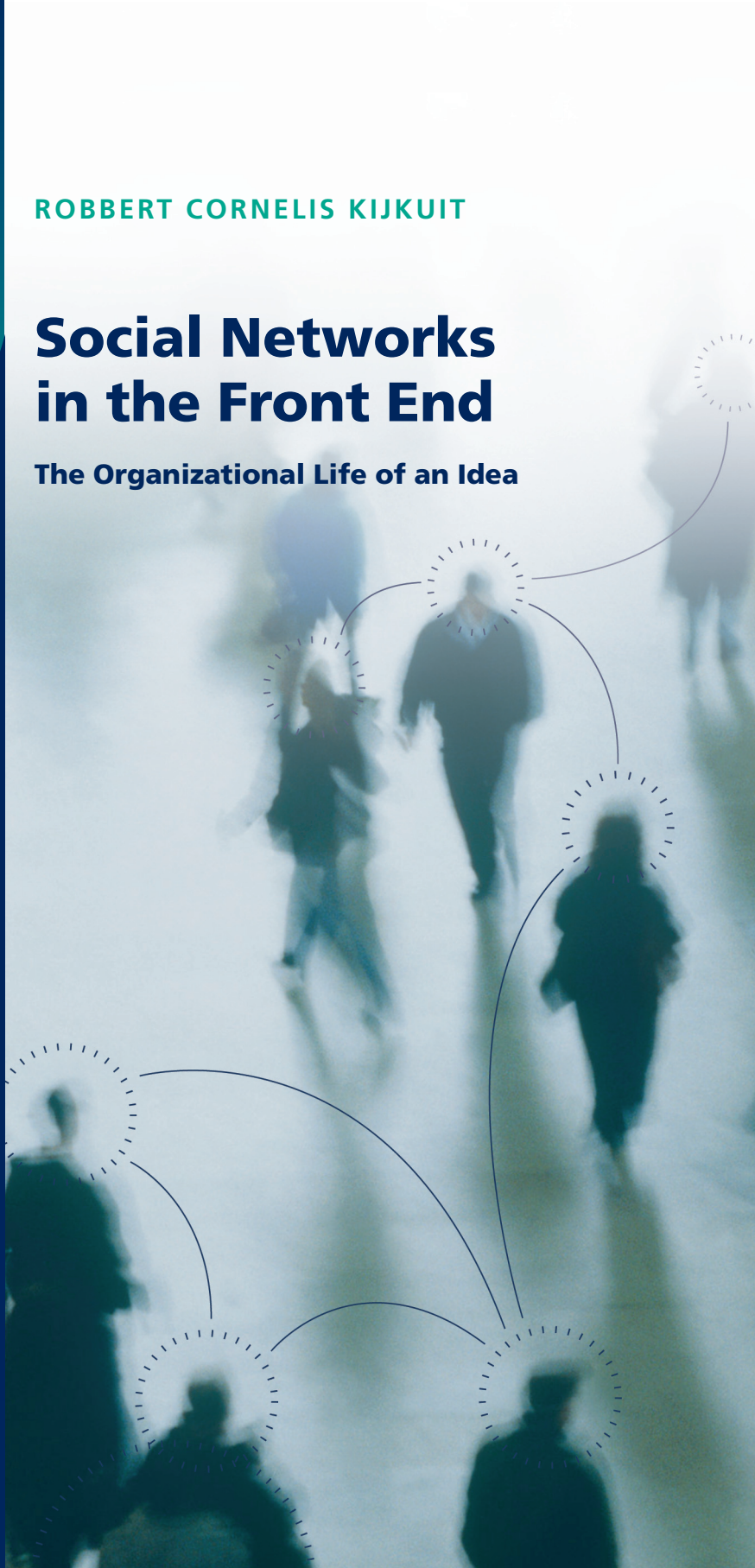
ROBBERT CORNELIS KIJKUIT

Social Networks in the Front End

The Organizational Life of an Idea



Social Networks in the Front End:
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Sociale netwerken in het front end:
Het organisationele leven van een idee

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Preface

"Een witte raaf onder de bedrijfskundigen" is how my promotor called me when I first approached him for co-supervising my M.Sc. thesis with the intention of doing a Ph.D. The intention was a result of numerous talks I had with Jan van den Ende. I had enjoyed my study 'Bedrijfskunde', i.e. Business Administration, but as the end was approaching, it left me with an empty feeling. Was this it? I was not satisfied, I wanted more. Growing up, I had a romantic view of university life, partly based on the many pictures of the historical campus of Cambridge in my youth encyclopaedia, but mainly because of the Sunday afternoon bike rides with my father to the "TH", i.e. Delft University of Technology. We drove around the campus and peeked through the windows to get a view of the fascinating experimental set-ups. This shaped my perception that a M.Sc. degree would provide me with an answer to my many questions. The reality for me was different and formed my main motivation to become a Ph.D. student: finding a better way to answer the questions that we encounter in life.

This thesis is the tangible side of the four and a half year 'quest'. It attempts to shed more light on the way in which people within organizations initiate, develop and evaluate new initiatives for products. I would like to believe that it succeeds to some extent, but is only a beginning. I hope that it will inspire others, but I know that this will require additional work. For the lessons I have learned over the last four and a half years, I would like to start by thanking Jan van den Ende. His continued enthusiasm and support to push me, even when working on the fourth revision, has been invaluable. I can only hope that he will be rewarded for his efforts in an appropriate manner. Secondly, I would like to thank Frans Smeets for his guidance and time. By never giving the answer, only the direction, he was, in my view, a true mentor. Thirdly, I would like to thank Bart Nooteboom and his everlasting critique, difficult to accept at first, but invaluable in the end. From RSM, I would like to thank the colleagues from my department for both their professional advice and their social companionship, specifically the hardcore lunch group. From other departments, I would like to specifically thank Jan van Dalen for his suggestions and Chris and Diederik for their insights and humour that added spice to everyday life as a

Ph.D. student. From Michigan I would like to thank Michael Jensen for opening my eyes to the real world and the graduate students for the social companionship. Within Unilever, I would like to thank the many people that were so kind to participate in my data collection and specifically Nel Mostert, Jan Vaessen and Jan de Rooij. Lastly, I would like to specifically thank Endry for her creative designs. For the support and lessons in my private life, I would like to thank Robbert, Jeroen, Boudewijn, AnneMieke en Lex, the nice part of my 'jaarclub', my old study friends, my surfing buddies and my survival buddies. And the best for last: my mother, who I resemble most, for helping me to understand both my good and bad sides and teach me to deal with my responsibilities. My great role model, my father and, through him, my grandfather, for stimulating me to think outside the box, to uphold high moral values and think about the true value of life. My sister who always reminds me to have fun and enjoy life, the lesson I find most difficult to learn. Finally, my girlfriend Sacha, whose unconditional love and support are truly admirable and unique and are more valuable than any title in the world.

Bob Kijkuit,
Rotterdam, February 2007

CHAPTER 1

Social networks in the front end of the new product development process

1.1 Social networks in the Front End

An effective 'front end' of the new product development process is important for the innovative performance of firms. The front end (FE) is the process during which ideas are born and further developed, ending with the go/no-go decision for the start of a project (Khurana & Rosenthal, 1998). Because of its importance, many firms put effort in organizing the front end of their product development process (Kim & Wilemon, 2002). A typical example is Shell, which has created its "GameChanger" suggestion and review system (Hamel, 1999; Van Dijk & Van den Ende, 2002). The dominant view behind such endeavors is that firms should collect as many ideas as possible, organize an effective review and selection process, and provide appropriate feedback to idea submitters (Wheelwright & Clark, 1992).

In this study we develop and test the appropriateness of a social network perspective on the FE. We study how the social network of an idea, i.e. the people discussing the idea with each other, including the dynamics of that network, affect the adoption of the idea by the firm. We also investigate how these social networks are built up. Whereas the dominant view on the front end advocates that the mere quality of an idea and its match with predetermined company requirements affect its adoption, our perspective is based on the assumption that the networks of employees surrounding ideas affect both the quality of the ideas and their alignment with company criteria, and are thus essential for their adoption. In doing so, our approach highlights the importance of interpersonal processes on the success of the front end, instead of, or on top of, the formal idea review process.

The importance of the social dimension of the front end of the new product development (NPD) process was already identified early on by Fleck (1979) who emphasized that

innovations are often unsolvable by any one person (Allen, 1977; Van de Ven, 1986). However, these early studies did not go into great detail regarding the characteristics and mechanisms of this social process. In more recent years, scholars have used more refined insights from the social network field to study the social process behind innovations more closely. Examples of such studies at the firm level are numerous and have focused on such topics as networks of learning (Powell, Koput, & Smith-Doerr, 1996), high-tech start-ups (Baum, Calabrese, & Silverman, 2000), university spinouts (Nicolaou & Birley, 2003), optimal cognitive distance (Gilsing, Nooteboom, Vanhaverbeke, Duysters, & Van den Oord, 2006; Wuyts, Colombo, Dutta, & Nooteboom, 2005), knowledge spillover (Owen-Smith & Powell, 2004) and firm's ego alliance networks (Ahuja, 2000; Stuart, 2000) to name a few. At the individual level network studies on innovation have focused on such topics as knowledge transfer (Cummings, 2004; Hansen, 1999; 2002; Reagans & McEvily, 2003), idea generation (Burt, 2004; Perry-Smith, 2006) and coordination (Obstfeld, 2005) to name a few.

In this research we follow the suggestions made early on by Van de Ven (1986) by looking at "the social process … by which people become invested in or attached to new ideas and push them into good currency", resulting in a social network perspective on the front end of the NPD process. The research is thereby split into two parts. The first and main part focuses on the networks surrounding project proposals in the FE and is based on the idea that networks of employees surrounding a proposal affect the quality of that proposal and its chances of adoption. Our perspective is based on the view that proposals in the front end are adapted and improved before they are actually reviewed by management. We develop a framework on how the structure and content of the network of the proposal, and its dynamics, affect the success of this adaptation process. We are thereby specifically interested in the tradeoff between sparse and dense networks. In the second part, we focus on the relationship level of the networks surrounding the above mentioned project proposals. We thereby specifically focus on how different aspects of the formal organizational structure influence the intensity of interaction in general in an R&D setting and specifically around project proposals. The perspective we take in this

part is that different dimension of relations can be explained by the ability, motivation and opportunity of actors.

