0,27**	1						
(6) Project Length	35,15	29,24	-		0,17†	-0,02	0,20*	-0,21*	-0,05	1					
(7) Resources	4,80	1,02	0,86		0,29**	-0,07	-0,02	0,08	0,02	-0,1	1				
(8) Newness	4,25	1,46	0,71		-0,10	0,07	-0,05	-0,15	0,03	0,12	0,07	1			
(9) Patent Orientation	4,91	0,95	0,77	0,45	0,28**	-0,22*	0,03	-0,12	0,23*	0,03	0,25*	0,1	1		
Level 2 (Firm)															
(10) Company Size	17419	42948	-											1	
(11) Proactiveness IP Dept	5,34	1,14	0,73											-0,1	1
(12) Strategic Patent Emphasis	5,37	1,09	0,83											-0,20	0,53***
N = 101 (Level 1); N = 72 (Level 2) *** p < .001; ** p < .01; * p < .05; † p < .1.															

Table 1: Means, Standard Deviations, and bivariate Correlation Coefficients

RESULTS

Table 1 shows means, standard deviations, ICCs, \sqrt{AVE} s, and bivariate correlations between the variables and constructs used to analyze the antecedent and outcome effects of patent orientation. Most notably, the construct ‘patent orientation’ is positively and significantly correlated with the outcome construct ‘product success’. General

project resources seem to play a considerable role here: projects with higher resources have a significantly higher degree of patent orientation and product success. In contrast, the control variable ‘newness to the firm’ is neither significantly correlated with patent orientation nor with product success. At the program level, it becomes evident that both antecedents are heavily correlated.

Table 2 summarizes the results of the multiple regression analyses. The variance inflation factors in all regressions did not exceed the value of 2.92 (at one of the industry dummy variable), multicollinearity is therefore not a problem (Hair et al. 2006).

	Model 1	Model 2	Model 3	Model 4
Dependent Variable	Product Success	Product Success	Patent Orientation	Patent Orientation
Control Variables				
Automotive / Aviation	-0,23	-0,18	-0,19	-0,10
Chemicals /	-0,29 †	-0,28 *	-0,07	0,03
Electronics / ICT	-0,29 †	-0,26 †	-0,19	-0,09
Mechanics / Metal	-0,15	-0,16	0,05	0,13
Project Length	0,19 †	0,19 *	-	-
Resources	0,30 **	0,25 *	-	-
Newness	0,14	0,17 †	-	-
Company Size ²	-	-	-0,03	0,00
Mediator Variable				
Patent Orientation		0,21 *		
Antecedents				
Proactiveness IP Dept ²				0,29 **
Strategic Patent Emphasis ²				0,15 †
*** p < .001; ** p < .01; * p < .05; † p < .1; ² Level 2 only (Firm)				

Table 2: Multi-Level Regression Results

	Model 5	Model 6	Model 7
Dependent Variable	Product Success	Product Success	Product Success
Control Variables			
Automotive / Aviation	-0,28 *	-0,23	-0,20
Chemicals /	-0,26 *	-0,18	-0,19
Electronics / ICT	-0,34 **	-0,27 *	-0,26 *
Mechanics / Metal	-0,16	-0,12	-0,15
Project Length	-	-	-
Resources	-	-	-
Newness	-	-	-
Company Size ²	0,22 *	0,25 **	0,25 **
Mediator Variable			
Patent Orientation			0,17 †
Antecedents			
Proactiveness IP Dept ²		0,10	0,05
Strategic Patent Emphasis ²		0,23 **	0,21 *
*** p < .001; ** p < .01; * p < .05; † p < .1; ² Level 2 only (Firm)			

Table 2 continued

The first regression model is the basic model at the project level where we only checked for the control variables' potential influence on project outcome. Resources and project length have a significant and positive relation to product success. Also, industry affiliation seems to be an issue, although of minor importance. The second regression model introduces patent orientation as an independent variable to the first basic model. Patent orientation does have positive and significant influence on product success ($\beta = 0.21$ and $p < 0.05$). Therefore, hypothesis H1 is confirmed by this empirical finding.

Models 3 and 4 explore the influence of program-level antecedents 'proactiveness IP department' and 'strategic patent emphasis' on patent orientation (at the project level). HLM analysis for the base model (3) showed no significant effects, whereas model 4 uncovered that both antecedents are positively and significantly related to patent orientation. Hypotheses H2a and H3a are therefore supported.

In order to adequately test for mediation effects in a multi-level antecedents-consequences-setting we further estimated the antecedents' direct influence on project outcome (models 5 and 6). Our calculations reveal that strategic patent emphasis has a positive and significant impact on project outcome ($\gamma = 0.23$; $p < 0.01$). As described above, this is a necessary condition for proving mediation effects of patent orientation. However, the antecedent variable 'proactiveness IP department' has only an insignificant relationship with project outcome, other than predicted. Therefore, it is excluded from further mediation analyses and hypothesis H3b is not supported.

Finally, in model 7 we run the regression including patent orientation as the project-level mediation term. Our results show that the relationship between strategic patent emphasis and product success drops slightly to $\gamma = 0.21$, being less significant than in model 6. This can be interpreted that patent orientation provides partial mediation between strategic patent emphasis and product success. Hypothesis H2b thus is tentatively supported. However, since the γ -coefficient for strategic patent emphasis is still somewhat significant, full mediation cannot be assumed.

DISCUSSION

The empirical findings support the concept of patent orientation and its positive effect on new product development success. Based on three iterative stages (gathering, disseminating, and using patent information) patent orientation helps cross-functional NPD teams achieving their project targets. Furthermore, we identified two program-level antecedents (strategic patent emphasis and proactiveness of the IP department) which in turn influence patent orientation at the project-level. The results show, that one of these antecedents, strategic patent emphasis, also has a significant direct effect on NPD outcome. This effect is to a small extent partially mediated by patent orientation. Therefore, in order to fully understand the effect of patent orientation on NPD suc-

cess, specific firm-level backgrounds should be considered. Obviously, organizational phenomena have an impact on the projects nested within them. These results have several theoretical and managerial implications.

Theoretical Implications

By addressing such an interdisciplinary topic, our results deliver theoretical implications in multiple fields. First, we contribute to the existing knowledge on information processing by considering patent information for the first time. We thereby comply with the request by Tushman and Nadler (1978) and Egelhoff (1991) to further refine and empirically test the rather abstract conceptualization of information processing. Adequate patent information processing, i.e. a fit between information demand and information supply as Tushman and Nadler (1978) formulate it, makes organizations reach their goals more effectively. Large parts of the existing literature have very much focused on market information as the prevalent source.

Second, we add a new dimension to the research on strategic orientations by conceptualizing and empirically testing patent orientation. Patent orientation extends existing concepts of strategic orientations (like market and technology orientation) by including protection and appropriation matters. Patent orientation in terms of processes, practices, and decision-making activities based on patent information has a positive effect on the organization. In particular, patent orientation leads to superior and well protected products. It thereby helps to establish sustainable competitive advantage.

Third, we identify patent orientation as an important new success factor for new product development. Independent from the functional background of the individual NPD team members, patent information must be processed and used in order to make the new product more successful. Furthermore, this can be fostered through a pro-active IP department and top-management support on patent matters.

This directly leads to the fourth implication. Our research is one of the first studies in the organization and NPD literature which addresses program-level matters and project-level matters simultaneously. Recently, the number of calls for cross-level research has been growing (e. g. Hitt et al., 2007; Salvato and Rerup, 2011). With our study we respond to these calls and show, that organizational characteristics indeed influence lower level units nested within the organization.

Managerial Implications

Our findings offer several managerial implications. First of all, firms should take care of implementing a sound patent orientation in their new product development. Patent orientation can help to avoid pitfalls from existing intellectual property. It can also lead to better protected new products and higher degrees of value appropriation from the initial investments in R&D. All of these aspects supposedly lead to more successful products.

Patent orientation in new product development is a highly cross-functional task, similar to market orientation. It concerns R&D managers, developers, patent professionals, marketing or product managers, and business development managers. If all of these different groups recognize the importance of patent data for their work during new product development, patent orientation ultimately is achieved. Project leaders should keep an eye on it during the course of their project in order to secure the project's success.

Furthermore, patent orientation can be fostered by the top-management through raising corporate awareness and emphasizing the importance of protecting own inventions while at the same time respecting external intellectual property. Also, IP and patent departments should be encouraged to play an active role in product development. In sum, organizations could possibly evolve towards some sort of pro-active patent culture.

Limitations and Outlook

The present study has some limitations that offer multiple opportunities for further research. First of all, the present study has focused on patents only. Additional information from other intellectual property rights, especially from trademarks, might also be another important source during new product development.

Our study has neglected moderating effects that could have an impact on the estimated relationships. The inclusion of contingent factors might help to learn more about the conditions under which patent orientation impacts project performance. Also, the relationship between the antecedents and patent orientation could be subject to contingency analyses.

A very promising opportunity for further research might arise from investigating patent orientation jointly with other strategic orientations. This is especially true for technology and entrepreneurial orientation.

Furthermore, our study has only looked at two program-level antecedents of patent orientation. There might exist other important antecedents at the project level which would be theoretically and managerially relevant to understand. In particular, project managers could learn from this, how to foster integration within their direct sphere of influence. This calls for more in-depth research on this issue. Although we took a first step into multilevel methods, it might be promising to include also other levels such as the individual patent professional or developer, or superordinate levels like industry or country. For instance, our study was initiated in Germany, though some of the projects in our sample actually were internationally distributed. Other countries with different intellectual property regimes might be interesting here, for example in emerging markets.

CONCLUSION

This chapter started with the observation that strategic orientations like market orientation and technology orientation largely neglect patenting aspects. In order to fill this gap we thus derived a conceptual model of patent orientation. Patent orientation is based on the processing of patent information. We initially asked the question whether patent orientation and information processing during NPD projects lead to a superior and more successful new product. This model includes antecedents and outcomes of patent orientation on the macro- and the micro level. Our empirical findings give very much of proof for assuming that patent orientation helps organizations developing products which eventually are more successful in the market place. The relation between patent orientation and project success is positive and significant. Also, we found out that proactiveness of the IP department and strategic patent emphasis in the organization can foster patent orientation at the project level. Our findings suggest that project managers should pay more attention to patent information processing. Also, top-managers should establish an organizational awareness for patent-related matters within the company. On the other hand, internal IP specialists should take action on their own in order to anticipate and deliver NPD relevant services to support the company's NPD projects. Both aspects can help establishing patent orientation within the organization. However, there are still some aspects that should require further observation.

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APPENDIX

Items, Constructs, and Reliabilities

1. *Product performance* (4 items; $\alpha = .94$)

As far as you can estimate, the new product achieved... a) ... its turnover objectives. b) ... its profit objectives. c) ... the expected market share. As far as you can estimate, the new product was a great commercial success. All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

2. *Project Resources* (2 items; $\alpha = .84$)

The R&D resources assigned to this project were adequate. The general resources assigned to this project were adequate. All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

3. *Newness to the Firm / Lack of Expertise* (3 items; $\alpha = .71$)

The product is based on technological knowledge with which we had only very little experience. The technology used for this product was absolutely new to our company. The project lay in a technology field in which our company already had a strong patent position, even before the project start (reverse coded). All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

4. *Patent Orientation 1 - Acquisition* (3 items; $\alpha = .75$)

During the project patent searches were conducted frequently. The state of the art relevant to the project was retrieved from patent information. Comprehensive patent analyses were conducted. All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

5. *Patent Orientation 2 - Dissemination* (3 items; $\alpha = .75$)

During the project, relevant patent information was exchanged by means of regular formal meetings (e.g. committees, team meetings etc.). Patent professionals discussed the latest patent situation with other NPD team members. Documents containing important information retrieved from patents were circulated regularly among the different NPD team members. All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

6. *Patent Orientation 3 - Use* (3 items; $\alpha = .85$)

Information retrieved from patents was used to support the process of defining the strategic goals and content of the project (e.g. taking the lead in certain technology fields, constraining competitors etc.). Information retrieved from patents was considered when generating and selecting product ideas. Technical development of the new product was supported by providing detailed technical information from patents. All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

7. *Patent Orientation* (3 items; $\alpha = .72$)

Second Order Construct persisting of the constructs 'Acquisition', 'Dissemination', and 'Use'.

8. *Pro-activity of Intellectual Property Department* (3 items; $\alpha = .75$)

The organizational unit formally responsible for patents ... a) ... offers joint workshops to the development teams. b) ... offers additional information (e.g. access to databases, forms, contact persons etc.). c) ... is in general highly service-oriented towards other departments inside the company. All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

9. *Strategic Patent Emphasis* (3 items; $\alpha = .85$)

Top management assigns a high importance towards patents. Top management fosters awareness for patent related tasks among all employees in the company. Protection of intellectual property is a major company-wide concern. All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

Chapter C:

Integrating the R&D and Patent Functions: Implications for New Product Performance

Previous versions of this chapter were presented at the Academy of Management Annual Meeting, Montreal (Canada), 6.-10. August 2010, and the Fachtagung der Wissenschaftlichen Kommission für Technologie, Innovation und Entrepreneurship im Verband der Hochschullehrer für Betriebswirtschaft, Christian-Albrechts-Universität Kiel, 3.-5. November 2010.