This first part of this research builds on recent developments in social network literature that has brought theoretical (Perry-Smith & Shalley, 2003) and empirical (Burt, 2004; Perry-Smith, 2006) explanations for the generation and, to a limited extent, the development of new ideas. The general assumption in these studies is that many infrequent social relations with people outside your own social circle can provide people with unique information that, if combined, can lead to new creative insights. However, the focus of these authors is on the initial phase of the FE process. We extend this perspective by looking at how social networks develop in later phases of idea development and evaluation. We are thereby interested to see if network conditions that enhance the novelty of the generated ideas may at the same time impede the further development of the ideas and their actual transfer into projects (Reiter-Palmon & Illies, 2004).

The research question for the first part is thus:

> *What is the influence of social networks in the front end of the new product development process on the acceptance of new project proposals?*

The second part of this research builds on the assumption that different aspects of the formal organizational structure influence the extent to which people interact. This part thereby builds on literature on social structures (Granovetter, 1973; Krackhardt, 1999; McPherson, Smith-Lovin, & Cook, 2001), absorptive capacity (Cohen & Levinthal, 1990) and relational risk (Bogenrieder & Nooteboom, 2004; Edmondson, 1999). We thereby specifically go into the tension between the benefit of diversity and the benefit of psychological safety, motivation and trust in a NPD context.

The research questions for the second part are thus:

How does the formal organizational structure influence the extent to which people contribute to the initiation, development and refinement of a project proposal in a NPD context?

And how does it affect tie intensity in general in a NPD context?

1.2 Research Design

To answer the research questions, we have conducted an exploratory study in which we focused on the influence of social networks in the front-end and thereby assess the appropriateness of existing network theories in such a context. Our focus has intentionally been dynamic, making a longitudinal data collection design at a single firm most appropriate. The longitudinal approach allowed us to follow ideas and people as they move through the funnel system of the focal organization. It provides us with extensive access to resources and people enabling us to construct very complete pictures of the social networks in the FE and behind proposals in specific. The single firm strategy clearly hampers the external validity of the results. However, it does create high internal validity ensuring that inter-firm differences do not play a role in the extent and nature of 'social networking'.

1.3 Existing views on the FE

In previous literature, the FE process is generally considered to be an integral part of the new product development process (NPD) and has, as such, been covered by NPD literature. This literature stream is considered to be part of the broader 'innovation research' stream, where NPD research focuses at the microlevel as opposed to the more economics-orientated approach focusing on such topics as innovation in regional clusters and countries or the evolution of certain technologies (Brown & Eisenhardt, 1995).

In an attempt to provide an "organizing template" for the vast literature on NPD, Brown and Eisenhardt (1995) distinguish between three research streams: rational plan, communication web, and disciplined problem solving. The "rational plan" stream focuses on "a very broad range of determinants of financial performance of the product" which has helped to broadly define the relevant factors (Brown et al., 1995). The "communication web" stream focuses on the effects of communication on project performance. Finally, the "disciplined problem solving" stream focuses on "how people can work together to effectively participate in the complex problem solving involved in NPD" (Khurana et al., 1998, p. 60).

The new product development (NPD) literature focuses more on the selection of ideas and the product development projects after selection (Brown et al., 1995; Wheelwright et al., 1992). Within this NPD literature, the FE has historically not always been identified as a separate process, but rather as the first phase or phases of the NPD process. According to Khurana and Rosenthal (1998), studies dedicated solely to the FE are rare, but several broader studies have included certain aspects of the FE and come from all three research stream of Brown and Eisenhardt (1995) mentioned above. Based on a review of FE literature in combination with a series of exploratory case studies, Khurana and Rosenthal (1998) advocated a holistic approach through either formal processes or a collaborative organizational culture, both of which should match with relevant contextual factors. In a separate review of FE literature, Kim and Wilemon (2002) highlighted similar problems as noted by Khurana and Rosenthal (1998) and have listed several suggestions for improvement. These suggestions include reward project members, support product champions, transparent screening criteria, consider a large amount of ideas, build an information system, formalize the FE process, involve customers and involve senior management.

Although there is a clear acknowledgement of the fuzziness of the FE, most of the studies and solutions cited in the studies of Khurana and Rosenthal (1998) and Kim and Wilemon (2002) advocate a further formalization of the process and take a top-down, organizational perspective (Reid & de Brentani, 2004). The studies reflect a classic

decision-making perspective, in which decision makers are assumed to make consistent choices that maximize the value for the firm, and that result from systematic assessments of all alternatives in comparison to predetermined criteria (Cooper, Edgett, & Kleinschmidt, 1997a, b; Khurana et al., 1998; Roussel, Saad, & Erickson, 1991). As a consequence, the NPD literature has hardly addressed the social processes involved in decision-making on new product development projects.

One of the few exceptions to the formalized perspective is formed by the alternative of a "cultural approach" noted in Khurana and Rosenthal (1998). However, the description of this cultural approach is rather limited and provides little detail on the social mechanisms through which such an approach works. The second noteworthy exception is the theoretical study by Reid and the Brentani (2004) highlighting the importance of the individual. The paper focuses on radical innovations and advocates that the individual plays a key role in bringing information from the environment into the organization. Information sharing between individuals is thereby considered crucial in the FE.

We build on this last study, but instead of merely citing the importance of the individual and the information sharing potential, we apply a social network perspective on the FE, the need of which was already proposed by Van de Ven (1986, p. 592) in his much cited paper on central problems in management of innovation: "As these ideas surface networks of individuals and interest groups gravitate to and galvanize around the new ideas. They, in turn, exert their own influence on the ideas by further developing them…"

1.3 Contribution to literature

By applying a network perspective to the FE we intend to address the gap between the social network literature, which focuses on idea generation, and the NPD literature, which focuses on idea evaluation, by developing and testing the appropriateness of a theoretical framework on the FE of the NPD process that concentrates on the transition from idea generation to evaluation. Our unit of analysis is the network of a proposal, which we define as all people that discuss a particular proposal with each other.

The first part of this research extends and contributes to existing literature in four ways. First, in building on recent trends within the social network literature to go beyond a pure structuralist view of networks (Adler & Kwon, 2002), we develop and find support for a dynamic network perspective, which has thus far hardly been applied in the context of creativity and innovation (Perry-Smith, 2006). We distinguish three phases in the front end, the initiation, development and refinement phase, and we propose that the structure and content of the network of the proposal should change over these phases for the network to contribute to the quality of the proposal. Second, we develop a theoretical framework that builds on a broad base of literature including literature on behavioral decision-making (Daft & Lengel, 1986; Mintzberg, Raisinghani, & Theoret, 1976; Weick, 1995), creativity (Kurtzberg & Amabile, 2001; Lubart, 2001), cognitive distance (Cohen et al., 1990; Nooteboom, 1999), social networks (Burt, 1992; Coleman, 1988) and innovation (Dougherty, 1992; Moenaert & Souder, 1996). We thereby discuss the FE in terms of the uncertainty and ambiguity, tacitness and complexity, absorptive capacity and the dynamic character. Third, we disentangle the discussion on density from tie strength by following Reagans and McEvily (2003, p. 245) who state that "network structure can affect knowledge transfer independent of the effects of common knowledge and tie strength" and provide empirical support for doing so. Lastly, we extend classic network measures to make them more applicable to small networks that vary in size thereby contributing to methodological literature in the social network stream.

For the second part of this research we build on social network literature related to network structuring and information seeking and apply this in a NPD context. Previous research has addressed the influence of formal organizational structures, such as unit and divisional co-membership (Han, 1996; Lazega & van Duijn, 1997; Stevenson, 1990) and hierarchical levels (Han, 1996; Stevenson, 1990) on tie formation, but has not focused on the effect of formal structures on the intensity of interactions. Second, previous research has not looked at tie intensity in temporary relations and networks, but instead more on "those interactions that are routinely involved in carrying out each job in a large corporate hierarchy" (Han, 1996, p. 49). Third, because previous work did not look at ties

embedded in temporary networks, they could also not take the effect of the network structure on tie intensity into account. Finally and most importantly, prior research has paid little attention to interaction in innovative contexts characterized by uncertainty and ambiguity, complexity and diversity of information.

The aim of the second part is to extend the insights from network structuring and information seeking theories to interaction in general in an NPD context and specifically to temporary relations aimed at coalition formation around proposals in the FE. The second part of this research thereby extends and contributes to existing literature in three ways. First, we extend existing frameworks on the influence of formal organizational structure by focusing on tie intensity in both temporary as well as stable working relations, do so in an innovative context, and thereby include the role of the network structure and people's absorptive capacity. Specifically focusing on temporary relations and the effect of the networks in which they are embedded, allows us to test and extend the theoretical assumptions of Stevenson (1990) for the effect of the formal organization on "the potential for collective action within organizations" (p. 129). Second, we extend existing theoretical insights by developing a theoretical framework that builds on the need for ability, motivation and opportunity (Adler et al., 2002) and draws on a broad base of literature including literature on social structures (Granovetter, 1973; Krackhardt, 1999; McPherson et al., 2001), absorptive capacity (Cohen et al., 1990) and relational risk (Bogenrieder et al., 2004; Edmondson, 1999). Lastly, we use develop and test hypotheses on project membership data as a proxy for people's absorptive capacity thereby contributing to methodological literature in the knowledge management stream.

1.5 Outline of the study

Based on the research questions, we have structured the research and this book in two main parts each consisting of three chapters followed by a final concluding chapter. The content of the chapters is briefly outlined below.

Part 1:

Chapter 2: The Organizational Life of an Idea: a social network perspective

In the first chapter of part one, we use the classic debate in network literature on sparse and dense networks as a starting and explore how information and coordinated action could play a role within the FE. We subsequently draw on related literature from the decision-making and creativity field and specifically focus on the dynamic character of the FE. This results in various hypotheses that are split-up into those that cover the structure of a network and those that cover the content of a network.

Chapter 3: Methodology: mapping small networks over time

In the second chapter of part one, we focus on the appropriate research design that we have chosen to enable us to test the appropriateness of the theoretical framework formulated in the previous chapter. We thereby specifically go into the process character of the FE and the resulting implications for data collection. Moreover, we address the setting in which we collected the data, the sources we thereby used and the way in which the various constructs were operationalized. The key challenges thereby were the relative small size and number of the networks, which had implications for the operationalization of the constructs and the way in which the data was analyzed.

Chapter 4 Network level results

In the third and final chapter of part one, we present the findings from the data analysis on the network level. The chapter starts with a description of the phases that make up the FE and the descriptive statistics of the measures used to map various dimensions of the networks. This is followed by a section in which we present findings that rule out potential alternative explanations. The actual results are subsequently discussed for network structure and content separately. Both sections start with the results table followed by a brief summary of the implications for the hypotheses. These sections are followed by a discussion of an exception in the data set. The chapter finishes with two sections in which we successively discuss the implications for theory on network structure and content separately and the implications for theory by combining the results on structure and content.