ABSTRACT

This paper examines the interface between a company's R&D function and its patent function in the context of new product development. In particular, efforts of integrating these two originally distinct corporate functions on the level of single product development projects and their impact on new product success are analyzed. Empirical analyses are based on a cross-functional sample of 101 recently finished new product development projects which are nested within 72 multi-national technology-based firms or strategic business units across various industries. The results show that the patent function can deliver important contributions during development projects. We find that this so-called contribution dimension of patent management integration has a positive and significant impact on the project's success. Also, the so-called collaboration dimension of patent management integration has a positive impact on project outcome. Additionally, this seems to be the case for both radical and incremental innovations as the degree of innovativeness doesn't seem to play a moderating role in the relationship between collaboration and NPD success. However, the relationship between the contribution dimension and the project outcome actually is affected by innovativeness. Obviously, patent management contributions become even more important during NPD when the new product gets more innovative. These findings have important implications for improving project performance by means of effectively integrating the patent and the R&D functions at the project level.

Key Words: New Product Development, Cross-functional Integration, Collaboration, Patent Management Activities, R&D, Patents, Project Performance.

INTRODUCTION

Global interconnectedness and shorter product life cycles are fundamentally changing the nature of competition amongst firms in most markets (D'Aveni, 1995). In this environment the survival of firms depends on their ability to successfully develop new products or services (Crawford and Di Benedetto, 2003).

In order to adequately manage a company under such competition and to secure the financial returns from investments in its innovations, the stewardship of a company's intellectual property gained high attention during the last decade (Cukier, 2005; Grindley and Teece, 1997; Kortum and Lerner, 1999). Nowadays, a company's value is more and more dependent on its intangible assets, i.e. internal knowledge pertaining to the company or external knowledge to which the company has direct access to, than on its tangible assets like machines, equipment or real estate (Nonaka, 1994). Therefore, a growing number of companies attempt to protect their intellectual assets more efficiently by the means of various intellectual property instruments in order to generate specific competitive advantages (Rivette and Kline, 2000; Teece, 2000). A patent is commonly considered to be one of the most important protection instruments because the owner of a patent has the opportunity to exclusive value appropriation from his protected innovation by prohibiting or at least delaying the imitation of his innovations by competitors (Cohen, Nelson, & Walsh, 2000).

But not every patent is of the same value to its holder. Actually, there are enormous differences. In most companies, 80 % of the overall portfolio value is created only by the 10 % most valuable patents (Scherer and Harhoff, 2000). These most valuable patents provide protection to the economically most relevant products or generate significant licensing revenues. This raises the question, how companies can obtain more of these important and valuable patents.

Anecdotal evidence from companies on the cutting-edge of innovation who are successfully generating patents – and supposedly profiting from these patents – seems to indicate that patent management plays important role here, especially its integration into new product development (NPD). These companies include for example W. L. Gore, BASF, Daimler, and Siemens Healthcare. They seem to stand out from their competitors in part through their premeditated, early, consistent and extensive involvement of patent related management tasks in the various stages of the new product development process.

A comprehensive successful-practice example comes from materials specialist W.L. Gore, a worldwide manufacturing company whose products are applied in multiple industries like automotive, healthcare, chemicals, electronics, etc. Intellectual property has been playing an important role in the company's culture ever since its founders filed their first corporate patents in the 1950s. The unique selling proposition (USP) makes up the nucleus of the product concept and is thoroughly derived by the project team. As soon as the final product concept has been developed, the USP is being transformed into patent applications immediately. During this process, the most important customer requirements are directly converted into patent claims almost word by word. Nearly all patentable inventions are actually filed for patent application. The result from this genuine cross-functional integration (including not only R&D and patenting but also marketing and manufacturing) is that the most important and valuable inventions resulting from every project are very well protected. Therefore, when proceeding as outlined by Gore, project teams are able to build up strong and very valuable patent portfolios surrounding the main features of their new products.

However, cross-functional integration of patenting and R&D is difficult to achieve and can be costly. Patenting and R&D usually are separate corporate functions with their own internal work routines and ways of thinking. While R&D is often

project-driven and therefore relatively short-term-oriented, patenting adopts a rather long-term perspective. Management has to overcome the barriers between these two crucial departments in order to align both functions during NPD.

Cross-functional integration of different functional tasks into the innovation process has often been the subject of past research and has been classified as an important success factor (Gerwin and Barrowman 2002; Kahn, 1996; Song, Montoya-Weiss, and Schmidt, 1997). The emphasis of previous research has been placed on exploring cross-functional integration at the interfaces between R&D and marketing (Griffin and Hauser 1996; Gupta, Raj, and Wilemon 1985) as well as between R&D and manufacturing (Song et al., 1997; Hauptman and Hirji, 1999; Tatikonda and Montoya-Weiss, 2001). More recently, the integration of other functions like purchasing or sales into NPD have been investigated (Atuahene-Gima, 1995; Di Benedetto, Calantone, Van Allen, and Montoya-Weiss, 2003; Ernst, Hoyer, and Rübsaamen, 2010). A recent meta-analysis by Troy, Hirunyawipada, and Paswan (2008) sums up the most important findings. However, a corresponding integration of patent-related tasks into NPD and its possible outcomes have not been adequately explored yet.

Although it seems to be a rather costly and time-consuming action at first glance, patent management integration might be worth the effort. For example, if a project team overlooks existing patents from third parties – no matter if accidentally or not – the whole company all of a sudden becomes vulnerable. Fighting off litigation resulting from ignored patents can be very costly, as some notorious cases have proven (e.g. Kodak vs. Polaroid). This is especially true in technologically advanced industries with products or systems comprising of many single patented inventions that are forming so called patent thickets. A good example for this is the current war on smartphone patents, where the number of litigation cases among competitors and other patent holders has increased and escalated a lot during the last couple of years (e.g. NTP vs. RIM which is also

known as the BlackBerry-case, Nokia vs. Apple and vice-versa, Apple against HTC, etc.).

The purpose of this research is to examine the importance of patent management integration during NPD. We try to find out if a strong patent-focus during NPD really is worth the effort so that it ultimately pays off. Also, we investigate the role of innovativeness and thereby look at the circumstances of patent management integration. Despite the increased importance of patent management for new product development, only very little is known on the R&D and patenting interface in NPD. Patents are often considered as a natural outcome of R&D activities (e. g. Artz, Norman, Hatfield, and Cardinal, 2010), but only very few studies have recognized the decisive role patent professionals could possibly play during these activities (e. g . Somaya, Williamson, and Zhang, 2007). We try to address this gap, and conduct our research on the project level, rather than on the program level, as it is in the NPD projects themselves where value is actually created (e.g. Brown and Eisenhardt, 1995; Ottum and Moore 1997; Im and Nakata 2008). Also, Troy et al. (2008) found out in their recent meta-analysis on cross-functional integration, that effects of integration on NPD success can only be observed at the project level and not at the program level. Furthermore, Leiponen (2008) states that “property-rights theoretic predictions should be analyzed at the level of projects” (p. 1377). Consequently, the focus of this research lies on identifying how and why to integrate patent management into single NPD projects. To this end, a set of patent management activities and cross-functional relations at the interface between patenting and R&D are identified and investigated in this study.

This paper thereby contributes to the existing research in several ways. It builds up a conceptual model that accounts for patent management integration in NPD projects and also explores its possible project outcomes. Most other related studies consider the program level instead, lack a clear NPD perspective, or don't explicitly address poten-

tial performance outcomes (e.g. Reitzig and Puranam, 2007; Somaya et al., 2007; Arora, Ceccagnoli, and Cohen, 2008). Furthermore, the model developed here in this paper is empirically tested on the basis of a large scale questionnaire survey. At this detailed level, there exist only a few case-based random observations so far (e. g. Granstrand, 2000; Pitkethly, 2001). Also, we contribute to the integration literature by considering two different dimensions of integration simultaneously and developing new measurement scales for each.

THEORY AND HYPOTHESES

Overview

This paper basically draws on two main research streams. On the one hand it relies on the research conducted in the field of patent management in the business context. On the other hand it builds up on the broad research on NPD. Because patent management tasks are often carried out by organizationally distinct intellectual property or patent departments, existing studies on interface management and cross-functional integration in new product development are relevant here.

We derive our hypotheses based on the resource dependency theory as developed by Pfeffer and Salancik (1978). The resource dependency approach takes into account, that different corporate functions within one company cannot act autonomously, because they are constrained by a network of interdependencies with each other (Hillman, Withers, and Collins, 2009). These interdependencies especially come to light when different functions have to work jointly towards one common goal and when this work is subject to highly uncertain conditions, like for example during new product development. In order to manage these interdependencies between different departments and in order to overcome functional specialization during NPD, many organizations have taken action in respect of cross-functional integration.

Cross-functional integration in NPD

Coming from a NPD perspective, cross-functional integration or the involvement of different functional tasks into the innovation process has been identified as an important success factor (Troy et al. 2008). Since its earliest mention by organization researchers Lawrence and Lorsch in 1969, the management and marketing literature has adopted multiple views on cross-functional integration. Independently of the different organizational functions investigated in the respective papers, a clear and commonly accepted definition of the term ‘cross-functional integration’ itself is missing so far. Instead, there exist numerous different terms or concepts broadly understood as some sort of cross-functional integration. Typical terms include integration, collaboration, interaction, involvement, cooperation, interconnectedness, or even teamwork. Drawing on the literature we categorized these different terms into the following two conceptually different streams which we call ‘*behavioral*’ and ‘*attitudinal*’ (in accordance with Olson, Walker, Ruekert, and Bonner, 2001, and Ernst et al., 2010).

The behavioral approach (or ‘*contribution*’ approach) concentrates on the execution of distinct NPD specific activities. This type of integration includes cross-functional activities like for example “Analyzing market opportunities” or “Generating NPD ideas” (e.g. Perks, Kahn, and Zhang, 2009; Xie, Song, and Stringfellow, 2003; Song, Xie, and Dyer, 2000; Gupta et al., 1986, Olson, et al., 2001) as well as function-specific contributions to NPD like “Purchasing evaluated supplier performance with regard to the new product” or “Determining the extent of supplier involvement” (e. g. van Echtelt, Wynstra, van Weele, and Duysters, 2008; Nijssen, Biemans, and de Kort, 2002; etc.).

On the other hand, the attitudinal approach (or ‘*collaboration*’ approach) encompasses the affective, volitional, intangible mutual or shared nature of working together. This type of integration includes aspects like collaboration, cooperation, team-

work, and harmony in the relationship of two or more different functions (e.g. Xie et al., 2003; Song et al., 2000; Kahn, 1996, Song et al., 1997; Hoegl and Wagner, 2005; Olson et al., 2001)

In this paper, we adopt an integration perspective comprising of both types, as this two-dimensional approach is stated to be advantageous over considering only one-dimensional integration by allowing a much more detailed view on integration matters (Olson et. al, 2001). Hence, we include the behavioral contribution dimension and the attitudinal collaboration dimension simultaneously in order to have a holistic analysis.

The contribution perspective allows a close look at the NPD-relevant activities from different functions at the project level, some of which are still rather unexplored (such as the patent function). This task- or activity-oriented perspective of integration can be interpreted as some sort of *quantitative* integration in terms of the amount of actions that were contributed by each function.

The collaboration dimension of integration reflects the underlying and rather in-explicit relationship between the functions considered (i.e. the patent function and the R&D function in our case) and is one of the most often used concepts. It can be interpreted as some sort of *qualitative* integration because it evaluates how well the different functions work together.

Collaboration of the patenting and R&D functions during NPD

Patents, copyrights, and trademarks count among the most important and strategically significant property rights (Cohen et al., 2000). A patent represents a prohibition right. It entitles the owner to prohibit third parties from practicing those actions which are the object of the claims, especially making any unauthorized commercial use of the patented invention. As a result, a patent owner holds a temporally and geographically

restricted monopoly on the commercial exploitation of the patented invention (Chisum, Nard, Schwartz, Newman, & Kieff, 1998).

There has been a sharp rise of patent applications across the globe in recent years (Cukier, 2005; Kortum and Lerner 1999). The increased patent prosecution corresponds with higher investment as large-scale application and retention of patents can be a substantial cost center for a firm. Therefore, managers and researchers increasingly try to find out if the investment in patents ultimately pays off and how to leverage returns on these investments. Previous research seems to justify the raised importance of patents. The main findings are that high-quality patent portfolios are positively correlated with sales growth, licensing revenues and the probability of forming successful R&D alliances (Ernst, 2001; Shane, 2001; Stuart, 2000).

Other studies seem to indicate that a vast majority of companies lack a professional management of their patents and therefore dispose of oversized and inefficient patent portfolios. Accordingly, Scherer and Harhoff (2000) found out that in most German and US companies more than 80% of the overall patent portfolio value is determined only by its 10% most valuable patents. Also, Ernst and Omland (2003) point out that often more than 50% of a company's patents remain unused. Even worse, many companies unknowingly run the risk of violating third parties' intellectual property rights, simply because their patent function and R&D are not in sync. And this risk seems to be rising day to day as there is a growing number of so-called patent sharks (Henkel and Reitzig, 2008).

Therefore, scholars recently paid increased attention to the R&D – patent interface in order to find out how companies try optimizing their internal organization at this critical point (Somaya et al., 2007; Reitzig and Puranam, 2009; Arora et al., 2008). Of course, R&D and patent management are heavily intertwined functions by the very nature of their core activities: It is within the R&D department of a company where inven-

tions are made that can later be filed for protection by the patent department. Also, patent work requires a very deep technological knowledge. Therefore, patent professionals inevitably must have a strong R&D background (being an engineer or scientist actually is a prerequisite for becoming a patent attorney). Yet surprisingly, R&D and patent function are very often organizationally distant. Quite often they face the risk of building up functional silos that develop their own internal modes of thinking and acting. These differences especially come to the light when representatives of both functions have to work jointly on NPD projects, where ad-hoc decisions forced by cost and time pressure on the side of the project management (often dominated by R&D) might clash with the rather formal, procedural approach and long-term orientation of the patent function. Barriers resulting from different mind-sets of the two functions arise, comparable to the differences between marketing and R&D (Dougherty, 1992). Also, patent professionals often complain about not having sufficient resources in order to timely and adequately react on all of project management's queries. On the other hand, with a high degree of cross-functional collaboration between the team members from R&D and patenting, these tensions and barriers might be reduced. As defined above, this attitudinal dimension of cross-functional integration implies a certain degree of mutual understanding and harmony. Also, joint motives lead to the alignment of both functions' activities solely with the project's overall performance. Both sides can in term profit from the other function's support in their respective fields – and eventually foster technological and commercial success from the project view.

In accordance with the resource dependency theory it seems that this so-called collaboration dimension of cross-functional integration between patenting and R&D supposedly leads to higher NPD project performance. Thus, hypothesis 1 can be formulated as follows:

Hypothesis 1: Cross-functional collaboration between the patent function and the R&D function during the NPD project has a positive impact on the project's overall performance.

Patent function contributions to NPD

Patent management intends to optimize the amount, quality and effectiveness of a company's patents in order to contribute to the company's overall success by generating a favorable and superior patent position (Ernst and Omland, 2003). Consistent integration of patent management through all stages of the NPD process is likely to have a positive impact on NPD performance because it first of all ensures freedom-to-operate all along the different process phases. Thus, even at the very early stages, important, yet not fully explored features of a new product can be effectively protected against imitation by means of broad conceptual patent applications. During later stages these conceptual patent applications can be refined by filing more detailed patent applications around the original concept. This so-called patent-fencing defends a firm's technological position in the field of the new product. Another important aspect is the immediate protection of unique selling propositions of the new product from a customer's perspective as soon as these additional product advantages are identified by the NPD team. If at later stages it turns out that certain patent applications are not needed anymore, they can be dropped in order to save financial resources.

In general, a proficient patent management can help a NPD team at making more profits with fewer patents by focusing on securing only essential protections they really need to exploit their innovations. This can be achieved best by streamlining patent protection with business, technology and marketing objectives. Profound market-specific knowledge is needed when it comes down to the decision on where to have exclusive rights or just share licenses (Bhatia and Carey, 2007).

Also, patent professionals can contribute to NPD by delivering accurate patent information at key milestones during the development project. That is because patents disclose detailed technological information and also because they provide important information on the R&D activities of competitors (Ernst, 2003). This information can be important, tactically and strategically, especially during the very early stages of the NPD process. Management decisions made during the initial or “concept” phases of NPD are considered to be of high importance and tend to cast a long shadow over the eventual process outcomes (Cooper and Kleinschmidt, 1995; Song and Parry, 1997). Patent information helps identifying white technology spots, which could possibly be occupied by the company and therefore supports idea generation. Also, critical inventions in fields where competitors already have build up strong patent positions can be stopped early enough. This helps focusing the development work on more promising (sub-) projects and saves company resources.

Companies that lack a precise understanding of their own and third parties’ patent portfolios can end up fighting off claims that a technology for a key product actually belongs to someone else. The consequences of unfocused or even completely neglected patent information management therefore can be very costly. As prominent litigation cases (like for example Kodak vs. Polaroid or the Blackberry case, see above) have proven, overlooked patents can lead to massive losses in revenues.

As resource dependency theory suggests, also the so-called contribution dimension of cross-functional integration between patenting and R&D should lead to a highly protected new product and consequently to a high overall new product performance. Accordingly, hypothesis 2 can be formulated as follows:

Hypothesis 2: Patent function contribution during the NPD project has a positive impact on the project’s overall performance.

The moderating role of innovativeness

For projects, which use rather new technologies and which enter rather unexplored technology fields, resource dependency theory suggests that the interdependencies between different corporate functions even increase. Therefore, we assume that in highly innovative projects the two dimensions of patent management integration each play an even more important role.

Considering the attitudinal integration, mutual trust and common understanding between the project members from both functions seem to become even more important in very innovative projects. Because the actual project outcome is highly uncertain, project members from both parties have to rely on each other and understand the common project goals. Both have to align their respective priorities and respond adequately to each others requests in order to achieve these goals. For example, the developers are very likely to encounter several uncertainties about the actual patent situation in the field of the new product. In order to avoid wrong decisions or waste resources, they are very much dependent on the timely and accurate inputs of the patent function. On the other hand, patent professionals have to understand the radically new product as good as possible in order to live up to these expectations. Therefore, good relationships and open communication with mutual trust between the functional specialists from IP and R&D assigned to the project seem to be even more relevant as the degree of innovativeness increases. We can formulate the following hypothesis 3:

Hypothesis 3: A high degree of innovativeness positively moderates the effect of cross-functional collaboration on the project's overall performance.

Radical innovations require more concerted actions by both functions, especially during the early project phases. The behavioral integration dimension therefore becomes

even more crucial during very innovative projects because the project team has almost no prior knowledge or experience on the new technologies and general uncertainty about prior art is very high. In order to reduce this uncertainty as far as possible, the project team has to rely heavily on the support of the patent function, especially its intelligence services. Also, in these radical innovation projects, timely securing initial claims becomes very crucial. A good opportunity for carving out own territory in new technology fields lies in applying for very broad basic patents which later on can be refined subsequently (see above). It becomes obvious that a high degree of behavioral integration is even more needed when projects are highly innovative. The amount of potential patent management activities (contributions) increases. Thus, we derive hypothesis 4:

Hypothesis 4: A high degree of innovativeness positively moderates the effect of patent function contributions on the project's overall performance.

Figure 3 summarizes the conceptual model and the four hypotheses.

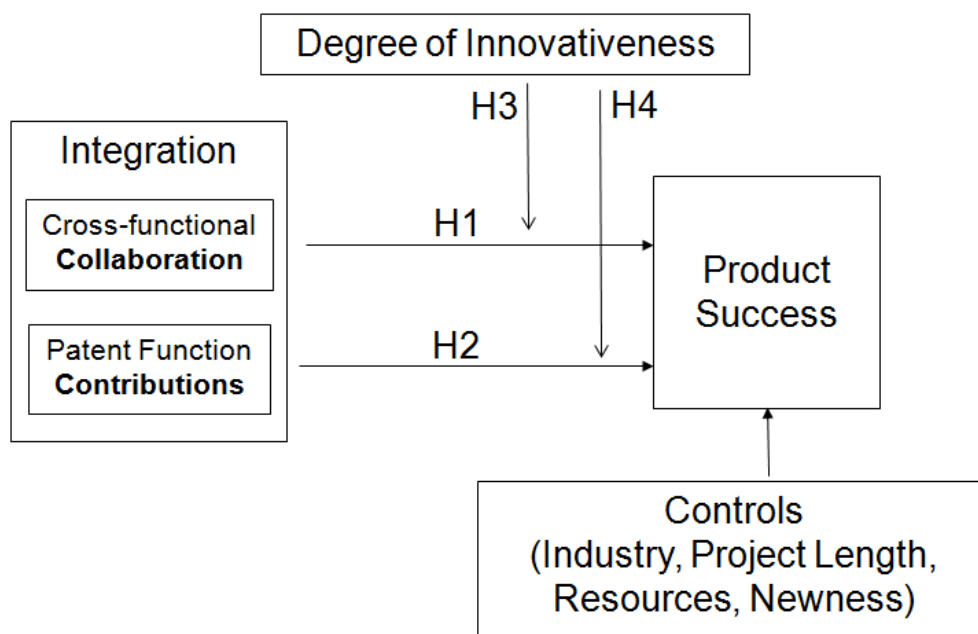


Figure 3: The Conceptual Model and Hypotheses

METHODS

Sample and Data Collection

We developed our conceptual model of patent function integration into NPD based on the existing literature, several expert interviews, and in-depth case studies with firms from various industries. Subsequently, we empirically tested our model with data from a large-scale questionnaire survey. The questionnaire was thoroughly pretested. The survey includes large multi-national technology-based firms or strategic business units across various industries. We included the following five industry clusters: Automotive / Aerospace / Aviation, Chemicals / Pharmaceuticals, Electronics / Information & Communication Technologies (ICT), Mechanics / Metal, and Medical.

The study was conducted in Germany with a list of the top 318 patent applicants at the German Patent and Trademark Office, all filing at least 13 patent applications per year. These applicants include German companies with highly international project organizations as well as international companies with major R&D facilities within Germany which conducted a substantial amount of developing and patenting work. This means that companies from other countries, which file patent applications at the German Patent and Trademark Office but that don't actually perform any R&D activities within the country, are not part of the population. Also, we did not include public entities like universities and research organizations.

We randomly selected 200 companies from our list of 318 applicants. This selection was necessary because of time and budget constraints in our research project. The selected companies were contacted via postal mail, email, and by phone. We offered a customized benchmarking report and an exclusive management summary as incentives for the firms to participate. The questionnaire was available in English and German. Translation was provided by a professional translation office specialized on patents, and was subsequently tested with native speakers.

The companies were asked to choose one or more recently finished NPD projects for the study. Because this is a cross-functional topic, each project should have been evaluated by two persons in two separate yet identical questionnaires: The project leader and the patent manager assigned to each project are arguably the persons serving this purpose best. Our respondents in general had vast project experience (35 projects assigned on average) and were very familiar with the specific projects they evaluated for our study with an average of 5.7 on a 7-point-Likert scale ranging from “1” (= no knowledge on the project) to “7” (= expert knowledge).

For this study, we received usable questionnaires from 72 companies, which leads to a response rate of 23 percent (related to the total of 318 companies in our list). We conducted a t-test for non-response bias which showed no significant differences between the responding and the non-responding firms on several variables. Also, early and late respondents did not differ. However, the unit of analysis is the project level, not the program level. In total, we yielded 101 projects from these 72 companies. 62 projects were complete with questionnaires from the two respondents. Another 39 projects were filled in only by the corresponding patent professional. In total, we used responses from 163 questionnaires for this study. Taking into account the ambitious research design, the sensitive information contained, and the difficult economic background – the survey was initiated during plain global financial crisis and German economic recession – the effective response rate can be considered as very satisfactory.

Measures

All constructs are measured on a 7-point-Likert scale ranging from “1” (= strongly disagree) to “7” (= strongly agree). The appendix shows details on the measurement scales and the respective construct reliabilities. Cronbach’s alpha coefficients

ranged from .69 (newness) to .95 (success) for all of the constructs and therefore mostly lie above the cut-off criterion recommended by Cohen, Cohen, West, and Aiken (2003).

Integration: Cross-functional collaboration was slightly adapted from Song et al. (1997), a study on the marketing, R&D and manufacturing interfaces. It consists of four items with Cronbach's $\alpha = .88$ (see appendix). As this is the very first study to examine patent function contributions during NPD, a new scale had to be developed. Similar to van Echtelt et al. (2008) and Nijssen et al. (2002), we identified supposedly important patent management activities. After very extensive and thorough investigation through literature search, own case studies, and expert interviews, the final construct consists of four items (Cronbach's $\alpha = .78$; see appendix).

Product Success: The scale for product success was adopted from various other NPD studies and comprises four items (e. g. Moorman, 1995; Song et al., 1997; Olson et al., 2001; Song and Parry, 1997; Schulze and Hoegl, 2006).

Degree of Innovativeness: As theoretically derived above, the degree of innovativeness serves as a potential moderator variable here. This scale has been adapted from Hauschildt and Schlaak (2001), and Gatignon, Tushman, Smith, and Anderson (2002) (three items, Cronbach's $\alpha = .80$; see appendix)

Controls: Four dimensions that can potentially impact the predicted relationships in the regression models were used as control variables: project resources, project length, product newness to the firm (or lack of expertise in the field), and industry. Project resources and project length reflect the importance assigned to a project within the company. Product newness takes into account the existence or non-existence of prior knowledge in the field of the new product which might affect the project outcome. The measures for resources and newness have been adapted from previous project-level studies (e.g. Song and Montoya-Weiss (2001) for resources; Garcia and Calantone (2002) and Gatignon et al. (2002) for newness) and slightly modified. In particular, we

included an item on the existing patent portfolio into the newness scale. In order to control for industry-specific differences, we include four industry dummy variables. There might be different approaches towards patenting depending on the type of industry, e. g. discrete like pharmaceuticals and chemicals vs. continuous like electronics and ICT (Cohen et al., 2000).