Part 2:

Chapter 5: How to Build a Network in the FE

In the first chapter of part two, we focus on theories at the relationship level and how the formal structure of organizations can influence the extent to which people interact in general in a R&D setting and specifically when developing project proposals. This theoretical chapter discusses various theories from social network, innovation and knowledge management literature organized in three categories, namely, ability, motivation and opportunity. This results in various hypotheses that are again split-up into those that cover the structure of a network and those that cover the content of a network.

Chapter 6: Methodology: mapping relations

In the second chapter of part two, we pay less attention to the data collection issues covered in chapter 3, but instead focus on the operationalization of various constructs and specifically on those that were new to the second part. As a result of these new constructs we also discussed the data source on which these constructs were based. The chapter concludes with an analysis section in which we explain the way in which data was statistically analyzed.

Chapter 7: Relationship level results

In the final chapter of part two, we discuss the findings from the data analysis on the relationship. The chapter starts with the descriptive statistics of the results. The actual results are subsequently presented in two sections, one for each regression model. The first model assesses to what extent formal structures influence the extent to which people discuss project proposals in the FE. The second model assesses to what extent formal structures influence the more general extent to which people interact in a NPD/R&D setting. Both sections start with the results table followed by a brief summary of the implications for the hypotheses and finishes with the implications for existing theory. The chapter finishes with a general discussion of the results in which we look at the combined results from both regression models and reflect on the link with the results from the previous section.

Chapter 8: Conclusions

In the final chapter we summarize the empirical findings from part one and two and present the overall conclusion. We hereby specifically highlight the link between part one and two. We also summarize the theoretical relevance and address the practical relevance of the work. The chapter ends with a discussion of the limitations of this study and suggestions for future research.

PART I:
THE ORGANISATIONAL LIFE OF AN IDEA

CHAPTER 2

The Organizational Life of an Idea: a social network perspective[2]

2.1 Introduction

One of the classic debates within the 'social network' literature has focused on the tradeoff between sparse and dense networks. The first is assumed to provide such benefits as diverse information (Burt, 2004; Obstfeld, 2005; Perry-Smith et al., 2003), autonomy (Burt, 1992, 1997) and control (Burt, 1992). The second is assumed to facilitate the building of trust, clear expectations (Coleman, 1988; Reagans & Zuckerman, 2001) and coordinated action (Obstfeld, 2005).

Until recently, the two concepts were considered to be mutually exclusive, resulting in part by the more static focus of the initial studies. Since then, two basic 'compromises' have been discussed. The first compromise focuses on the separation in time. It is essentially a dynamic view advocating the need for a transition from a sparse to a dense network or vice a versa (Gilsing & Nooteboom, 2005). The second compromise focuses on the separation of content. Podolny and Baron (1997), in their study on organizational mobility, suggested that whether ties in sparse networks are beneficial depends on the content conveyed through those ties. A good example of such a network in the innovation literature is a 'cross-functional project team'. The communication network related to functional specific problems will be very sparse, with frequent communication between team members and their functional areas and little communication amongst team members. On the other hand, the communication network related to the overall design will be very dense primarily focusing on the team members. Obstfeld (2005) labeled this second compromise the 'compromised view'.

[2] This chapter is based on a paper written with Jan van den Ende, accepted for publication in the Journal of Management Studies.

Although very thorough and complete, most of the above mentioned network studies make two implicit assumptions. The first assumptions relates to the correlation between density and tie strength. From a pure structuralist point of view, sparseness or density merely refers to the degree to which a group of actors are tied to each other. However, both in theoretical and methodological discussions, density is often combined with tie strength. In these studies, sparse networks are assumed to consist of relatively weak ties, whereas dense networks are assumed to consist of relatively strong ties. However, and Burt (1992) has highlighted this early on, sparse networks and weak ties are merely a correlate. For this reason, various authors have focused purely on tie strength and the effect it can have on the possibility of obtaining various benefits from a network (Hansen, 1999; Nicolaou et al., 2003; Rangan, 2000; Seibert, Kraimer, & Liden, 2001).

The second assumption, which refers specifically to the network studies relating to creativity (Burt, 2004; Perry-Smith, 2006; Perry-Smith et al., 2003) is that creative ideas, or in this case project proposals, do not develop over time, but are instead end-products. This assumption contradicts with a common view in the innovation literature that ideas or products either implicitly or explicitly go through an innovation funnel (Wheelwright et al., 1992). A funnel refers in this context to the process during which an idea develops from a 'one-liner' to a full proposal or product. The funnel is not only used to coordinate and mobilize collective action, but maybe more importantly to improve on the original conception. This is distinctly different from the process described by Burt (2004) and Perry-Smith & Shalley (2003) who take the initial creative insight as the end point.

In this part, as we noted earlier, we will focus on the tradeoff between diverse insights and coordinated action in networks around proposal for new products in a NPD context. Our unit of analysis is thereby the network of a proposal, which we define as all people that discuss a particular idea or proposal with each other. In our theoretical framework we treat network structure and content separately and develop dynamic hypotheses.

2.2 Network benefits

In much of the literature on the role of social networks in organizational processes, the treatment of form and benefits is interwoven. An example includes the recent work by Obstfeld (2005) in which sparse and weakly tied networks are associated with creative ideas and dense and strongly tied networks are associated with coordinated action. Other examples of such joint treatments of form and benefit include the seminal work of Burt (1992) and Coleman (1988). However, several researchers have found support for the benefit of bridging ties in combination with strong ties (McEvily & Zaheer, 1999; Nicolaou et al., 2003; Seibert et al., 2001). Furthermore, research has shown that issues such as information complexity and absorptive capacity (Gilsing et al., 2006; Hansen, 1999; Reagans et al., 2003; Wuyts et al., 2005) are important determinants affecting the extent to which a given network can effectively provide certain types of information. These results support a need to separate the discussion on network benefits from the discussion on network forms.

We do so by starting with a general overview of the two key network benefits, namely information and control by drawing on the extensive literature on social capital. We subsequently discuss issues pertaining to the content of what is provided and the context in which benefits are provided, before discussing the social mechanisms through which the benefits are provided and formulate the relevant hypotheses. It should be noted that literature pertaining to organizational learning and more specifically 'communities of practice' has focused on similar benefits and social mechanisms. This stream of research is closely related and has focused on such issues as story telling (Brown & Duguid, 1996), relation risk (Bogenrieder et al., 2004; Edmondson, 1999) and trust (McAllister, 1995). However, it would go beyond the scope of this study to review this entire stream of literature. Instead we draw, where appropriate, on specific aspects of this research tradition to supplement the theories outlined in network literature, specifically in the section dealing with psychological risk.

Information

The first and most often cited benefit of social networks is information (Burt, 1992, 1997; Campbell, Marsden, & Hurlbert, 1986; Coleman, 1990; Granovetter, 1973). Burt (1992) identifies three forms of information benefits: access, timing and referrals. Access is a broad term, but Burt uses it more specifically to refer to the ability of a network to provide an actor with access to *valuable* information well beyond what the actor could process alone (Burt, 1997). The network surrounding an actor essentially acts as additional processing capacity. With the advent of information technology, access itself is not the main issue, screening is. It is exactly this screening ability of a network that Burt refers to when he uses the term 'access'. Besides providing access to valuable information, networks can also ensure than an actor is informed early. Burt gives the example of information on a stock market crash. Getting information about a stock market crash when it happens is not nearly as useful as getting it the day before. Lastly, whereas *access* and *timing* refer to information flowing to an actor, networks can also facilitate information flowing out. Through referrals, other people, not directly connected to a focal actor, can become positively aware of the focal actor in a timely fashion increasing the opportunities presented to him or her.

In relation to innovation, the discussion on information benefits generally focuses on the diversity of information. The notion that diverse information, if combined, can lead to creative ideas and products is deeply rooted in innovation (Schumpeter, 1934 and others) and creativity literature (Guilford, 1967). The interest from network researchers for the benefit of diverse information in an innovation context dates back to the early studies by Allen (1977) on interaction patterns of R&D scientists. The role of networks in providing diverse information has also been the foundation of the more recent network studies in the context of innovation at the individual level (Burt, 2004; Obstfeld, 2005; Perry-Smith, 2006; Perry-Smith et al., 2003). The benefit of diverse insights in relation to networks has also received attention in other contexts at the micro level, such as deal-making in banking (Mizruchi & Stearns, 2001). In this study the focus is not only on the initial generation of creative ideas, but also on what they label as the 'multiple-lens' hypothesis.

It refers to the benefit of receiving diverse "criticisms that allow an actor to anticipate a variety of contingencies" (Mizruchi et al., 2001).

It is important to note here that what network researchers label "information benefits" should be considered broadly. It does not only refer to "easily codifiable knowledge that can be transmitted without loss of integrity once the syntactical rules required for deciphering it are known" (Dyer & Nobeoka, 2000). A typical example of such information is information on job opportunities (Granovetter, 1974). On the contrary, the concept of "information benefits" also, if not more often, refers to "sticky, complex, and difficult to codify" knowledge (Dyer et al., 2000). Typical examples of this type of information includes specialized knowledge on the way in which transducers are glued in a gravity wave detector or the rules medical experts follow in order to reach a diagnosis (Von Hippel, 1994).

Coordinated action

The second benefit of networks is the ability to facilitate collective action and coordinate tasks (Burt, 1992, 1997; Coleman, 1990; Gargiulo & Benassi, 2000; Gulati & Gargiulo, 1999; Obstfeld, 2005). Coordinated action and information are, as Burt (1997) notes, mutually reinforcing and cumulate over time. Where information can provide actors with opportunities, coordinated action can provide the cooperative behavior needed to explore those opportunities (Podolny et al., 1997).

Adler and Kwon (2002) and Sandefur and Laumann (1998) split this benefit up into two separate benefits: control and solidarity. Control in those studies refers to the influence of an actor resulting from a favorable position in a system with an asymmetric distribution of power or information. Solidarity refers to the encouragement actors feel to comply with social norms, local rules and customs reducing the need for formal controls (Adler et al., 2002). We would, however, argue that the result of both benefits is essentially coordinated action. The difference is the mechanisms through which this coordinated action is created.

An example of the way in which control mechanisms work is the position of the Majority Leader of the U.S. Senate (Coleman, 1988). Such a formal position comes with extra resources that allow a senator to build up a set of obligations from other senators making it possible to use those obligations to get legislation passed. Another example of the control mechanism comes from Burt (1992) who introduced the *tertius gaudens* strategies. In these situations actors, under conditions of uncertainty, are assumed to be able to negotiate favorable terms between two parties, because of an asymmetrical distribution of information and lack of direct contact between those two parties.