Analysis

Interrater Agreement: In order to avoid potential single informant bias our study was designed to include dyadic responses on each observation (see above). We received dyadic responses on 62 projects and checked for the ratio of agreement between the judgments of the respective patent manager and the project leader assigned to each of these. To this end we calculated the within-group interrater agreement r_{wg} according to the proceedings established by James, Demaree, and Wolf (1984) and James, Demaree, and Wolf (1993). The results show high values of interrater agreement with each r_{wg} exceeding the proposed threshold of 0.7 for every item in every dyad. These results strongly indicate that patent professionals and project managers in our sample generally agree on their evaluations. We therefore also included the remaining projects with only one informant into our further analysis. Moreover, we merged the dyadic assessments into one combined evaluation by calculating the mean in order to adequately include both functions' point of view. All in all it seems that we have minimized the possibility of having a key informant bias in our data.

Confirmatory Factor Analysis: We conducted confirmatory factor analyses (CFA) using the AMOS software package. All items for the independent variables and dependent variables loaded to the constructs reasonably well, lying above the cut-off criterion of 0.5 (Hair, Black, Babin, Anderson, & Tatham, 2006). The fit-indices for the

model are χ^2 (CMIN) = 218.85 with DF = 137, CFI = 0.93, TLI = 0.91, and RMSEA = 0.077, suggesting good fit (Hair et al., 2006).

Furthermore, we used CFA to check for discriminant validity according to Fornell and Larcker (1981). Discriminant validity is given when the square root of the average variance extracted (\sqrt{AVE}) for each factor exceeds the correlations with all other factors. This was the case for all constructs so that discriminant validity can be assumed. Also, further proof of construct reliability is given since all \sqrt{AVE} s lie above 0.70 (Hair et al., 2006).

Common Method Bias: As we use data for the independent and the dependent variable from one common source, we used several techniques to check our data for potential common method bias. First, Harman's one factor test at both levels of analysis was negative, which means that no single factor accounted for the majority of the covariance in the independent and dependent variables (Podsakoff and Organ, 1986). This can be interpreted as a first indication that common method bias is not an issue here. Additionally, we assessed method bias using the approach recommended by Lindell and Whitney (2001). We used the construct "innovativeness" as an ex-post marker variable. Partial correlation analysis then showed that the partial correlations between the independent and the dependent variables were high and significant, very similar to the values from the original bivariate correlation analysis. This suggests that the relationship between these variables is not caused by common method bias. Finally, we took a closer look at the 62 dyads by separating the two sets of answers. We calculated correlation between product success rated by informant one and the two integration dimensions rated by informant two, therefore using different sources. The resulting Bravais-Pearson correlation coefficients were high ($r = 0.31$ for collaboration, and $r = 0.33$ for contribution) and significant ($p < 0.05$, and $p < 0.01$ respectively), which is similar to the corre-

lations obtained from the full data (see table 3). All in all, these analyses offer strong evidence that common method bias can be screened out in our study.

RESULTS

Table 3 shows means, standard deviations, and bivariate correlation coefficients between the variables and constructs used to analyze the effects of cross-functional integration between the patent function and the R&D function on NPD success. The constructs ‘patent function contribution’ and ‘cross-functional collaboration’ are both positively and significantly correlated with the outcome construct. Project resources and newness to the firm seem to play a significant role here as well: projects with more resources assigned and in fields where the firm lacks expertise have a significantly higher degree of cross-functional integration and are significantly more successful. However, this does not apply for any of the industry dummy variables. Also, the (external) degree of innovativeness and project length don’t seem to be relevant here.

		Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	
(1)	Product Success	5,14	1,21	1										
(2)	Automotive / Aviation	0,24	0,43	-0,08	1									
(3)	Chemicals / Pharmaceuticals	0,20	0,40	-0,07	-0,28**	1								
(4)	Electronics / ICT	0,17	0,38	-0,08	-0,25*	-0,22*	1							
(5)	Mechanics / Metal	0,28	0,45	0,09	-0,35***	-0,31**	-0,28**	1						
(6)	Project Length ^a	1,42	0,32	0,11	0,03	0,22*	-0,33**	-0,02	1					
(7)	Resources	4,84	1,02	0,31**	-0,07	-0,04	0,16	0,00	-0,08	1				
(8)	Newness / Lack of Expertise	3,98	1,50	-0,21*	0,10	0,00	-0,11	0,05	0,09	-0,16	1			
(9)	Degree of Innovativeness	4,00	1,56	0,13	0,04	-0,10	-0,06	0,19†	0,27**	0,14	0,11	1		
(10)	Collaboration	5,81	0,93	0,43***	-0,05	-0,03	-0,08	0,06	0,05	0,36***	0,11	0,28**	1	
(11)	Patent Function Contributions	5,18	0,99	0,33**	-0,11	0,04	-0,18†	0,19†	0,02	0,25*	0,01	0,30**	0,36***	
	N = 101	*** p < .001; ** p < .01; * p < .05; † p < .1.						^a Lg10						

Table 3: Means, Standard Deviations, and bivariate Correlation Coefficients

Table 4 summarizes the results of three multiple regression analyses where the product success is the dependent variable. The variance inflation factors in all regressions do not exceed the value of 2.62 (for one of the industry dummies). Multicollinearity is therefore not a problem for the regression analyses (Hair et al. 2006).

The regression models explain up to 37 % of the variance for the dependent variable ‘product success’. In model 2 one can see that both integration constructs have a significant and positive relation to product success. Therefore, hypotheses H1 and H2 are confirmed by these empirical findings.

Regression model 3 treats with uncovering potential interaction effects between the two integration constructs and the alleged moderator variable ‘degree of innovativeness’. Our empirical results show, that the relationship between patent function contributions (behavioral integration) and new product success is significantly moderated by the new product’s degree of innovativeness. Hence, hypothesis H4 is confirmed. How-

ever, no significant results can be found concerning the assumed moderating role of innovativeness on the relation between collaboration (attitudinal integration) and new product success. Hypothesis H3 therefore cannot be supported by these empirical findings – other than predicted.

All of the control variables in model 3 remain insignificant, except for ‘newness to the firm / lack of expertise’. The variable ‘innovativeness’ shows no direct impact on product success. According to Cohen et al. (2003), we can therefore assume that innovativeness is a pure moderator in our setting.

Dependent Variable: Product Success	Model 1	Model 2	Model 3
Control Variables			
Automotive / Aviation	-0,24 †	-0,13	-0,08
Chemicals / Pharmaceuticals	-0,26 †	-0,20	-0,14
Electronics / ICT	-0,28 *	-0,14	-0,10
Mechanics / Metal	-0,17	-0,10	-0,10
Project Length	0,13	0,15	0,15
Resources	0,29 **	0,13	0,15
Newness to Firm / Lack of Expertise	-0,20 *	-0,24 *	-0,23 *
Moderator			
Degree of Innovativeness	0,08	-0,05	-0,05
Independent Variables			
Collaboration		0,34 ***	0,35 ***
Patent Function Contributions		0,17 †	0,20 *
Moderation Effects			
Collaboration x Deg. of Inno.			0,03
Pat. Func. Contr. x Deg. of Inno.			0,19 *
Summary Statistics			
R ²	0,20	0,33	0,37
R ² adjusted	0,14	0,25	0,28
ΔR ²	0,20 **	0,13 ***	0,04 †
*** p < .001; ** p < .01; * p < .05; † p < .1.			

Table 4: Multiple Regression Analyses – Integration and Performance

To analyze the form of the moderating effect of innovativeness on the relationship between patent function contributions and new product success, we calculated simple slopes at the moderator's mean and one standard deviation above and below this mean (Hair et al., 2006). The results of the simple slopes analyses are illustrated in figure 4. Also, the significance of the regression coefficients at these three levels was examined. Figure 4 shows, that the patent function's contributions have a positive effect on new product success at all three levels of innovativeness. The influence of patent function contributions increases when the new product is more innovative. Furthermore, the regression coefficients at the medium and high level of innovativeness are highly significant ($p < 0.001$).

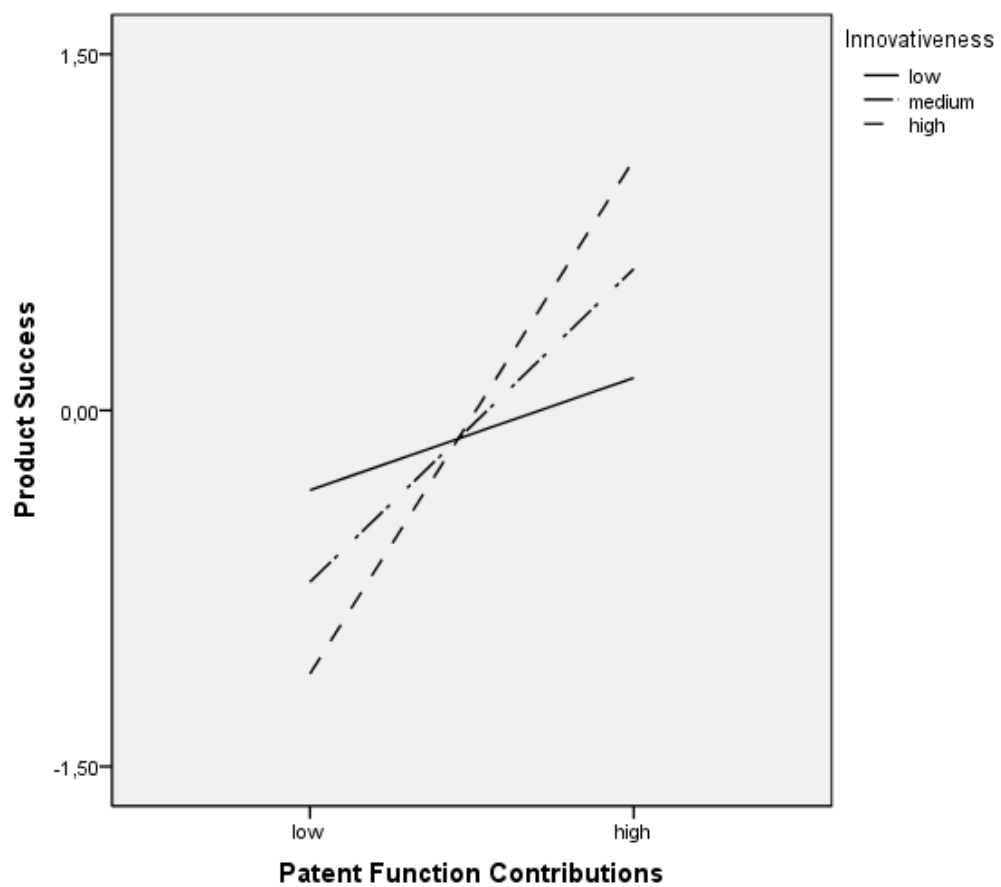


Figure 4: Simple Slopes Analyses

DISCUSSION

The empirical results suggest that the patent function can play an important role in NPD. Both dimensions of patent management integration have a direct, positive and significant effect on new product outcome. Unlike other functions that only deliver relatively minor contributions to NPD (e.g. fostering creativity, cutting cost on the supplier side etc.), patent management activities seem to be important throughout the whole project and actually do have a direct significant impact on the project's success itself. Therefore, investments in patent integration obviously pay off on the operational level of individual NPD projects. Also, patent management activities (behavioral integration) become even more important when the new product's degree of innovativeness is higher. However, the influence of patenting and R&D collaboration (attitudinal integration) remains constant at different levels of innovativeness. These findings have several theoretical and managerial implications.

Theoretical Implications

Our results provide theoretical implications in multiple fields. First, we contribute to the existing literature on cross-functional integration by conceptually and empirically showing the positive effects of patent management integration into new product development. We thereby start an almost totally new stream in NPD interface studies. Large parts of the existing literature so far have very much focused on integrating marketing, manufacturing, and R&D as the prevalent functions in NPD. As intellectual resources become more and more important for creating sustainable competitive advantages, corporate patent functions automatically gain more influence within organizations. Patent functions (or IP departments in general) can help transform unprotected knowledge into sustainable codified intellectual property that is inimitable by third parties. Our results suggest that patent functions indeed are able to substantially contribute

to organizational performance and should be considered in future studies on NPD interfaces.

Second, within the field of cross-functional integration, we contribute to the existing literature by conceptualizing and empirically testing two distinct integration dimensions simultaneously. Although this approach previously has been stated to be advantageous (Olson et al., 2001), only very few studies have actually followed this suggestion (e. g. Song et al.; 2000; Xie et al. 2003). According to our findings, attitudinal integration in terms of mutual understanding and joint motives, which help overcoming functional barriers, directly leads to higher new product success. The impact of behavioral integration in terms of practices and decision-making activities is not that strong (though still significant), but it has a strong indirect effect moderated by the product's degree of innovativeness.

However, innovativeness doesn't affect the relationship between attitudinal integration and project outcome. This is a very surprising finding and seems to contradict our hypothesis. According to our data, attitudinal integration obviously has such a strong direct effect on new product development outcome that it seems to be independent from environmental influences such as innovativeness. A possible explanation for this independency could be that attitudinal integration always matters, even in projects with incremental degrees of innovativeness or in me-too projects. Here, project managers and regular team members usually are very knowledgeable about the current patent situation and the state of the art because they already have gathered experience from previous projects. Thus, they can handle most of the regular patent management activities by themselves and don't necessarily need the permanent support by the patent department. However, they still depend on a good relationship with the IP department, if for example something unforeseeable occurs and they suddenly need a quick advice or a brief assessment of the modified IP situation. If the barriers between the two functions

are low and mutual understanding is high, these ad-hoc inquiries can be handled timely and in an informal manner. Thus, a good relationship between the NPD teams and the patent professionals with a profound appreciation and open-mindedness for the other party's respective work seems to be important for every NPD project, and not just for the radically innovative ones.