Coordinated action through control would seem to lead to suboptimal results for the collective as a whole. However, as Adler and Kwon (2002) note when discussing the example of Coleman (1988) on the use of power in the US senate, power helps to get things done. As a result, they argue that organizations using power, such as the U.S. Senate, might therefore be more effective than organizations where a more balanced distribution of power could lead to endless debates. The UN would seem to fit this last description. Both of these legislative bodies have received substantial critique, it seems that it is the context that determines the appropriate mechanism. When monitoring is difficult and speed is crucial, action, even if suboptimal, is preferred over inaction. However, when time is not of essence and more extensive monitoring is possible, solidarity seems a much more solid working base.

Control can also take a different form. It can refer to the freedom of actors to be able to choose their course of action without pressures to conform to formal procedures and social obligations (Hansen, 1999; Perry-Smith, 2006), referred to by Burt (1997) as autonomy. It allows an actor to be "free to take advantage of … ideas without the constraints of breaking established norms, worrying what key others will say, or experiencing personal stress from potentially going against some accepted tenets of the network" (Perry-Smith et al., 2003, p. 98). Translating this to the network level suggests that asymmetrically distribution of information provides actors with the freedom to express their views without worrying about what others might say; a crucial condition in an innovative setting.

The ‘solidarity’ mechanism works through reputation and the build up of group or cooperative norms and a shared language (Krackhardt, 1999; Obstfeld, 2005; Reagans et al., 2003). The reputation argument is that people are more likely to demonstrate cooperative behavior, because if they do not, news of their ‘betrayal’ will swiftly travel around the group, frustrating future attempts to interact with other members of the same group. The group norm argument is that ‘mutual friends’ facilitate the development of group rules or shared values by which each member must play to remain part of the group (Krackhardt, 1999). This assures that if people help others now, others will help them in the future. Action through solidarity is accomplished by aligning views and is considered especially important in a decision-making context. As Whyte (1989) notes: the first task of decision-making groups is to ‘produce consensus from the initial preferences of its members’. This is complemented by views from creativity literature which highlight that action or an initiative is only valuable if collectively desired (Sternberg & Lubart, 1991) or has gained social acceptance (Simonton, 1989) thereby creating the broad support that is important during the actual execution of a project. The main drawbacks of decisions based on solidarity are the risk of groupthink (Janis, 1972) and lock-in (Gargiulo et al., 2000). Both group think and lock-in are related to the concept of autonomy mentioned earlier and refer to the tendencies for group insights to converge over time and block fresh outside perspectives. As Powell and Smith-Doerr (1994) put it: “The ties that bind may also turn into ties that blind”.

Beyond the consensus that social networks can provide various types of benefits, there is little agreement as to which network characteristics can provide these benefits. Adler en Kwon (2002) distinguish between research focusing on structure and research focusing on content.

2.3 New Product Development context

The focus of this study is on the role of social networks in a new product development setting. More specifically, this study deals with the question how social networks influence success chances of new product proposals in the front end. As we noted earlier, the front end is often labelled the 'fuzzy front end', because both process and idea or proposal are vague and ill-defined (Kim et al., 2002). This setting is thus distinctly different from previous studies on networks and creativity in four ways. First, the context is filled with uncertainty and ambiguity. Second, the information is inherently complex and tacit. Third, related to the complexity and tacitness is the importance of building on diverse information. Lastly, NPD is a dynamic process that evolves over time.

Uncertainty and ambiguity

According to NPD literature, uncertainty reduction is the key process during the NPD (Kim et al., 2002). This contradicts with previous research on networks and innovation, which is apparent from the following statement: "we also assume here that uncertainty and insecurity are relatively low" (Perry-Smith et al., 2003, p. 94). NPD literature advocates that whether a project proposal is accepted is dependent on the ability of those people working on the proposal to reduce the uncertainty sufficiently to meet the selection criteria (Kim et al., 2002; Moenaert, De Meyer, Souder, & Deschoolmeester, 1995). Furthermore, decision-making literature highlights that ambiguity of preferences is equally important in a decision-making context (Daft et al., 1986; March, 1987; Thomas & Trevino, 1993). While uncertainty refers to a lack of information, ambiguity refers to the existence of multiple and conflicting interpretations regarding an organizational situation (Daft et al., 1986).

It is under circumstances of high uncertainty and ambiguity that sensemaking is considered a crucial process that enables organizational members to function (Weick, 1995). It is defined as the process through which individuals develop meaning of their surrounding and act accordingly (Drazin, Glynn, & Karanjian, 1999). As Weick (1995) pointed out, this process is not only about 'reading', but also about 'shaping' the environment, which makes it distinctly different from such activities as understanding

and interpretation. Previous applications of sensemaking to the study of creativity and innovation have essentially focused on how the creative individual or unit makes sense of the diverse information with which he or she is confronted (Dougherty & Hardy, 1996; Drazin et al., 1999; Hill & Levenhagen, 1995). More general research on sensemaking has focused on the uncertainty and ambiguity that is faced by decision-makers (Daft & Lengel, 1984; Daft et al., 1986; Thomas et al., 1993). Preferences of managers are often vague and contradictory and develop over time (March, 1987). We would therefore argue that 'reading' and 'shaping' in the FE is a joint process of employees from different hierarchical levels within an organization.

We propose that whether a proposal is accepted is not only dependent on whether an idea meets some predetermined criteria, but also on the shaping of these criteria during the NPD. This co-development may ensure that a proposal fits current practice better, which may overcome the risk avoidance of managers, an issue that has been considered problematic in an innovation context (Christensen, 1997). In this light, social networks are not only relevant for generating solutions, but maybe even more importantly, for identifying problems and opportunities that fit in the organization.

Tacitness and complexity

Previous applications of network theory to creativity and innovation at the individual level assume that "general information about work or projects may be enough to help spark new ideas" (Perry-Smith et al., 2003). Perry-Smith and Shalley (2003) go on by citing Bouty (2000) and stating that "information exchanged between R&D scientists for instrumental purposes does not require the trust associated with other types of exchanges". These remarks show that knowledge complexity and tacitness is not considered to be high. This contradicts with innovation studies that have highlighted the tacitness and complexity of information exchanged in NPD settings (Cohen et al., 1990; Dougherty, 1992; Dyer et al., 2000; Madhavan & Grover, 1998; Teece, 1996; Von Hippel, 1994). The information in a NPD setting is tacit to the extent that it is context specific know-how and is difficult to articulate. Moreover, researchers have highlighted that besides the actual knowledge, the NPD routines also have a large tacit component

(Madhavan et al., 1998). NPD routines refer to the way in which actors have developed routines for the combination of individual stores of tacit knowledge. Both tacit knowledge and routines are gathered over time by actors. Not so much through education, but more through a "long process of apprenticeship" (Polanyi, 1967) and cooperation with others. Education, as found at most universities, provides rather explicit 'text-book' knowledge and little cooperation and as such provides a basis on which tacit knowledge and routines can build, rather than directly providing tacit knowledge.

The complexity of information in NPD setting is caused not only because it builds on the latest theoretical knowledge from science (Rosenberg, 1982), but also because it deals with "the specific and the particular" (Von Hippel, 1994). Lastly, product developers increasingly draw upon a complex array of interdependent technological insights (Dougherty, 1992; Griffin, 1997), adding to the complexity of the information recognition and assimilation process.

Cognitive distance

As we noted above, exposure to a diversity of insights is one of the mechanisms through which social networks are assumed to facilitate innovation. Creativity and innovation studies have however highlighted that there is a limit to the appropriate amount of diversity. An aspect that was not, or at least not explicitly, considered by related studies of Burt (2004), Cummings (2004) and Perry-Smith and Shalley (2003). Diversity is associated with both the number of actors involved and the degree to which their knowledge or skills are different (Gilsing et al., 2005; Wuyts et al., 2005). Cohen and Levinthal (1990) argue that the ability to recognize, evaluate and assimilate diverse knowledge is largely a function of the level of prior related knowledge and label this ability 'absorptive capacity'. They define prior related knowledge to include basic skills, a shared language, and knowledge of the latest scientific or technological developments. Cohen and Levinthal (1990) continue by pointing to the tradeoff between diversity and commonality of knowledge across individuals. Whereas some degree of overlap facilitates the recognition and assimilation of new knowledge, diversity permits the capacity to make novel linkages and associations. This view is supported by others who

have referred to this degree of overlap as cognitive distance (Nooteboom, 1999). Creativity studies have also advocated the need for mutual understanding to enable individuals to build effectively and creatively on diverse knowledge (Kurtzberg et al., 2001; Mumford & Gustafson, 1988). However, the level of theoretical detail and empirical validation does not match the innovation studies highlighted earlier.

While the importance of prior related knowledge and mutual understanding is not new to network literature, it does supplement the related network studies cited earlier by highlighting the importance of the content of network ties.

Process view

The final and most important difference between previous network studies on innovation and this study is the process and dynamic view on innovation. Most of the previous research essentially focuses on information benefits, such as the work by Perry-Smith (2006), Burt (2004), Cummings (2004), Reagans et al. (2004), Reagans and McEvily (2003), Perry-Smith and Shalley (2003), Reagans and Zuckerman (2001) and Hansen (1999). Network dynamics are included in Perry-Smith and Shalley's (2003) model, but focus on the career of idea generating individuals not on the dynamics of the process itself. Other researchers have focused on control or coordinated action benefits in an innovation context, such as Obstfeld (2005) and Reagans and McEvily (2003). However, besides the early work of Allen (1977) and the recent theoretical work of Kijkuit and Van den Ende (2007), few network studies at the individual level have considered the entire process of innovation from generation to evaluation, the importance of which was noted by Perry-Smith (2006).

Outside of the innovation context, a process and dynamic view is more common in network literature. Podolny and Baron (1997) were amongst the first to recognize that where information provides actors with opportunities, coordinated action can provide the cooperation and support needed to explore those opportunities (Podolny et al., 1997). A noteworthy example of a process view for this study is the work by Mizruchi and Stearns (2001) on deal-making in the banking sector. In that study the focus is not only on

information benefits, but also on the approval needed to close a deal. This study showed that the network on which actors rely for advice on deals create conditions that at the same time make it less likely for a deal to close successfully. Other examples of 'dynamic' studies include Rowley et al. (2000), Gilsing and Nooteboom (2005). The question that the Mizruchi and Stearns's (2001) study raises for the present study is if conditions enhancing the quality of generated project proposals may at the same time impede the actual transfer of these proposals into projects.

In the NPD literature and practice, process models are very common and are often referred to as 'stage-gate' or 'funnel' models. A typical example is depicted below.