This brings up the question, if attitudinal integration influences behavioral integration which is the other independent variable in our model. Therefore, we additionally checked our data for possible interaction effects between these two independent variables. The analysis showed a very low and negligible impact from this interaction term on the project outcome, which is very far from being statistically significant. This leads to the conclusion that both dimensions are different concepts of their own right. Therefore, in order to fully capture the nature of integration, a two-dimensional approach seems to be adequate.

As a third implication, we identify certain patent management activities as important drivers for new product success. This allows broadening our understanding of NPD specific processes. Patent management activities therefore must be included into typical operational NPD tasks.

Managerial Implications

The results can have important implications for managers. The findings suggest that project managers should foster collaboration with the patent department (attitudinal integration) and pay more attention to relevant patent management contributions as defined here (behavioral integration), because when integrated efficiently and effectively, product outcome can be improved.

Behavioral integration: Early and consistent integration of patent management activities through all stages of the NPD process is recommended. This leads to better

protected products which eventually are more successful in the market place. Protection is not confined to patents, but the patent function can help identifying patentable inventions or propose other means of protection (such as trade secrets or copyrights). When the product is supposed to be radically innovative and project goals are less clear, patent management becomes even more important. However, patent management resources should be allocated effectively and efficiently. Quantitative (i.e. behavioral) integration by means of patent function contributions is especially valuable in highly innovative projects where it increases the probability of new product success. But it seems that in projects with rather incremental advances, behavioral integration becomes a little less important. In these less innovative projects, patent management obviously becomes more of a routine work which the NPD team can handle mostly independent from the patent department. In other words, quantitative integration should be deployed according to the innovativeness of the new product. Generally integrating the patent function on a behavioral/quantitative level doesn't necessarily lead into the right direction and might turn out to be just a misallocation of resources. Rather, behavioral integration efforts should focus on a certain highly innovative projects.

Attitudinal integration: Furthermore, these patent management activities in NPD must be accompanied by an open atmosphere between the regular NPD team members and the patent professionals assigned to the project. This implies an environment of mutual trust where both parties recognize the other party's contributions. Project managers should align the respective functional activities towards the joint project goals, independent from the novelty of the new product. When the patent function is truly collaborating with the NPD team, project outcome can be improved. A good relationship between the NPD teams and the patent professionals with a profound appreciation and open-mindedness for the other party's respective work seems to be important for every NPD project. In other words, qualitative integration should be high regardless the degree of

innovativeness. In general, it seems to be recommended to integrate the R&D function and the patent function by means of cross-functional collaboration on an affective, volitional level.

All in all, companies must react to the increased importance of intellectual property matters by carefully managing the organizational interdependencies between the patent function and other corporate units such as R&D and marketing. How this can be accomplished during new product development – one of the most important tasks for any technology-based company – we have shown by taking a very close look on collaboration and joint activities inside individual NPD projects.

Limitations and Outlook

The present study has some limitations that offer multiple opportunities for further research. First, our study has a cross-sectional setting with ex-post evaluations. Future research might conduct longitudinal studies in the field.

Also, this paper has not looked at antecedents of patent management integration. Since patent management integration is an important driver of project performance, it would be theoretically and managerially relevant to understand more about antecedents, maybe on both firm and project level simultaneously. Management could learn from this, how to foster integration. Especially the different instruments of interface management could be interesting here. This calls for more in-depth research on this issue.

Our paper has considered only one potential moderating effect. Other potential moderators might have a significant impact on the estimated relationships as well. The inclusion of contingent factors or certain patent strategies could help to identify other conditions under which the impact of patent management integration on performance varies.

The present study has focused on patents only. The management of other IP regimes, especially trade marks and copyrights, can also have an important impact on project performance. This would therefore be intriguing for researchers and managers to analyze, similar to the conceptual model developed and applied in this paper. Looking at other IP regimes further raises the question of IP integration, i.e., the integrative management of multiple IP regimes.

Lastly, our study was initiated in Germany, though some of the projects in our sample actually were internationally distributed. Other countries with different patent policies might be interesting here, for example countries in emerging markets.

CONCLUSION

The paper started with the observation that the relation between the patent function and the R&D function might play an important role in new product development. We initially asked the question whether the increased focus on patent management during NPD projects is economically justified. Our empirical findings give very much of proof for answering this question with yes. Both relations from integration to project success are positive and significant. The strong influence of patent management integration on overall product success gives strong support for a decisive role of patent management in NPD. Our findings suggest that project managers should pay more attention to relevant patenting contributions as defined here, because when integrated efficiently and effectively, product outcome can be improved. This is especially the case, when a new product gets highly innovative. Overall, the results of this study suggest that the integration of patent management impacts project performance. However, there are still some aspects that should require further observation.

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APPENDIX

Items, Constructs, and Reliabilities

1. *Cross-functional Collaboration between patenting and R&D* (4 items; $\alpha = .88$)

There was a very open atmosphere between participating developers and patent professionals throughout the project. The participating developers and patent professionals pursued similar general motives throughout the project. There was a give-and-take relationship between participating developers and patent professionals throughout the project. Overall, there was great satisfaction concerning the relationship between participating developers and patent professionals. All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

2. *Patent Function Contributions to the NPD Project* (4 items; $\alpha = .78$)

Patent professionals secured freedom to operate for the consecutive project stages by filing applications for broad basic patents and other important patents. At important financial decision points during the project, patent professionals delivered assessments of the patent situation in the field of the new product (e.g. in the context of feasibility studies). Patent professionals supported the developers in capturing the specific state of the art and in identifying white technology fields. Overall, patent professionals delivered important contributions to the innovation project. All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

3. *Product performance* (4 items; $\alpha = .95$)

As far as you can estimate, the new product achieved... a) ... its turnover objectives. b) ... its profit objectives. c) ... the expected market share. As far as you can estimate, the new product was a great overall success. All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

4. *Degree of Innovativeness* (3 items; $\alpha = .80$)

The new product uses technologies that have never before been applied in our industry. The new product was the first of its kind that was introduced to the market. The new product was very innovative and absolutely new to the market. All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

5. *Newness to the Firm / Lack of Expertise* (3 items; $\alpha = .69$)

The product is based on technological knowledge with which we had only very little experience. The technology used for this product was absolutely new to our company. The NPD project lay in a technology field in which our company already had a strong patent position, even before the project start (reverse coded). All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

6. *Project Resources* (2 items; $\alpha = .84$)

The R&D resources assigned to this project were adequate. The general resources assigned to this project were adequate. All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

Chapter D:

Antecedents to R&D and Patent Function Integration in New Product Development Projects

A previous version of this chapter was presented at the 17th International Product Development Management Conference (IPDMC) in Murcia (Spain), 13.-15. June 2010.

ABSTRACT

This paper examines the interface between corporate R&D and patent functions in the context of new product development (NPD). In particular, efforts of fostering patent management activities on the business unit level and on the project level are analyzed. To this intent, the impact of a set of antecedents on the behavioral and the attitudinal dimension of cross-functional integration is investigated. Empirical analyses are based on a cross-functional sample of 101 recently finished new product development projects which are nested within 72 multi-national technology-based firms across various industries. The analysis suggests that patent management integration can be influenced by a company's management through several specific antecedents. We find that team involvement of patent professionals and strategic patent emphasis within the whole organization both have a positive and significant impact on the two dimensions of cross-functional integration. However, goal incongruity and formalized NPD and patenting processes only affect the attitudinal dimension. Furthermore, formalization is only moderately significant here. These findings have important implications for improving patent management integration into product development by means of effectively supporting and fostering specific organizational actions.

Key Words: New Product Development, Cross-functional Integration, Collaboration, Patent Management Activities, Antecedents, Multi-level Analysis.

INTRODUCTION

In recent years, companies have increasingly attached high importance to patents, because they are perceived as one of the most important mechanisms for securing a company's intellectual assets (Cukier, 2005; Grindley and Teece, 1997; Rivette and Kline, 2000). A patent owner has the exclusive right to commercially exploit his protected invention and to prohibit or at least delay the imitation by competitors (Cohen, Nelson, & Walsh, 2000). Patents establish temporally and geographic monopolies and therefore enhance the competitive position of the patent owning organization.

With the increased importance of intellectual assets in general and patents in particular, the management of these assets has become a strategic task with far-reaching consequences for the whole organization. For example, overlooked patents from third parties can have a devastating impact on a company, as prominent litigation cases have shown (e. g. Kodak vs. Polaroid or NTP vs. RIM). Patent management therefore is not any longer an exclusive concern of specialized patent or intellectual property departments. Instead, successful technology-based companies like W.L. Gore, Siemens, or Daimler have put an emphasis on patent related matters throughout the whole organization. Especially during new product development (NPD), where inventions are actually made and intellectual assets are generated, patent management can support other functions in achieving their respective goals, i. e. launching a successful and well protected new product in the market place.

In the previous chapter we have shown, that the integration of patent management into new product development indeed has a significant and positive influence on the success of individual new product development projects (see the preceding paper/ chapter in this book). We thereby identified patent management integration as an important new success factor in NPD. We had a close look on integration at the project level, because within this focal unit of analysis value creation can be observed directly (e.g.

Brown and Eisenhardt, 1995; Im and Nakata 2008). Also, Troy, Hirunyawipada, & Paswan (2008) found out in their recent meta-analysis on cross-functional integration, that effects of integration on NPD success can only be observed at the project level and not at the program level. Furthermore, Leiponen (2008) states that “property-rights theoretic predictions should be analyzed at the level of projects” (p. 1377).

In this paper, we turn our attention to the organizational antecedents of patent management integration. We address the question, how successful integration of the R&D function and the patenting function can be achieved. Past studies have largely neglected patent management integration in NPD. There exist only a few case based observations and anecdotal evidence on the organizational drivers of this sort of cross-functional integration (Bromfield and Barnard, 2010; Granstrand, 2000; Pitkethly, 2001).

Consequently, we address this gap by building and testing a model of multi-level organizational antecedents for patent management integration. Patent management is both a strategic and an operational concern. Furthermore, NPD projects are dependent on its members’ behaviors, but they are also nested within broader organizational contexts. We therefore consider influencing factors at the macro level and at the micro level simultaneously in this study.

HYPOTHESES DEVELOPMENT

Overview

Patent management integration into new product development mainly touches two different research streams. On the one hand, literature on corporate patent management is relevant here. On the other hand, we build up on the ample research on cross-functional integration in NPD.

In order to conduct certain corporate routines and processes more efficiently, functional departments with specialized tasks have been installed within organizations. Typical functional departments include marketing, R&D, manufacturing, and more recently also intellectual property. However, when it comes to non-routine tasks with highly uncertain outcome and interdisciplinary consequences, it becomes obvious, that these functions cannot act fully autonomously. In fact, functional departments within organizations are rather very much dependent on each other, as research dependency theory suggests (Pfeffer and Salancik, 1978). There exist several intraorganizational networks of functional interdependencies which force the individual departments to adapt their organizational behavior to the current environment (Hillman, Withers, and Collins, 2009). These interdependencies especially come to light during new product development. In order to manage these interdependencies between different departments and in order to overcome functional specialization during NPD, many organizations have taken action in respect of cross-functional integration.

Cross-functional integration in NPD

Cross-functional integration of different departments into the new product development process has been identified as an important success factor on several occasions (Gerwin and Barrowman 2002; Kahn, 1996; Troy et al., 2008). The main focus of previous studies lay on the interfaces between R&D and marketing (Griffin and Hauser, 1996; Gupta, Raj, and Wilemon, 1985) and between R&D and manufacturing (Song, Montoya-Weiss, and Schmidt, 1997; Tatikonda and Montoya-Weiss, 2001). More recently, the integration of other functions, like purchasing or sales, into NPD have been investigated (e. g. Ernst, Hoyer, and Rübsaamen, 2010).

In the preceding chapter, we extended the knowledge on cross-functional integration by showing that the addition of patent related tasks has a significant and positive

impact on NPD outcome. These tasks are usually carried out by patent professionals, often belonging to an organizationally distinct unit.

In the literature, there exist a variety of different definitions of cross-functional integration. In accordance with Olson, Walker, Ruekert, and Bonner (2001), we take a two-dimensional approach on integration, because this has been stated to be advantageous. Drawing on the literature we distinguish between ‘behavioral’ integration and ‘attitudinal’ integration. As we have shown in the previous chapter, both dimensions are approaches of their own right and cover different aspects of integration.

The behavioral approach (or ‘*contribution*’ approach) concentrates on the execution of distinct NPD specific activities. Different functions contribute different activities that are relevant for developing new products. Past literature has considered activities like for example “Analyzing market opportunities” or “Generating NPD ideas” (e.g. Perks, Kahn, and Zhang, 2009; Xie, Song, and Stringfellow, 2003; Song, Xie, and Dyer, 2000). In the context of patent management, these relevant contributions consist of “Securing freedom to operate” or “Delivering assessments of the current patent situation in the field of the NPD”, for example. This task- or activity-oriented perspective of integration also corresponds to the rational plan stream in the framework provided by Brown and Eisenhardt (1995). It can be interpreted as some sort of *quantitative* integration in terms of the amount of actions that were contributed by each function.

On the other hand, the attitudinal approach (or ‘*collaboration*’ approach) contains the affective nature of working together. This type of integration includes aspects like collaboration, teamwork, and harmony in the relationship of two or more different functions (e.g. Xie et al., 2003; Song et al., 2000; Kahn, 1996, Song et al., 1997; Hoegl and Wagner, 2005). The collaboration dimension of integration reflects the underlying and rather inexplicit relationship between the functions considered (i.e. the patent func-

tion and the R&D function in our case). It can be interpreted as some sort of *qualitative* integration because it evaluates how well the different functions work together.

Differences between the patent function and R&D

Some scholars recently identified the R&D–patent interface as critical for optimizing the internal organization (Somaya, Williamson, and Zhang, 2007; Reitzig and Puranam, 2009; Arora, Ceccagnoli, and Cohen, 2008). Although the R&D function and the patenting function are heavily interdependent, members of both departments often remain within their functional silos during NPD, in which they have developed their own internal modes of thinking and acting. Over the years, barriers with different mind-sets and different organizational behaviors have grown, comparable to the differences between marketing and R&D departments (Dougherty, 1992). In general, patent professionals have a rather long-term orientation and take a more formal and procedural approach than project managers and developers. On the other hand, project management and other regular NPD team members are used to working in volatile environments with shorter time-frames and high cost and time pressures. Often, they don't see the short term necessity to take on important patent related matters. Patent work is often considered to be a nuisance as it seemingly distracts from the actual developing work and slows down the project's progress. For example, many project managers might be more concerned with bringing their product to the market on time than with rather long-term patent protection, whose implications are not so evident at first sight. Obviously, patent professionals and NPD managers assigned to the same project might have differing perceptions of what is important for the project to become successful. They are likely to lack a common understanding of the overall goals and the situation the other party is in. Many times, functional incentives are still prevalent among the different team members

and restrain the overall project goals. Consequently, tensions and distrust arise, and the integration of patent management is ultimately impeded.

Antecedents to patent management integration into NPD

In order to overcome these barriers to patent management integration, companies can deploy different managerial instruments. Anecdotal evidence from the literature and own in-depth-case studies point towards the following four project-level and program-level antecedents which we will introduce and discuss in the following:

- Goal incongruity (project level)
- Involvement of patent professionals (project level)
- Strategic patent emphasis (program level)
- Formalization of the patent management process (program level)

Goal incongruity: Analogue to previous studies on cross-functional integration (e. g. Song et al., 2000), we understand goal incongruity as the basic difference between the regular team members' and the patent professionals' goals and values. Due to their different values and perceptions of time-frames and goals of the NPD work, tensions might arise between regular members of the core NPD team and the respective patent professionals assigned to the project. If the level of incongruity in these goals is too high, attitudinal integration, which is the way of jointly collaborating on a mutual task, is impeded. We therefore assume the following hypothesis H1a:

Hypothesis 1a: Goal incongruity between project members and patent professionals has a negative impact on cross-functional collaboration.

Behavioral integration is likely to be affected by incongruent goals as well. If the goals of both departments are well aligned, the patent professionals fully understand the project members' specific needs. Consequently, they deliver concise and timely contributions. Hence, we formulate hypothesis H1b:

Hypothesis 1b: Goal incongruity between project members and patent professionals has a negative impact on patent function contributions.

Involvement of patent professionals: In previous qualitative research and case studies, personal involvement of patent professionals in the project team has been identified to foster the integration of patent management (e. g. Bhatia & Carey, 2007; Grandstrand, 2000; Pitkethly, 2001). Frequent participation of patent professionals at regular meetings of the project team can help both ways. If both sides interact, discuss, and share their unique experiences, they become more used to each other. On the one hand, patent professionals might identify more with the team and the new product. On the other hand, members of the core team from R&D or marketing get to recognize the importance of patent management for their daily project work and can benefit from this. These team members are more likely to recognize and to acknowledge the valuable inputs of the patent function. Therefore, both sides understand they can in term profit from the other function's support and attitudinal integration (collaboration) is achieved. This leads to hypothesis 2a:

Hypothesis 2a: Involvement of patent professionals in the NPD team has a positive impact on cross-functional collaboration.

When involved on a regular basis, patent professionals gain more insights into the project's background and adjust better to the project's specific requirements. Thus, their patent management activities become better aligned with the overall project goals (Bhatia and Carey, 2007). Furthermore, the participation of patent professionals is important throughout the whole project. Especially during the early stages, patent professionals can contribute significantly, for example by helping to file broad basic patent applications which assure a certain degree of freedom to operate for the course of the project. All in all, early and consistent participation supposedly leads to higher levels of integration. Thus, hypothesis 2b can be formulated as follows:

Hypothesis 2b: Involvement of patent professionals in the NPD team has a positive impact on patent function contributions.

So far, we have only considered the group level (i.e. individual projects) as the focal unit of analysis. However, we previously argued that individual NPD projects cannot be seen without their broader organizational context. NPD projects are nested within a super ordinate organization that implicitly or explicitly imposes certain boundary conditions (Hitt, Beamish, Jackson, & Mathieu, 2007; Salvato and Rerup, 2011). Therefore, we now turn to the potential antecedents at the program level.

Strategic Patent Emphasis: Top-management support has been considered to be an important driver for general cross-functional integration (e.g. Dougherty, 1992, Griffin and Hauser, 1996). Several studies and meta-analyses seem to confirm this proposition (e.g. Troy et al., 2008; Gerwin and Barrowman, 2002). In the context of patent management, anecdotal evidence reports that an organizational emphasis on the strategic importance of patents is helpful for patenting (Bhatia and Carey, 2007; Cukier, 2005;

Grindley and Teece, 1997). Hence, the implementation of a detailed IP and patent strategy which is aligned with the general company strategy is a first step to diffuse the importance of patents top-down into the organization (Rivette and Kline, 2000). Furthermore, all employees in the company should be aware of important patent related tasks (Pitkethly, 2001; Granstrand, 2000). It must be made visible, that the protection of own intellectual assets and the respect for third party IP both should be major company-wide concerns. Also, serial inventors with valuable patents should be rewarded publicly so that the importance of their patents is actively communicated among all other employees. The top-management is responsible for imposing and diffusing this strategic emphasis on patent related matters throughout the whole company. This has two effects. On the one hand, a common understanding for patent related matters among every member of the organization raises awareness for the need to collaborate with the patent department (attitudinal integration). On the other hand, operational behavioral patent management integration at the level of individual projects is facilitated. We therefore posit hypotheses H3a and H3b as follows:

Hypothesis 3a: Strategic patent emphasis within the organization has a positive impact on cross-functional collaboration.

Hypothesis 3b: Strategic patent emphasis within the organization has a positive impact on patent function contributions.

Formalization: Over the years, the formalization of the development process has been identified as an important success factor for new product development (Cooper and Kleinschmidt, 1995; Ernst, 2002). Formalization happens at the program level, because it establishes obligatory procedures which are identical for every project at the

subordinate levels. However, the formal procedures for conducting patent management activities during innovation processes are still not a matter of course. As our explorative interviews in the forefront of our study revealed, patent management activities are still being performed at random in some companies. By contrast, other companies seem to have codified their patent management routines exhaustively. In their innovation processes exist clearly defined phases (from conceptualization to market launch) with clearly defined and obligatory patent management activities. Also, at important decision points, these projects must be systematically evaluated from a patent perspective, followed by a joint decision on continuing or abandoning the project. With these patent management routines formally in place, we assume that integration can be achieved readily. Project teams naturally integrate the patent management activities (behavioral integration) and pay attention to the input of the patent professionals (attitudinal integration). Accordingly, hypotheses H4a and H4b can be formulated as follows:

Hypothesis 4a: Formalization of patent management in NPD has a positive impact on cross-functional collaboration.

Hypothesis 4b: Formalization of patent management in NPD has a positive impact on patent function contributions.

Figure 5 summarizes the conceptual model.

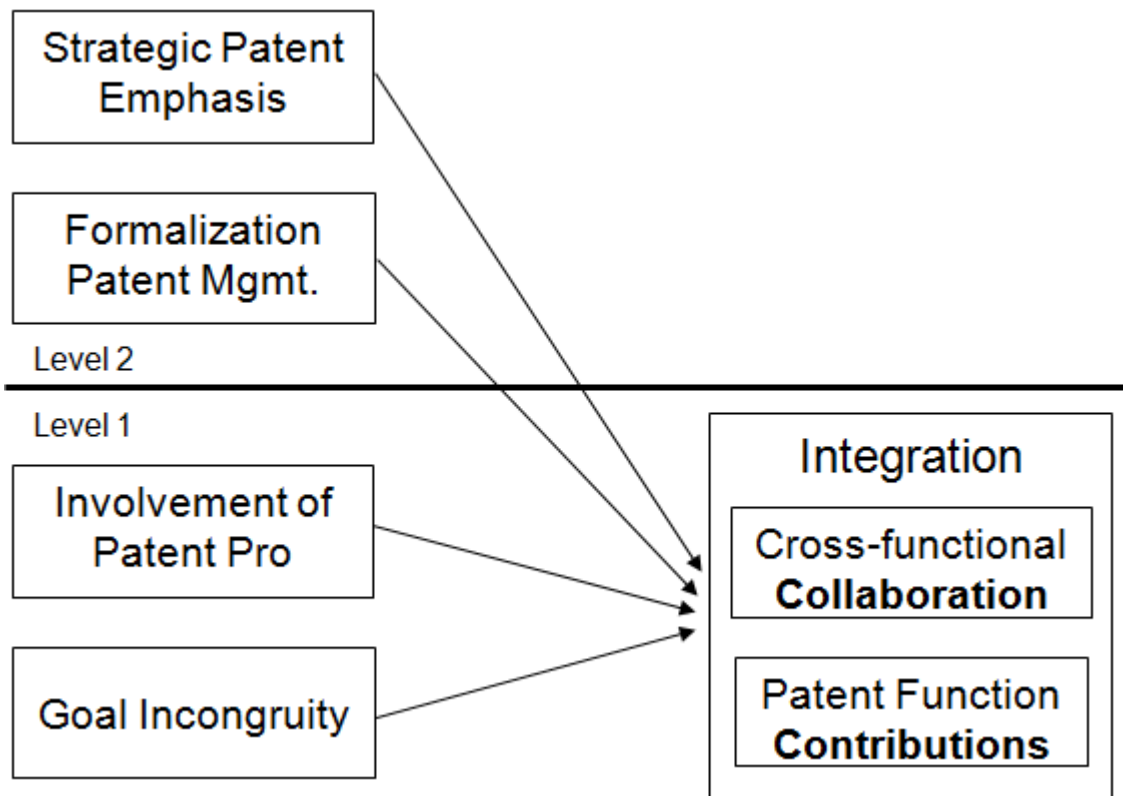


Figure 5: Conceptual Model

METHODS

Sample and Data Collection

We developed our framework based on extensive search of the literature in the fields of new product development, cross-functional integration, and patent management. This analysis was accompanied by several exploratory interviews with R&D and patent managers. Furthermore, we conducted in-depth case studies on the topic. In a subsequent step, we empirically tested our model with data from a large-scale questionnaire survey. The questionnaire was thoroughly pretested. The survey includes medium-sized and large multi-national technology-based firms or strategic business units across various industries. We focused on the following five industry clusters: Automotive / Aerospace / Aviation, Chemicals / Pharmaceuticals, Electronics / Information & Communication Technologies (ICT), Mechanics / Metal, and Medical.

The study was conducted in Germany with a list of the top 318 patent applicants at the German Patent and Trademark Office, all filing at least 13 patent applications per year. The applicants include technology-based German companies, some of them with highly international project organizations, as well as German branches of international companies. We made sure that all of these firms had major R&D facilities within Germany and that they conducted a substantial amount of developing and patenting work on these sites. This means that companies from other countries, which file patent applications at the German Patent and Trademark Office but that don't actually perform any R&D activities within the country, are not part of the population. Also, we did not include public entities like universities and research organizations.

From the 318 companies in our list, 200 were randomly selected. These were contacted in three subsequent steps: via postal mail, email, and later on by phone. We offered a customized benchmarking report and an exclusive management summary as incentives for firms to participate. The questionnaire was available in English and German. Translation was provided by a professional translation office specialized on patents, and was subsequently tested with native speakers.

The companies were asked to choose one or more recently finished NPD projects for the study. As this study has a very cross-functional topic, each project should have been evaluated by two persons in two separate yet identical questionnaires: The project leader and the patent manager assigned to each project are arguably the persons serving this purpose best. For the first project of each company, both of the respondents were asked to answer an additional set of firm-level questions. Our respondents in general had vast project experience (35 projects assigned on average) and were very familiar with the specific projects they evaluated for our study with an average of 5.7 on a 7-point-Likert scale ranging from "1" (= no knowledge on the project) to "7" (= expert knowledge).

For this study, we received usable questionnaires from 72 companies, which leads to a response rate of 23 percent (related to the total of 318 companies in our list). At the company level, 37 firms delivered dyadic responses from the patent professional and the project leader. As we have a multi-level research setting, the second unit of analysis is the project level. In total, we received 101 projects from these 72 companies, which is an average of 1.4 projects per company. 62 projects were complete with questionnaires from the two respondents. Another 39 projects were filled in only by the corresponding patent professional. In total, we used responses from 163 questionnaires for this study. Taking into account the ambitious research design, the sensitive information contained, and the difficult economic background – the survey was initiated during in plain global financial crisis and German economic recession – the effective response rate can be considered as very satisfactory.