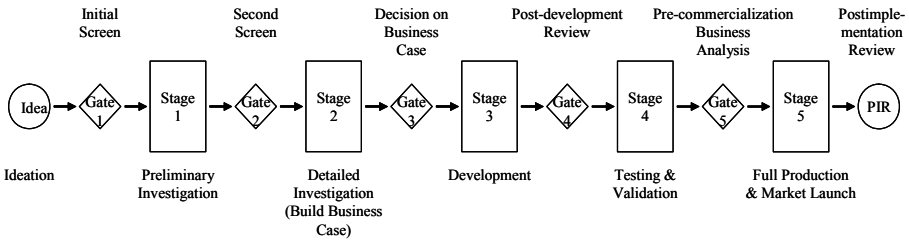

Figure 2.1 Cooper (1986), Winning at new products.

Extensive models include all activities from 'idea generation' to 'post implementation review'. In this study we explicitly concentrate on the pre-development activities, which refer to all activities from idea generation up until the go/no-go decision to execute a NPD project (Khurana et al., 1998). Authors focusing on these activities advocate that the FE process is geared towards reducing the uncertainty surrounding an idea to a point where it meets with a firm's set of pre-determined selection criteria (Kim et al., 2002; Moenaert et al., 1995).

Process models are also common in the creativity and decision-making literatures. According to the creativity literature, the creative process consists of activities, such as problem identification, problem construction, and response generation (Lubart, 2001). The decision-making literature identifies similar processes, but includes the decision

process in its models. Simon's classic decision-making model (1965) identified three phases, namely intelligence, design and choice. In response to empirical studies, Mintzberg et al. (1976) later on built on this model and highlighted that the decision-making process is highly complex and dynamic surrounded by both uncertainty and ambiguity (Cohen, March, & Olsen, 1972). Mintzberg et al. (1976) again identified three phases: the identification phase, which consisted of recognition and diagnosis routines, the alternative development phase, which consisted of search and design routines, and the selection phase, which consisted of screening, evaluation-choice and authorization routines.

In FE models the analogy of three phases is also found in, for instance, the model of Cooper (1988), who distinguishes between idea generation, product definition and project evaluation. Khurana and Rosenthal (1998) go further and identify various sub processes such as opportunity identification, project strategy formulation and project preplanning. For this paper we follow the analogy of three main phases and define the front-end of new product development to consist of three phases, namely 'initiation', 'development' and 'refinement'.

The most important activities in the initiation phase are problem identification, problem structuring and idea formulation (Khurana et al., 1998; Leifer et al., 2000; Schwenk, 1984). This phase involves recognizing gaps or flaws with the current state of thinking (Lubart, 2001), which is often the result of questioning the status quo, the need to solve a problem or dissatisfaction with the current state of affairs (Dasgupta, 1996), resulting in an initial creative idea. We would like to stress here that problem identification and structuring are not always explicit, since the generation of an idea often takes place on the "fringe of consciousness" (Dasgupta, 1994, p. 34).

In the development phase, social action becomes important. Key activities in this phase are response generation (Amabile, 1996) and concept development (Urban & Hauser, 1993). During this phase, the idea moves from a one-liner into a detailed proposal. People that generated the idea may dive into relevant literature or consult colleagues and friends

to clarify key issues. This may lead to exploring alternatives and searching in new directions, making the proposal more robust and perhaps even resulting in a redefinition of the original idea. The phase ends with a "review by a mid-level group of managers (peers)" (Clark & Wheelwright, 1993, p. 307). These reviews can be seen as a readiness review rather than a formal go/no-go decision and include a check for company fit and an assessment of the appropriateness of the proposal relative to a firm's available development resources (Clark et al., 1993).

If a proposal makes it through to the refinement phase, the focus lies on further detailing and supplementing the project proposal based on the 'mid-level reviews', including more accurate estimates of required resources and the fit within the existing project portfolio. The key activities are screening (Cooper, 1988) and decision making (Frederickson & Mitchell, 1984). This final phase ends with an evaluation by senior management, who will base their decision on their personal opinion and in part on information provided by relevant experts and their management peers. The most important groups of decision criteria in the NPD literature refer to market prospects, technological feasibility and company fit (Cooper et al., 1997a, b; Roussel et al., 1991). In this study, in line with previous research (Khurana et al., 1998), we consider the front-end to finish when the go/no-go decision has been made.

Finally, it is important to note that the phases of the front end are interdependent and not necessarily sequential (Khurana et al., 1998). This has also been highlighted by Mintzberg et al. (1976) and Saunders and Jones (1990), who have emphasized the importance of viewing the decision process as a dynamic, open-system process subjected to interferences, feedback loops and dead ends. Further development of a proposal can, for instance, lead to an almost completely new idea or a negative evaluation can send a proposal back into the development phase. This does, however, not change the fact that the three phases do represent the major phases that all proposals go through before they are considered for funding.

2.4 Network structure

Network level

Network structure characteristics can be divided into network level and dyadic level characteristics. The two most often cited characteristics at the network level are size and density. Size refers to the number of actors in a given network. Network researchers often use the term 'degree centrality' to refer to this dimension of a network (Freeman, 1979). Density refers to the degree to which actors within a network are tied to each other. It is commonly operationalized by dividing the number of actual ties in a network by the maximum possible number of ties in a network. Variations on this operationalization include ego density (Burt, 1982), efficiency (Burt, 1992), alter network density (Mizruchi et al., 2001), average degree (De Nooy, Mrvar, & Batagelj, 2005), Simmelian ties (Krackhardt, 1999). The operationalizations at the network level refer to the degree to which actors within a network are tied to each other. At the individual level, it refers to the degree to which the contacts of an actor are connected to each other. It should be noted that social network literature on structure also considers the position of actors in a network to be crucial, which is often operationalized by measuring different dimensions of an actor's centrality (Freeman, 1979). However, we look at the network or relational level and as such do not consider the position.

Size

Network research often advocates the benefits associated with larger networks, including unique information, more information and faster information (Burt, 1992). The most obvious benefit builds on the basic idea that 'two people can do more than one' increasing either the amount of information or the speed with which information is processed. Second, information from a larger network is also likely to be more unique, because the chances that two or more people posses the exact same knowledge are negligible, entailing that a larger network, ceteris paribus, will always provide more unique information than a small network. The provision of more, faster and unique information can clearly contribute in an innovation setting by sparking creative insights,

which is supported by the results of Perry-Smith (2006). Larger networks can also facilitate the reduction of uncertainty and ambiguity regarding the technical and market feasibility. This reduction can be caused by additional information and criticism. This last point was made by Mizruchi and Stearns (2001) labeling it the 'multiple-lens' hypothesis referring to the fact that criticism allows actors to anticipate a range of contingencies. Finally, a larger network can also influence the view within an organization on which ideas are worth exploring further. This process of sensemaking can influence managers directly, but also indirectly through their subordinates. If managers or decision-makers are told from different people about an interesting proposal then it is likely that they will be more receptive to such an idea. A larger network can thus facilitate the adoption of a proposal through a form of coordinated action or hearsay.

However, from a decision-making perspective, large(r) networks may also have a downside according to literature on 'top management teams' (TMT). Although size has been found to increase the "range of perspectives" (Haleblian & Finkelstein, 1993), it is considered to create problems of control and coordination in decision-making (Seashore, 1977; Smith et al., 1994; Thomas & Fink, 1963). Smaller groups allow for a form of team work, which is considered critical for decision-making in NPD (Ancona & Caldwell, 1992). This is supported by empirical findings that found a negative indirect effect of group size on informal communication and social integration, in line with arguments set forth by Seashore (1977) and Thomas and Fink (1963). Smaller networks would therefore seem critical in the refinement phase to create consensus. In short, it is evident that although large networks provide diverse insights, can reduce uncertainty and ambiguity and could positively influence the dominant view, they create problems during decision-making. This brings us to the following hypotheses:

> *Hypothesis 1a:* Large networks of proposals during the initiation and development phase increase the probability of proposal acceptance.

> *Hypothesis 1b:* Networks of proposals that decrease in size from the development to the refinement phase increase the probability of proposal acceptance.

Density

There are two views on density. One view advocates the benefit of low density and focuses on the effect it has on information benefits. Burt (1992) was among the first to highlight the advantage of low density or, as he would say it, 'non-redundancy'. The idea is that in a network with low density, actors are likely to receive a greater diversity of information, because the actors in the network tend to be tied to diverse others (Burt, 2004; Mizruchi et al., 2001; Perry-Smith et al., 2003). These diverse others are assumed to provide diverse experiences, unique resources, multiple thought worlds, which are all associated with more creative thoughts. Furthermore, low density (sparseness) also provides the benefit of autonomy (Burt, 1997) and the lack of social pressure to conform (Perry-Smith et al., 2003). Actors are less constrained in such a network structure and as a result have more freedom, which is an important requirement for creative thoughts (Perry-Smith et al., 2003).

The view advocating high density was popularized by Coleman (1988). This network structure is assumed to work through two mechanisms, namely reputation and group or cooperative norms (Krackhardt, 1999; Reagans et al., 2003). The reputation argument is that people are more likely to demonstrate cooperative behavior, because if they do not, news of their 'betrayal' will swiftly travel around the group, frustrating future attempts to interact with other members of the same group. The group norm argument is that dense networks facilitate the development of group rules or shared values by which each actor must play to remain part of the group (Krackhardt, 1999).

Regarding information benefits, high density has been associated with more accurate and reliable information (Granovetter, 1983; Ibarra, 1995; Nooteboom, 1999), the development of a shared language (Naphiet & Ghoshal, 1998; Obstfeld, 2005), increased absorptive capacity (Gilsing et al., 2005) and a higher speed of information transfer. First, the increased redundancy of information in a denser network enables actors to cross validate information from multiple sources by consulting third parties. Second, the development of a shared language and work routines enables actors to communicate more

easily, which helps in both recognition and transfer of valuable knowledge. It is essentially one of the building blocks of prior related knowledge advocated to be crucial in a NPD setting (Cohen et al., 1990). Third, the triadic structures common in dense networks allows actors to pool the absorptive capacity of others to better understand information coming from a third party (Gilsing et al., 2005). Finally, higher connectivity of a network decreases the average path length between any two actors leading to higher speed of information transfer.

Regarding control benefits, high density has been associated with an increased willingness to help (Reagans et al., 2003) and the creation of trust (Coleman, 1988). First, the increased willingness of actors to devote time and effort to help others is important in an innovation context, because the tacitness and complexity of the knowledge is high. This means that an actor has to spend a considerable amount of time to communicate what he or she knows. Second, there is no formal funding during the FE making it highly uncertain whether help on a proposal will 'deliver' concrete benefits to an actor in the short run. Trust is, therefore, an important dimension for three reasons:

1. Trust can create psychological safety (Edmondson, 1999). When actors suggest or discuss ideas with others, they run the risk of losing face, reputation and acceptance, because their ideas are considered too simple or farfetched. This is referred to as 'intangible costs' (Bogenrieder et al., 2004).
2. Trust mitigates the risk of being 'too smart', thereby exposing other people's weaknesses (Bogenrieder et al., 2004). A good example is a classroom situation in which the 'nerd' knows the answer to the question that the 'school bully' was not able to answer.
3. Trust can mitigate the risk of 'spill-over' and competition (Bogenrieder et al., 2004; Reagans et al., 2003). Spill-over refers to the fact that actors may use an idea generated by others to their own benefit without rewarding the idea generator. Competition refers to the fact that knowledge sharing between actors makes them more redundant (Reagans et al., 2003). Bogenrieder and Nooteboom (2004) do stress that this risk is mainly problematic when dealing with 'core' knowledge.

Despite the positive influence of high density on certain aspects of information benefits, even Coleman (1988) acknowledged that density can "reduce innovativeness in an area". High density in an innovation context is therefore usually advocated for its ability to facilitate coordinated action (Obstfeld, 2005; Reagans et al., 2001). The high levels of density can help align views, resolve conflicts and mobilize support. Furthermore, dense networks also transmit a clear normative order within which people can optimize performance (Coleman, 1990). In short, high density provides a basis for social action, a view supported by empirical findings (Obstfeld, 2005).

The question posted earlier is how to combine these two opposing network structures. Several researchers have advocated that these opposing network structures can co-exist at different levels (Mizruchi et al., 2001; Nicolaou et al., 2003; Podolny et al., 1997; Reagans et al., 2001), internal network versus external network, advice network versus approval network, and information network versus buy-in network. These studies did however not focus on an innovative setting. We therefore follow Gilsing and Nooteboom (2005) with the idea of a separation in time. A network structure in an innovative setting should thus evolve over time from a sparse network facilitating the creation and initial development of innovative proposals, to a dense network facilitating the refinement and coordinated action needed to get a proposal accepted.

> *Hypothesis 2a:* Low density during idea development increases the probability of proposal acceptance.

> *Hypothesis 2b:* High density during idea refinement increases the probability of proposal acceptance.

Tie strength

Whereas size and density are characteristics at the network level, tie strength refers to the dyadic level. The discussion on tie strength started with Granovetter's famous "Strength of weak ties" manuscript (1973), but shifted to network structure as people assumed that

density and tie strength exhibited high correlation (Nicolaou et al., 2003). However, as we noted earlier, several researchers have shown the benefit of low density in combination with strong ties (McEvily et al., 1999; Nicolaou et al., 2003; Seibert et al., 2001).

Strength of ties is generally considered to be a multi-dimensional construct. According to Granovetter (1973), tie strength is a combination of amount of time, emotional intensity, intimacy and reciprocal services, resulting in a continuum with weak ties on one end and strong ties at the other. Other dimensions that have been identified in the context of innovation at the organizational level include scope and formal control (Gilsing et al., 2005). In that study, scope refers to the range of activities involved in a tie and formal control refers to the control of opportunity or incentive either by contract, mutual dependence or hostages. An alternative indication of tie strength is the extent of multiplexity, referring to multiple contents in a relationship (Granovetter, 1973). However, as Granovetter (1973) notes, "ties with only one content or with diffuse content can be strong as well" (Granovetter, 1973, p. 1361), we will therefore limit the discussion here to strong versus weak ties, based on the four dimensions noted above. Strong ties are thus characterized by frequent interaction, high emotional intensity and intimacy and bilateral communication and weak ties by the opposite.

Both types have their benefits. Weak ties can provide information or access to resources at a low cost in terms of time and effort, making it possible to maintain many ties. Hansen (1999), therefore, stressed the 'search' potential of weak ties. Furthermore, these ties also provide autonomy, which is often linked with the ability to think 'outside the box' (Perry-Smith et al., 2003). A good example of the autonomy that weak ties provide can be seen if one considers writing a Ph.D. thesis. Ph.D. candidates often seek advice from various sources to help develop their ideas. However, as long as these sources are not on his or her Ph.D. committee he or she can choose to ignore the advice and go in a different direction. Doing the same with committee members will severely frustrate ones attempt to obtain a Ph.D. The obvious problem of weak ties is their somewhat superficial nature. Hansen (1999), therefore, stressed the importance of strong ties if one aims at

'transferring' knowledge. These strong bonds motivate contacts to be of assistance and are more readily available than weak ties (Granovetter, 1983). Furthermore, strong ties facilitate the formation of trust (Reagans et al., 2003) and mutual understanding (Gilsing et al., 2005) thereby further facilitating the transfer of information and the construction of knowledge, especially more complex knowledge (Hansen, 1999; Uzzi, 1999). In other words, if a thorough understanding is needed to resolve certain technical or market issues, strong ties are supposed to be better. Summing up, weak ties are appropriate for the exchange of relatively simple knowledge, have the advantage of autonomy and are of low cost, making it possible to maintain more ties. Strong ties can provide more and more complex information and support, however, at a higher cost.

Although the reference lists of network studies on innovation often suggest otherwise, the importance of tie strength has not been the sole domain of network studies. Hoopes and Postrel (1999) cited innovation studies in the automobile, mainframe computer, semiconductor photolithography and pharmaceutical industry that stress the importance of "frequent, early and 'thick' communication" (p. 839). Information-processing literature has also shown that information channels allowing for immediate feedback so that interpretations can be checked are crucial in a context filled with ambiguity and tacit information (Daft et al., 1986; Daft, Lengel, & Trevino, 1987). As Cohen and Levinthal (1990) argue, building on diverse knowledge in an innovation setting is not simply a question of brief exposure to new information, but requires intense interaction.

In an interesting study on dyadic communication patterns between R&D and marketing, Moenaert and Souder (1996) advocated that transferring extra-functional information requires the ability to decode functional-specific language, which requires an interactive communication process. They argue, based on MIS literature, that next to comprehensibility, credibility is an important aspect influencing the effectiveness of cross-functional information sharing in an NPD setting. In the study, they considered various dimensions of communication and the influence on both the credibility and comprehensibility of information.

First, the study showed that the quality of the relationship between actors influences the effectiveness of interpersonal communication (Moenaert et al., 1995 and others check). The quality of the relationship is dependent on factors as trust, degree of interest, enthusiasm, support and participation between two actors. Second, the frequency of past interactions was found to positively influence the effectiveness of interpersonal communication when dealing with complex R&D information (Moenaert et al., 1996). Frequent past interactions did not only help to overcome technical communication barriers, but also helped to increase the perceived credibility of information. Moreover, the study also found a weak positive correlation between frequency of past interaction and perceived novelty and claim that this runs counter to the "strength of weak ties" theory of Granovetter (1973). We would, however, suggest that these results are specific to situations where actors belong to highly different knowledge domains and communication barriers play a large role. The importance of past interactions has also been advocated by Faraj and Sproull (2000) in literature on team performance, who have shown that teams share knowledge more effective when they had previous interpersonal interactions. Summing up, innovation studies go further than network studies by arguing that in a cross-functional relationship or team, strong ties are always preferred over weak ties.

Considering the inherent uncertainty, ambiguity of the FE process and the complexity and diversity of information that results from sparse and heterogeneous networks, we propose that strong ties are important throughout the entire FE. During initiation, strong ties are crucial, because new and complex knowledge from which ideas can be born is not discussed in brief 'coffee corner' discussions. During development, when rough ideas are put into a first draft, substantial help is required from others who, as research has shown, are much more likely to be of assistance when they are strongly tied to the person asking for assistance. Finally, during refinement of the idea, getting the organizational support to get ideas funded requires extensive discussions.

> *Hypothesis 3:* Strong ties during idea initiation, development and refinement increase the probability of proposal acceptance.

2.5 Network content

Much of the classic literature on networks has employed a 'structuralist' perspective, focusing on how the structure of social interaction generates certain benefits (Adler et al., 2002). More recently, there has been an increased attention for the content conveyed through ties. Consider Podolny and Baron's (1997) study on organizational mobility, in which they suggested that "perhaps it can be said that not all structural holes are of the same color". They suggested that whether ties spanning structural holes are beneficial depends on the content conveyed through those ties. They emphasized that ties that primarily serve as conduits of task-related information and resources as well as reflecting task interdependencies should span structural holes to move an individual up through the organizational ladder. However, ties, which primarily serve as a means of conveying role expectations and an organizational identity, should not span structural holes. Other examples of studies focusing on content rather than structure have considered the diversity of knowledge resulting from organizational membership (Cummings, 2004; Reagans et al., 2003; Reagans et al., 2001). See the illustration below as an example. Both networks have an identical network structure, but the content conveyed through the ties in network 1 is likely to be distinctly different than the content conveyed through the ties in network 2, because the organizational position of the people is different.

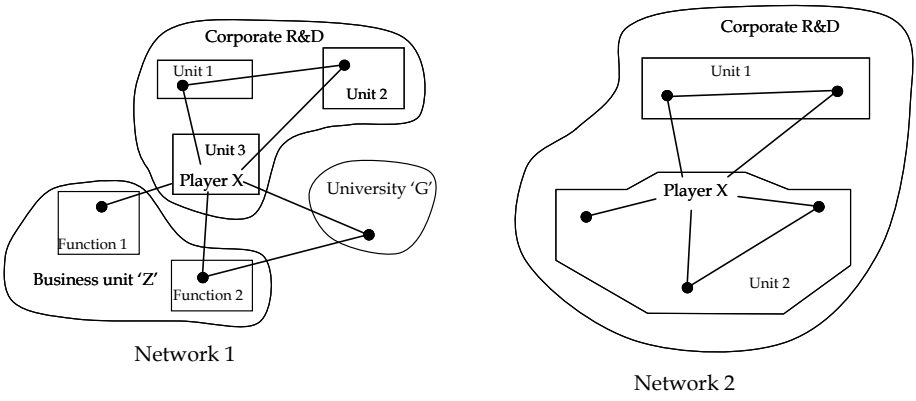

Figure 2.2 Network range

The illustration shows that occupying different positions across various units and functions can provide a network with diverse information. However, organizational positions can also facilitate coordinated action. Studies in NPD literature, from what Brown and Eisenhardt (1995) label the rational stream, focus on the support needed from senior managers. This support refers to the provision of resources to a project. The underlying reasoning is that this support facilitates the attraction of project members, funding and the required approval to go ahead. It is would therefore also seem important to consider the average seniority or degree to which decision-makers are involved in a network.

Concluding we would suggest that next to looking at the network structure it is important to consider how the organizational role and experience of actors influences the extent to which networks provide information benefits and a basis for coordinated action.