Measures

All constructs are measured on a 7-point-Likert scale ranging from “1” (= strongly disagree) to “7” (= strongly agree). The appendix shows details on the measurement scales and the respective construct reliabilities. Cronbach’s alpha coefficients ranged from .76 (contributions) to .88 (collaboration) for all of the constructs and therefore lie above the cut-off criterion recommended by Cohen, Cohen, West, and Aiken (2003).

Integration: Cross-functional collaboration was slightly adapted from Song et al. (1997), a study on the marketing, R&D and manufacturing interfaces. It consists of four items with Cronbach’s $\alpha = .88$ (see appendix). As this is the very first study to examine patent function contributions during NPD, a new scale had to be developed. Similar to van Echtelt, Wynstra, van Weele, and Duysters (2008) and Nijssen, Biemans, and de Kort (2002) we identified supposedly important patent management activities.

After very extensive and thorough investigation through literature search, own case studies and interviews, the final construct consists of four items (Cronbach's $\alpha = .76$; see appendix).

Involvement of Patent Professionals in NPD Team: This scale has been newly developed based on anecdotal evidence and expert interviews. We thoroughly pre-tested this scale and the final construct consists of three items (Cronbach's $\alpha = .80$; see appendix). A sample item is "Other project members recognized the participating patent professionals as important members of the team".

Goal Incongruity: The scale for goal incongruity was developed by Song et al. (2000) at the interface between marketing and R&D. For this study, it was transferred into the R&D and patenting context. The items were changed slightly. The final construct consists of three items (Cronbach's $\alpha = .86$; see appendix). A sample item is "Patent professionals and developers had fundamentally different expectations with regard to the intended project outcome".

Formalization of Patent Management and Strategic Patent Emphasis: These two company level scales were newly developed for this study. The items were derived from an extensive literature review and in-depth case studies. They were pretested thoroughly. The final constructs consist of three items each (see appendix). Sample items include "In the NPD process, there exist clearly defined phases (from conceptualization to market launch) with clearly defined and obligatory patent management activities" (for formalization) or "Protection of intellectual property is a major company-wide concern" (for strategic patent emphasis).

Controls: Several variables that can potentially impact the predicted relationships in the regression models were used as control variables. At the project level, we included the allocation of resources and the degree of innovativeness. Project resources reflect the importance assigned to a project within the company. Innovativeness takes

into account environmental uncertainty. The measures for resources and innovativeness were adapted from previous project-level studies (e.g. Song and Montoya-Weiss (2001) for resources; Hauschildt and Schlaak (2001) and Gatignon, Tushman, Smith, and Anderson (2002) for innovativeness) and slightly modified. At the program level, we included company size in terms of number of employees. Also, we controlled for industry effects on both levels of analysis, as there might exist different approaches to patenting depending on the type of industry (e.g. discrete like pharmaceuticals and chemicals vs. continuous like electronics and ICT). Industry variables were included as dummy variables.

Analysis

Interrater Agreement: In order to avoid potential single informant bias our study was designed to include dyadic responses on each observation (see above). We received dyadic responses on 62 projects from 37 companies and checked for the ratio of agreement between the judgments of the respective patent manager and the project leader assigned to each of these. To this end we calculated the within-group interrater agreement r_{wg} according to the proceedings established by James, Demaree, and Wolf (1984) and James, Demaree, and Wolf (1993). The results show high values of interrater agreement with each r_{wg} exceeding the proposed threshold of 0.7 for every item in every dyad. These results strongly indicate that patent professionals and project managers in our sample generally agree on their evaluations. We therefore also included the remaining projects and companies with only one informant into our further analysis. Moreover, we merged the dyadic assessments into one combined evaluation by calculating the mean in order to adequately include both functions' point of view. All in all it seems that we have minimized the possibility of having a key informant bias in our data.

Confirmatory Factor Analysis: We conducted confirmatory factor analyses (CFA) on both levels of our model using the AMOS software package. All items for the independent variables and dependent variables loaded to the constructs reasonably well, lying above the cut-off criterion of 0.5 (Hair, Black, Babin, Anderson, & Tatham, 2006). The fit-indices for the model are χ^2 (CMIN) = 206.99 with DF = 137, CFI = 0.93, TLI = 0.91, and RMSEA = 0.071 suggesting good fit (Hair et al., 2006). The model at the program level has the following fit-indices: χ^2 (CMIN) = 12.61 with DF = 8, CFI = 0.98, TLI = 0.96, and RMSEA = 0.090, again showing a satisfactory model fit, especially when considering the relatively small sample size at the program level.

Furthermore, we used CFA to check for discriminant validity according to Fornell and Larcker (1981). Discriminant validity is given when the square root of the average variance extracted (\sqrt{AVE}) for each factor exceeds the absolute value of the respective correlations with all other factors. This was the case for all constructs so that discriminant validity can be assumed. Also, further proof of construct reliability is given since all \sqrt{AVE} s lie above 0.70 (Hair et al., 2006).

Common Method Bias: As we use data for the independent and the dependent variable from one common source, we used several techniques to check our data for potential common method bias. First, Harman's one factor test at both levels of analysis was negative, which means that no single factor accounted for the majority of the covariance in the independent and dependent variables (Podsakoff and Organ, 1986). This can be interpreted as a first indication that common method bias is not an issue here. Additionally, we assessed method bias using the approach recommended by Lindell and Whitney (2001). We used the construct "innovativeness" as an ex-post marker variable. Partial correlation analysis then showed that the partial correlations between the independent and the dependent variables were high and significant, very similar to the val-

ues from the original bivariate correlation analysis. This suggests that the relationship between these variables is not caused by common method bias.

Multi-Level Regression Analyses: In order to test the hypothesized relationships between the variables at the project level we conducted multiple regression analyses with ordinary least squares estimations. Since we included higher-level organizational antecedents in our theoretical framework, a multi-level modeling approach was required additionally. Project level is regarded as level 1, program level as level 2, assuming that level-1-units are nested within level-2-units. Hierarchical Linear Modeling (HLM) is applicable in this context as it allows for identifying variance between program- and project-level variables (Hofmann, 1997; Bryk and Raudenbush, 2002).

According to our research setting we chose the random effects “intercept-as-outcome” approach which tests for the influence of the level 2 units when explaining level 1 variance (Hofmann, 1997). Level 1 and level 2 variables were grand-mean centered (Hofmann and Gavin, 1998). We used the HLM 6 software package for our analyses.

We calculated the intra-class correlations (ICCs) for the level 1 variables (see table 5). The results show that 50 % of behavioral and 61 % of attitudinal integration variance is caused by the organizational context the projects are nested in. This result delivers very strong support for our multi-level setting and thus for applying HLM (Kreft and de Leeuw, 1998).

RESULTS

Table 5 shows means, standard deviations, ICCs, \sqrt{AVE} s, and bivariate correlations between the variables and constructs used to analyze the effects of organizational antecedents on patent management integration into NPD. Most notably, the involvement/participation of patent professionals is highly and positively correlated with both

dimension of the integration, whereas the goal incongruity construct is significantly and negatively correlated only to the attitudinal dimension of integration ('collaboration'). General project resources and the degree of innovativeness both seem to play considerable roles here: projects with higher resources and in largely undiscovered technology fields have a significantly higher degree of both integration dimensions. In contrast, the dummy variables for industry are almost not correlated with integration. At the program level, it becomes evident that both antecedents are heavily correlated.

	Mean	SD	√AVE	ICC	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Level 1													
(1) Contributions	5,18	0,99	0,70	0,50	1								
(2) Collaboration	5,81	0,93	0,81	0,61	0,36***	1							
(3) Automotive / Aviation	0,24	0,43	-		-0,11	-0,05	1						
(4) Chemicals / Pharmaceuticals	0,20	0,40	-		0,04	-0,03	-0,28**	1					
(5) Electronics / ICT	0,17	0,38	-		-0,18†	-0,08	-0,25*	-0,22*	1				
(6) Mechanics / Metal	0,28	0,45	-		0,19†	0,06	-0,35***	-0,31**	-0,28**	1			
(7) Resources	4,84	1,02	0,87		0,25*	0,36***	-0,07	-0,04	0,16	0,00	1		
(8) Innovativeness	4,00	1,56	0,74		0,30**	0,28**	0,04	-0,10	-0,06	0,19†	0,14	1	
(9) Involvement of Patent Pro	4,23	1,59	0,78		0,35***	0,34***	-0,38***	0,33**	-0,05	0,03	0,15	0,19†	1
(10) Goal Incongruity	2,41	1,18	0,84		-0,13	-0,71***	0,04	-0,09	0,05	0,12	-0,26**	-0,16	-0,24*

Table 5: Means, Standard Deviations, and bivariate Correlation Coefficients (Level 1 Variables)

	Mean	SD	√AVE	(11)	(12)
Level 2					
(11) Company Size	17544	42912	-	1	
(12) Formalization	5,05	1,49	0,83	-0,09	1
(13) Strategic Patent Emphasis	5,39	1,09	0,83	-0,20†	0,49***

N = 101 (Level 1); N = 72 (Level 2) *** p < .001; ** p < .01; * p < .05; † p < .

Table 5 (continued): Means, Standard Deviations, and bivariate Correlation Coefficients (Level 2 Variables)

Table 6 summarizes the results of the multiple regression analyses. The variance inflation factors in all regressions did not exceed the value of 2.86 (at one of the industry dummy variable). Multicollinearity is therefore not a problem (Hair et al. 2006).

The regression models 1 and 3 are the basic models at the project level where we only checked for the control variables' potential influence on both integration dimensions. Resources and innovativeness have a significant and positive relation to both integration constructs.

The regression models with the two project level antecedents explain 19 % of the variance for the dependent variable 'contributions' (model 2) and even 57 % of the variance for the dependent variable 'collaboration' (model 4). In model 2 one can see that only the project level antecedent 'involvement/participation' has a significant and positive relation to the behavioral dimension of integration ('contributions'). 'Goal incongruity' doesn't seem to have an effect here, other than predicted. Model 4 shows that both antecedents have a significant impact on collaboration. Especially the highly significant negative influence of 'goal incongruity' stands out. Therefore, hypotheses H1a, H2a, and H2b are confirmed by these empirical findings, whereas H1b is not.

Models 5 and 6 explore the influence of the program-level antecedents 'formalization' and 'strategic patent emphasis' on both integration dimensions (at the project level). HLM analyses for the two base models showed no significant effects and are thus not presented here. Model 6 shows that both program level antecedents have a positive and significant influence on collaboration, although the effect for 'formalization' is slightly less significant. Model 5 uncovered that only 'strategic patent emphasis' is positively and significantly related to behavioral integration ('contributions'); 'formalization' is not related. This means, that hypotheses H3a, H3b, and H4a are supported, whereas H4b cannot be backed by our findings.

	Model 1	Model 2	Model 3	Model 4
Dependent Variable	Contributions	Contributions	Collaboration	Collaboration
Control Variables				
Automotive / Aviation	-0,19	-0,08	-0,22	0,02
Chemicals / Pharmaceutica	-0,04	-0,08	-0,18	-0,13
Electronics / ICT	-0,27 *	-0,22 †	-0,27 *	-0,07
Mechanics / Metal	-0,02	0,03	-0,20	0,06
Resources	0,24 *	0,22 *	0,35 ***	0,16 *
Innovativeness	0,26 **	0,20 *	0,24 *	0,09
Company Size	-	-	-	-
Antecedents Level 1				
Involvement of Patent Pro		0,27 *		0,20 *
Goal Incongruity		0,03		-0,62 ***
Summary Statistics				
R ²	0,21	0,26	0,22	0,60
R ² adjusted	0,16	0,19	0,17	0,57
Δ R ²	0,21 ***	0,05 *	0,22 ***	0,38 ***
*** p < .001; ** p < .01; * p < .05; † p < .1				

Table 6: Multiple Regression Analyses – Integration and Antecedents (Level 1)

	Model 5	Model 6
Dependent Variable	Contributions	Collaboration
Control Variables		
Automotive / Aviation	-0,04	-0,09
Chemicals / Pharmaceutica	0,08	0,02
Electronics / ICT	-0,10	-0,13
Mechanics / Metal	0,16	0,01
Resources	-	-
Innovativeness	-	-
Company Size	0,00	0,02
Antecedents Level 2		
Formalization	0,16	0,25 †
Strategic Patent Emphasis	0,26 *	0,28 *
*** p < .001; ** p < .01; * p < .05; † p < .1		

Table 6 (continued): Multiple Regression Analyses – Integration and Antecedents (Level 2)

DISCUSSION

Our empirical findings suggest that both dimensions of patent management integration with R&D in NPD projects can be influenced by several organizational antecedents. It seems that two organizational antecedents are universally applicable to foster patent management integration into new product development. These are 'participation of patent professionals' and 'strategic patent emphasis'. 'Goal incongruity' and 'formalization' affect only one dimension of integration each. From these results we can derive several theoretical as well as managerial implications which we will discuss in the following.