Range

In the density section above, the source of diverse information is assumed to result from the social structure of networks, namely low density. However, network studies have also looked at networks that span across organizational structures as a source of diversity. Burt (1983) initially used the term 'network range' very broadly to define an actor's network in terms of the number of contacts and the quality of contacts of which the last referred to both the structural non-redundancy as well as the institutional or organizational non-redundancy. Later, Burt (1992) used the term 'institutional holes' to specifically refer to ties that span across the bureaucratic structure of an organization. However, as Burt notes (1992, p. 149), he formulated a question that "was poorly designed for this study population" making the data "useless". More recent studies on knowledge sharing found more robust results and showed that network range improved both team productivity and ease of knowledge transfer (Cummings, 2004; Reagans et al., 2003; Reagans et al., 2001). This is supported by NPD literature that has stressed the importance of interdepartmental and interfunctional communication for over 20 years (Hoopes et al., 1999).

The sources of diversity considered in the knowledge management studies above not only looked at whether ties cut across organizational boundaries or geographic locations, but also whether they cut across "salient demographic categories" (Reagans et al., 2001). Other demographic categories that have been studied include difference in sex, age, hierarchical level and expertise. The effects of demographic differences on knowledge sharing have, however, mainly shown negative results (Cummings, 2004). According to Cummings (2004), these consistent negative effects are likely resulting from an emphasis of team members on social categories than on work-relevant information. He therefore focuses on work-related diversity, which he labels 'structural diversity', based on the assumption that the value of knowledge sharing is increased through exposure to unique sources of knowledge related to work. The downside of range is often underexposed in network literature relating to innovation and creativity at the individual level, unlike the network literature at the organizational level (Nooteboom, Vanhaverbeke, Duysters, Gilsing, & Van den Oord, 2005; Wuyts et al., 2005). Decision-making literature, on the other hand, has emphasized that although an increase in the range of perspectives is considered positive (Haleblian et al., 1993), it is also creates problems of coordination and control in decision-making (Seashore, 1977; Smith et al., 1994; Thomas et al., 1963).

Two sources of diversity are discussed in more detail below: functional membership and unit membership. First, a difference in functional assignment generally creates unique knowledge through differences in training and experience (Bunderson & Sutcliffe, 2002). Integration of perspectives from different disciplines has also been a much cited benefit in innovation literature (Wheelwright et al., 1992). Examples of functions include marketing, production, supply chain, R&D. Moreover, a functional diverse network also allows access to specialized social networks, which the actors from the various disciplines build up in their specific area of expertise. Second, networks can also span across units within disciplines. For instance, the mere indication that a network contains many R&D scientists still tells us little about the spread of those R&D scientists over the various specialties. A car manufacturer will for instance group their material specialists, their aerodynamic specialists, their electrical specialists, their internal combustion specialists and so on. It is clear that a network containing only material specialists is not

nearly as diverse as a network containing material, electrical and aerodynamic specialists. Moreover, working in different business units also enables actors to leverage unique knowledge, because task information or work practices in one unit may not be available in another (Cummings, 2004).

> *Hypothesis 4:* Networks of proposals of which the range decreases from the development to the refinement phase increase the probability of proposal acceptance.

Seniority and decision-maker involvement

Lastly, we discuss the role of average seniority and degree to which decision-makers are involved in the networks surrounding proposals. These organizational positions, especially decision-making power, come with formal organizational power, similar to the example of the US senate discussed earlier. Decision-makers have a direct effect on decisions through a vote regarding a specific proposal. More senior personnel can facilitate coordinated action more indirectly through influencing others in decision-making positions using the 'shorter' organizational lines that exist among senior personnel. This could work through persuasion with good arguments or through the use of 'bargaining chips' in the same way as senators who build up a set of obligations from other senators making it possible to use those obligations to get legislation passed. However, these organizational positions do not only facilitate coordinated action, but can also provide information benefits.

Research has suggested that senior personnel may be better at the encouragement of risk taking, identifying opportunities and making tradeoffs between market opportunities, technologies, competitors' strategies and resource constraints (Gupta, Raj, & Wilemon, 1986; Moenaert, Deschoolmeester, De Meyer, & Souder, 1992). Empirical results show that seniority contributes to the novelty of information during the initial phases of the NPD, the 'fuzzy front end' (Moenaert et al., 1996). This is supported by others (Roussel et al., 1991) who have highlighted that experience is most critical to reduce uncertainty during the front-end of NPD. Network studies have also highlighted that contacts in the

higher echelons of an organization receive more information through the formal reporting structures (Han, 1996). However, other studies from the rational innovation stream, highlighted earlier, focus on the support that is needed from senior managers as opposed to actual scientific or creative input (Brown et al., 1995). Some even suggest that high management involvement will be counterproductive in the initial phase (Benner & Tushman, 2003). On the other hand, even if the creative input were suboptimal, more senior people are at the very least better able to give input on the key strategic and market developments of the organization. This brings us to the following hypothesis:

> *Hypothesis 5*: Seniority in the networks of ideas throughout all three phases of the FE process will positively influence the probability of proposal acceptance.

Decision making power has a clear direct effect on proposal acceptance through their 'voting right'. This position can, however, also influence proposal acceptance in the initiation and development phase. As Kijkuit and Van den Ende (2007) argue, interaction with decision makers has an even more specific role, by giving the people working on the idea a sense of what fits within the organization and the decision makers themselves a sense of what is possible, based on the idea of sensemaking (Weick, 1995). The authors argue that this process of "reading and shaping" does not only serve as a means for people generating and developing proposals to assess the organizational fit, but can also influence the criteria or the way in which they are applied by the decision makers. This process may also decrease the NIH syndrome that might occur and could positively influence the attitude of key opinion makers and other decision makers, which is important, because gate reviews in NPD are often group decisions (Clark et al., 1993). This brings us to the following hypothesis:

> *Hypothesis 6*: Decision makers in the networks of ideas throughout all three phase of the FE process will positively influence the probability of proposal acceptance.

CHAPTER 3

Methodology: mapping small networks over time

3.1 Unit of analysis

As indicated earlier, this study attempts to understand how social networks play a role in the NPD process. More specifically, we are interested in how networks around proposals for new products are formed and evolve over time as they move from rough ideas to detailed project proposals. As noted, the unit of analysis is therefore the network around a proposal and not individual people. In particular, we focus on the front end of the NPD for two reasons. First, it is the phase of which managers and researchers claim that improvements are likely to far exceed those that result from improvements aimed at the design engineering process (Khurana et al., 1998). Second, the FE phase is intrinsically non-routine, dynamic and uncertain (Kim et al., 2002). The initial ideas may be born out of meetings, personal work of scientist or attending conferences and often miss a clear focus, fit with the organization and a customer. There is a lot of uncertainty and ambiguity surrounding the idea and the idea will need technical and market input before it can be turned into a project proposal. Moreover, the idea will also need support to get the required funding. All this work needs to be done without a formal structure and with little to no funding (Kim et al., 2002). In short, this setting seems an ideal context to explore how social action plays a role in the NPD context in general and the FE in particular.

3.2 Exploratory study

The ideal way to test hypotheses is through the use of archival or survey data. This type of data would allow researchers to collect a large number of observations on the independent and dependent variable after which averages can be calculated and the causal relations between variables can be tested for statistical significance. For the current study, this would require researchers to collect data on submitted project proposals. Assess their

eventual success, their initial value before the 'networking' started and the structure and content of the network around the proposals at various points in time. This creates several problems. First, there is the problem of retrospective bias. Since the outcome of the proposal is already known in the retrospective design described above, people, when surveyed or interviewed, might be less inclined to be associated with unsuccessful proposal and as a result understate their contribution or overstate their contribution if the proposal was successful. This is also referred to as the halo-effect (Pedhazur & Schmelkin, 1991). Furthermore, the same problem will occur when trying to assess the quality of the initial rough idea. Second, there is the problem of re-calling interaction. Respondents should not only recall their interaction with others on the specific proposal, but also the extent of the interaction and most importantly the timing. Lastly, there is the problem of a 'survivor bias' (Singelton & Straits, 2004), referring to an overrepresentation of successful proposals. Ideas that prove to be unfeasible early on, will never make it to an official management review and as a result will not be found in any official organizational records.

Consequently, we opted for a longitudinal on-site field study, which resulted in a 14 month study during which data was gathered on 18 proposals by conducting over 200 interviews. The on-site design enabled us to collect detailed, first-hand information on newly generated ideas, allowed us to asses the initial quality of ideas, if and how this changed during the process, who got involved at what stage of the process and the nature of the contributions. This data was gathered from multiple sources and included formal records and archival data allowing for triangulation of the network and attribute data. In reporting our findings, we have sought to combine the (seemingly) objective and easily comparable nature of quantitative figures with the richness of case-based research. Instead of relying only on descriptive stories of various network characteristics and using quotes from respondents as 'proof', we have used the more traditional quantitative measures form structural network analysis to support our claims. We thereby use a independent samples ANOVA and t-tests to test whether certain variables really differ between degrees of success, but more details on this later.

Clearly, this small sample, in-depth longitudinal research design has several limitations. To what extent can the data be used for hypotheses testing? And how can the results be generalized? As Gilsing and Nooteboom (2005) indicate, qualitative and in-depth research is not useful for hypothesis confirmation, but rather falsification and theory building. The richness of in-depth and longitudinal data provides room to construct new causal relations between different explanatory variables that were only considered separately and show the relevance of new variables.

3.3 Setting

The hypotheses were 'tested' at two central Research labs employing around 1200 R&D scientists of a large multinational in the fast-moving consumer goods industry. Our study focused on the foods division of this company. The labs were located in the UK and the Netherlands with around 2500 employees, 1100 of who were dedicated R&D scientists for the food industry. The development of new products in this company can roughly come from two sources, namely development centers dedicated to divisions/brands or from the central R&D labs. In general, the development centers focus on the more incremental improvements, whereas the central R&D labs focus on the development and application of new technologies that require more fundamental research.

The work in the central R&D labs is project-based. In an attempt to align the central R&D labs with the 'business' and make them more customer orientated, several initiatives were launched under the general label 'ideation'. One of these initiatives was a funnel management system in which it was possible for scientists to submit proposals for new projects. The proposals could be submitted at any time by anyone. Management wanted to provide their scientists with an opportunity to come up with 'out of the box' proposals, besides their regular ongoing project work, and provide a platform from which these proposals could be funded.