Theoretical Implications

Attitudinal and behavioral integration of the R&D and the patenting function during NPD can both be fostered by the participation of patent professionals at the project level and by emphasizing the strategic importance of patents at the program level. Obviously, the early and consistent involvement of patent professionals through all project stages is an important factor to increase both dimensions of integration. If patent professionals keep in touch with the core project members so that relevant information can be shared both ways at a regular basis, patent management activities are executed more proficiently (behavioral integration). Also, a mutual understanding between the NPD core team and the patent managers is fostered (attitudinal integration), as both parties are becoming more accustomed to one another through their increased interaction.

At the program level, strategic patent emphasis seems to establish patent management integration regarding the attitudinal and the behavioral dimension likewise. If the top-management raises corporate awareness and emphasizes the importance of protecting own inventions while at the same time respecting external intellectual property, integration in NPD projects can be achieved more easily.

Furthermore, we identified two antecedents which only affect one type of integration each. At the project level, this is goal incongruity which is the basic difference between the regular team members' goals and values and those of the patent professionals. If the level of incongruity in the goals of each function is too high, attitudinal integration, i. e. the way of jointly collaborating on a mutual task, is hindered. Surprisingly, behavioral integration doesn't seem to be affected by incongruent goals. Obviously, behavioral integration, i. e. the amount of the contributions the patent function delivers during the project, is independent of goal alignment whereas attitudinal integration, i. e. the level of collaboration, is highly dependent on it. A possible explanation for this unexpected finding could be that different goals, mind sets and values within the functional silos are difficult to change during the length of the project. It seems that the regular team members and the patent professionals, who are historically rather unfamiliar to closely working with one another, don't have enough time to adapt and to align their respective goals, mind sets and values during the ongoing NPD projects. The result is that patent professionals actually deliver some contributions but they are likely to do so with a certain degree of discomfort as they are not fully convinced of the other party's goals. For example, the regular NPD team members might consider time-to-market as extremely critical for their project's success whereas the patent professionals aim for a perfect yet long-winded patent protection of the new product. In this case, both functions goals are not aligned and might even run in the opposite direction. Patent management activities are carried out (behavioral integration) but a common ground for understanding the other parties' respective activities is missing (attitudinal integration).

Lastly, we observed that the program-level antecedent 'formalization of patent management' only has a fairly significant influence on collaboration (attitudinal integration). Furthermore, the contribution dimension of integration again is not affected at all. We therefore assume that formalization only plays a minor role during integration mat-

ters. Obviously, it is not so important if certain patent management steps are part of the codified NPD proceedings. Instead, intangible or volitional aspects are more important. It is not sufficient to design detailed processes and subsequent steps. Rather, these abstract processes must be filled with life and should be actually applied during the individual projects.

Managerial Implications

As we have shown in the preceding chapter of this dissertation, both types of integration (attitudinal and behavioral) directly lead to higher new product success. Therefore, it is very important for managers understand different actions that help to increase cross-functional integration between patenting and R&D during NPD. Our study delivers several starting points for managers who want to foster patent management integration in their companies.

First, companies should assign patent professionals who are responsible for bridging the organizational gap between individual NPD teams and the patent department. Project managers should take care that these patent professionals are accepted as regular and important team members within their projects.

Second, patent awareness belongs on the agenda of the top-management and should diffuse throughout the whole organization. It is important that every employee who is concerned with R&D and NPD understands that own IP is a very valuable corporate asset. During our in-depth expert interviews some managers from leading companies hinted that in the very long term they strive to create a sort of pro-active patent culture within the whole organization where patenting and IP management activities just happen naturally among all functions.

Third, project managers should try to align the goals of the different functions during the course of the project in order to improve collaboration. This could be done by

unifying the project incentives and the reward mechanisms. If these are not in place, tensions might arise between regular members of the core NPD team and the respective patent professionals assigned to the project because their values and priorities usually are too different.

Fourth, formalization of patent related tasks can be helpful when integrating R&D and patenting. Although its impact is lower than that of the other actions described here, it seems to be a good starting point for facilitating integration.

All in all, we can see that management at the top level and at the project level can make use of different measures in order to influence on patent management integration into new product development.

Outlook and Limitations

Our study has some limitations that might offer various opportunities for further research. First, our study has a cross-sectional setting with ex-post evaluations. Future research might conduct longitudinal studies in the field. Also, this paper has looked at only two antecedents per level. There might exist other antecedents at both levels which could possibly help explaining integration, especially with regard to the contribution dimension. Starting points for the inclusion of other antecedents could possibly be found in the literature on team work or studies on general interface management.

This research has neglected moderating effects that could have an impact on the estimated relationships. The inclusion of contingent factors, for example, team size or newness of the product to the firm could help to identify certain conditions under which the antecedents impact integration.

Lastly, our study was initiated in Germany, though some of the projects in our sample actually were internationally distributed. Other countries with different patent policies might be interesting here, for example countries in emerging markets.

CONCLUSION

Cross-functional integration between the patent function and the R&D function is critical to the success of new product development projects. Consequently, this paper turns to the organizational antecedents which can potentially foster the integration between these two intertwined but distinct functions. We identified two antecedents at the project level and two antecedents at the program level which seem to influence on integration. However, our empirical findings suggest that these four antecedents don't affect the two dimensions integration alike. Attitudinal integration and behavioral integration both are influenced by strategic patent emphasis and by the participation of patent professionals. Goal incongruity and formalization affect attitudinal integration but seem to have no significant influence on behavioral integration. Overall, the results of this study suggest that the management can make use of several measures in order to increase patent management integration during NPD and therefore ultimately increase project performance.

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APPENDIX

Items, Constructs, and Reliabilities

1. *Cross-functional Collaboration between patenting and R&D* (4 items; $\alpha = .88$)

There was a very open atmosphere between participating developers and patent professionals throughout the NPD project. The participating developers and patent professionals pursued similar general motives throughout the project. There was a give-and-take relationship between participating developers and patent professionals throughout the project. Overall, there was great satisfaction concerning the relationship between participating developers and patent professionals. All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

2. *Patent Function Contributions to the NPD Project* (4 items; $\alpha = .76$)

Patent professionals secured freedom to operate for the consecutive project stages by filing applications for broad basic patents and other important patents. At important financial decision points during the project, patent professionals delivered assessments of the patent situation in the field of the new product (e.g. in the context of feasibility studies). Patent professionals supported the developers in capturing the specific state of the art and in identifying white technology fields. Overall, patent professionals delivered important contributions to the innovation project. All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

3. *Involvement of Patent Professionals in NPD Team* (3 items; $\alpha = .80$)

During all phases of the project (from idea generation to market launch), patent professionals were highly involved in the innovation team. Other project members recognized the participating patent professionals as important members of the team. Patent professionals were at no point in time members of the project team (reverse coded). All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

4. *Goal Incongruity* (3 items; $\alpha = .86$)

Patent professionals and developers had fundamentally different expectations with regard to the intended project outcome. Perceptions of adequate time frames varied significantly between project members and patent professionals. Patent professionals and developers considered the other group's approach as misleading. All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

5. *Formalization of Patent Management* (3 items; $\alpha = .86$)

In the innovation process, there exist clearly defined phases (from conceptualization to market launch) with clearly defined and obligatory patent management activities. At important decision points, innovation projects must be systematically evaluated from a patent perspective. At these decision points, it is obligatory to come to a joint decision on continuing or abandoning the project, based on the evaluation of the respective patent situation. All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

6. *Strategic Patent Emphasis* (3 items; $\alpha = .85$)

Top management assigns a high importance towards patents. Top management fosters high awareness for patent related tasks among all employees in the company. Protection of intellectual property is a major company-wide concern. All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

7. *Project Resources* (2 items; $\alpha = .84$)

The R&D resources assigned to this project were adequate. The general resources assigned to this project were adequate. All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

8. *Degree of Innovativeness* (3 items; $\alpha = .80$)

The new product uses technologies that have never before been applied in our industry. The new product was the first of its kind that was introduced to the market. The new product was very innovative and absolutely new to the market. All items were measured on the following scale: strongly disagree (1) to strongly agree (7).

Chapter E:
Overall Conclusion and Outlook

OVERALL CONCLUSION AND OUTLOOK

This dissertation investigates patent management in new product development. In particular, we consider two different approaches: patent orientation and cross-functional integration of patent management.

First, we introduce the concept of patent orientation which comprises a broad, organizational perception of patent management during new product development (chapter B). Patent orientation is an addition to other strategic orientations like market orientation and technology orientation. It covers patent-related aspects which have been neglected in other orientation concepts so far. As patent-related matters become more and more important, the theoretical and managerial need for understanding and implementing desired organizational behavior in this field grows. The concept of patent orientation addresses both of these needs.

Essentially, patent orientation is concerned with the appropriation of the values created during NPD projects. It is based on the processing of patent information during new product development which happens independently from the functional background of the different people involved in the processing activities. Analogue to other well established strategic or organizational orientations, patent orientation refers to the processes, practices, and decision-making activities with regard to appropriating the value from the newly created product and ultimately securing financial returns from the investments in new product development. Patent orientation consists of three iterative stages (gathering information, disseminating information, and responding to information), and implies the intentions and actions of key players such as R&D managers, patent managers, marketing/product managers, and new business development managers when working together in NPD projects. The results of chapter 2 suggest that patent orientation has a strong and positive influence on the success of new product development projects. Furthermore, patent orientation can be established by the top-

management through emphasizing the strategic importance of patents. Also, patent departments should show a high degree of pro-activity and service orientation towards other functional departments. This thesis thereby extends the current literature on strategic orientations, proves the positive effects of an organization's patent orientation, and identifies macro-level antecedents to patent orientation in the context of new product development. Hence, this thesis delivers new insights into strategic orientations and gives strong evidence for the importance of patent-oriented new product development. Furthermore, our framework bridges the micro- and the macro-level of an organization and thereby allows unique insights with practical relevance. Practitioners benefit especially from this direct link between the high-level strategic considerations down to the very detailed level of single operational activities. However, some questions remain open and could be addressed by future research. In particular, it could be interesting to investigate the interplay between market orientation, technology orientation, and patent orientation simultaneously. Furthermore, the influence of different patent strategies on the relationship between patent orientation and new product outcome could be of future interest. Maybe aggressive blocking strategies have a different effect than purely defensive strategies. Also, potential implications for open innovation have not been treated in this research and might be directed in future research.

Second, this thesis also takes on a narrower, operational perception on patent management in NPD by investigating the cross-functional integration between the patenting function and R&D during NPD (chapter C) and its antecedents (chapter D). It is explored what integration actually means in this context. As every integration-effort is accompanied by significant organizational costs, this thesis addresses the question, if patent management integration is worth the effort in terms of increasing new product development success. In order to capture the full scope of integration, two different concepts of integration are considered in this thesis. In particular, the effects of the atti-

tudinal dimension (volitional, qualitative collaboration) and of the behavioral dimension (quantitative contributions, amount of activities) of integration on NPD success are considered simultaneously. This holistic approach to integration is an important contribution to the field of interface studies because it uncovers divergent effects of the different integration dimensions, especially when varying degrees of innovativeness are taken into account. This finding has important implications for researchers and managers. It becomes obvious, that both dimensions are effects of their own right and that both have a positive and significant impact on the project outcome. It is suggested that a mutual understanding and a volitional way of collaborating seem to play a decisive role in every NPD project. Also, project managers should pay much attention to relevant patent management contributions, especially when the new product is highly innovative.

Once empirically detected that cross-functional integration of patenting and R&D positively impacts NPD outcome, this thesis furthermore examines how companies can accomplish patent management integration through different organizational measures both at the project level and at the program level. All of these measures seem to have a positive and significant impact on new product development projects. Thus, the results suggest that patent management integration can be influenced by a company's management through several specific antecedents. Team involvement of patent professionals and strategic patent emphasis within the whole organization have a positive and significant impact on both dimensions of cross-functional integration. However, goal incongruity and formalized NPD and patenting processes only affect the attitudinal dimension. Furthermore, formalization is only moderately significant here. These findings imply that cross-level effects indeed exist and that top-managers as well as project managers both can take concerted action to improve patent management integration. However, each dimension of integration should be addressed by different measures.

All in all, this thesis contributes to the existing literature on strategic orientations and interface management by introducing patent orientation and patent management integration as new success factors in new product development. Overall, one can conclude that the increased focus on patent management during NPD projects is economically justified. The results of this study's different chapters suggest that patent orientation and the two different forms of integrating patent management each impact NPD project performance. Thus, patent orientation is established as a distinct and proprietary strategic orientation. Also, there seems to be strong case to consider both dimensions of operational cross-functional integration simultaneously in future studies. Furthermore, managers have different tools at hand to foster the patent management during new product development.

However, there are still some aspects that should require further observation. For example, additional antecedents at the project level and at the program level could be examined. Also, the newly developed concept of patent orientation should be further investigated. For instance, it could be of great theoretical and practical interest, how patent orientation relates to other strategic orientations like for example market orientation or entrepreneurial orientation. As for cross-functional integration, further research on the diverging two dimensions of integration could be undertaken in order to possibly understand even more of this phenomenon. In order to comprehend patent management on the program level and on the project level first, consequences for the project teams or individual team members have been neglected in this study. Future research could possibly turn to these other levels of analysis. Furthermore, the findings of this thesis could be challenged in longitudinal studies as well as in countries with differing intellectual property regimes. Another potential extension of the findings presented here could lie in transferring and testing the concepts of patent management integration in an entrepreneurial setting, i.e. within new technology-based ventures.