In order to boost the visibility of these 'ideation' initiatives, large information/brainstorm sessions were organized. These sessions were aimed at informing the R&D scientists of

new market developments in different divisions of the company, provide an opportunity to brainstorm on possible new products and inform the scientists on the funnel system and the way in which they could submit proposals. The first few sessions were organized on a monthly basis, but as the system become more visible, the sessions became less frequent. In total, five sessions were organized. The data collection for this study started after the third session, when the system was already running for over half a year. At first the last session was used as an initial source of ideas. People attending the session were contacted and asked if they were working on any ideas that they might want to submit in the future. These interviews were used to collect data and as a source of information on initiatives that were not directly related to the sessions.

The funnel used for this initiative was very similar to the funnel approach advocated by Clark and Wheelwright described earlier (1993). The proposals had to pass two gates to be granted funding. The majority of the work on the proposals was done before this first gate. There was no funding available for this work, which meant that scientists had to do this in their 'spare' time or as one scientist said: "I'll simply write my time for this idea on one of my other projects". Scientists would take between 3 to 10 months before submitting ideas for their first review. The main reason for differences in time was the amount of 'spare' time scientists had, to work on the proposals.

The first gate consisted of a review by a group of mid-level managers. This review was based on a brief 2-5 page proposal and a presentation or discussion. These reviews had three general outcomes: proposals were turned down immediately, suggestions were made for major revisions or suggestions were made for minor revisions. In the last two cases, proposals usually needed additional work to clarify technical hurdles and often buy-in from a sponsor. Proposals needing major revision would often still be turned down before being reviewed by management. This 'additional work' is conducted during, what we have labeled, the refinement phase. This last phase ends with the second and last gate consisting of a review by senior management.

3.4 Data

Access to the company was gained through the director of the main R&D lab employing around 1300 people of which 700 R&D scientists. The director placed me with a staff unit who was responsible for internal training of personnel with a main focus on project and creativity training. This unit was also involved in setting-up the 'creation' process. After signing a confidentiality agreement, stating that we would not disclose any specific details on proposals, we held several extensive discussions with the staff department head, various scientists, other department heads and the lab director to understand how the lab functioned.

Sample

From October 2003 until September 2004 we collected data on most proposals that came up during that period. The idea for a new proposal would come up, as noted, as a result of the information sessions, but also during regular work meetings or private work of scientists. The information sessions in combination with regular talks with department heads and staff members of the funnel system ensured that we could contact people shortly after they had started working on a particular initiative. In retrospect, this method proved crucial as it became clear that R&D scientists would often do a lot of 'work' on the proposals before submitting anything formally in the system. An important reason for this working method, as two R&D scientists explained, was that they were scared of being rejected before the idea was mature enough or before they could show that there was a business interest. The various sources initially provided me with data on 23 proposals. We eventually dropped 5 of those proposals from my sample, because the initiators did not have sufficient time to work on them.

Collection method

We used both archival and interview data. The interview data was collected through a semi-structured interview, which was based on the discussions with organizational members and was pre-tested on 10 respondents from various levels. We used two versions of the interview, one for people involved from the beginning and a second for people who got involved later on. Both interviews consisted of two parts. The more

extensive version started with open questions in which we asked for a description of the idea and the people who were involved with the generation. Both the extensive and the shorter version of the interview proceeded with a series of 5-point likert scale questions relating to the potential of the idea. The second part of the interview focused on the social interaction around an idea in which we asked respondents to list the names of the people both inside and outside of the lab with whom they had a substantial, two-way discussion on the idea. We would ask additional questions regarding the nature of the discussions, the prior relationship with the discussants and the intensity of the discussion. Archival data was used to assess the organizational location of contacts and their hierarchical level. Name interpreter questions were used for contacts outside the firm. This number was however limited, approximately 6% of the interaction was conducted with outside contacts.

The data collection regarding the networks was divided in two stages. In the first stage we mapped the initiation network and the initial further development of the idea into a proposal. The initiation network was based on those people involved in the initiation. These networks were quite small including around 3 people on average. All the people involved in the initiation we interviewed.

The second stage focused on the further development and, if appropriate, refinement of the proposal. The majority of the 'networking' was done during the development phase. The second stage interviews were scheduled two months after the initial interviews with the initiators if they had indicated that they were still actively involved. During these interviews we mapped the changes, if any, in the proposals and the people that were contacted. We would subsequently interview these 'contacts' if the initiators had discussed the proposal longer then 30 minutes with the person. We did not contact people with whom initiators had very brief discussions (less then 30 minutes), because the initial (test)interviews showed that (1) these 'contacts' were generally not interested to participate in an interview, (2) these 'contacts' did not contact additional people and (3) the initiators were not too keen that we would "bother" all their discussion partners. This does not mean that we did not map these '30-minute-or-less' discussions in the networks

(they were reported as low intensity discussions, see page 60-61 for details). The 'contact interviews' with '30-minute-plus' contacts were used to check the intensity, nature of the discussion and allowed us to assess whether these contacts themselves contacted additional people. We would again only contact this third group of people if the discussions lasted longer than 30 minutes. The second stage interviews would continue in the set-up described above until the proposal was either dismissed or granted funding. The overall response rate was around 95%. Respondents, besides those that contributed less than 30 minutes, only rarely reported that their contribution was so small that they did not feel it was necessary to interview them. In total, we held over 200 interviews to collect all the data. For the data on the proposal networks, we conducted 10 interviews on average per proposal. Lastly, it should be noted that the frequency of re-interviewing was usually dependent on the amount of time scientists spend on the proposal, but at the very least we would check-up by email once every two months.

Next to the data collection relating to the networks and the proposals, we interviewed 10 of the 18 middle line reviewers and two 'ideation' support staff people. These interviews focused on the decision making process in general and five proposals in specific. The main purpose of these interviews was to find out how proposals were introduced and discussed, the relation between middle liners and the proposal networks and details on the actual voting/review process. The 'decision-making' interviews started with the support staff people. These interviews were unstructured and focused on the overall process, specifically the way in which decisions were made. We, subsequently, selected five proposals that were, at the time of the interviews, recently reviewed by the middle line managers. In the interviews we asked the managers to indicate when they first heard of the proposals, if they knew who was involved in the process, what their relation was to that person or those people and finally if the idea was close to their personal expertise.

3.5 Variables

As we highlighted earlier, our data was collected through both open-ended and structured questions. The open-ended question's main purpose was to shed light on the causal

mechanisms behind the networks and the structured 'variables'. The main purpose of the structured questions was to provide us with quantitative indicators of various dimensions of the networks, allowing for a more 'rigid' comparison between networks. The indicators were, if possible, adopted from previous research. In the remaining cases, we designed indicators specifically for this study.

Dependent and independent variables

Success. In this study, we distinguish between three levels of success, namely low, medium and high. The level of success is dependent on the stage that is reached by a proposal. Low success entails that proposals were dismissed during the first review, because decision makers did not see sufficient potential in the proposal. Medium success entails that middle management saw some potential, allowing the proposal to pass the first gate, but that the proposal did not make it to or survive the final management team review. High success entails that the management team saw enough potential too grant (full) funding and turn the proposal into a project.

Phases. We defined the three phases in the FE process as follows. The initiation phase starts with the intention to write a project proposal on a specific subject. This intention could come up during a discussion between different people or be the result of the personal work of a scientist. The network in this phase thus consisted of the people that were involved in the initial discussion on a specific subject for a proposal or the person that had an idea to write a project proposal on a specific subject. The development phase was the phase in which the initial idea is discussed and specified further resulting in a first draft, which would be reviewed by the middle-line review team. This phase ended with the first middle-line review. The last phase, the refinement phase, started after the first middle-line review and ended with the management team review. The scientists working on the proposal that made it to this phase focused on working further on specific points that were pointed out by the middle-line review team.

Size. This basic indicator of network structure was calculated by counting the number of nodes (i.e. people) in a given network.

Size convergence. This measure is an extension of the basic measure of size, which accounts for the extent to which a network changes in size from one phase to the other. This measure is mainly intended to assess whether the size of networks indeed changes from the development to the refinement phase. The measure is calculated by dividing the size of the networks in the refinement phase by the size of the networks in the development phase. This measure ranges from 0 to ∞, where numbers approaching 0 are an indication of a high degree of convergence and numbers approaching ∞ signal the opposite.

Density. The classic operationalization of cohesion is density, which, as noted earlier, refers to the number of actual ties in a network divided by the maximum possible number of ties in a network. It does not account for the strength of ties. Moreover, as De Nooy et al. (2005) note, the measure is not useful when comparing networks of different size, because the measure is strongly depend on the number of nodes in a network. Consider the following two networks:

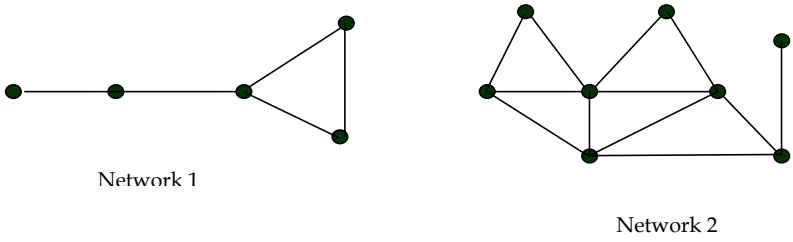

Figure 3.1 Network density using Burt's efficiency measure

The density according to the classic measure for 'network 1' is 0.50; whereas the density for 'network 2' is 0.46. This clearly does not reflect the intuitive idea that the actors in network 2 are much more interconnected than the actors in network 1. We therefore follow Reagans and McEvily (2003) and view network density as an indication of "strong third-party connections". To solve the comparison problem, we use a slightly adjusted version of Burt's (1992) "efficiency" measure designed for ego networks and used the average for each actor in a given network for density at the network level. With this measure one can assess the extent to which the contacts of person *i* are communicating

with each other and how strong this communication is relative to the direct communication between person *i* and his contacts. This measure, thus, also takes the strength of the relationships into account. This indicator fits with the intuitive idea that if person x is communicating with others on a proposal who themselves are also communicating with each other about the same proposal creates a much denser network, than if person x is the only one communicating with others. The measure is built up in the following way. First, we start with assessing the extent to which the contact *j* of person *i* is connected to any other contacts of person *i* (so-called 'third-party connections'), which we label *q*. For this we use:

$$\sum_q p_{iq} m_{jq}, \qquad q \neq i, j$$

where p_{iq} is the proportion of *i*'s network time invested in the relationship with *q* (interaction with *q* divided by the sum of *i*'s relations), and m_{jq} is the marginal strength of contact *j*'s relation with contact *q* (interaction with *q* divided by the strongest of *j*'s relationships with anyone). For more details see Burt on page 51-53 (1992). $\sum_q$ is added to account for all the third-party connections around the relation between person *i* and person *j*.

We then sum across all of *i*'s direct relations and divide this by the number of relations of person *i*. However, unlike Burt we do not use '1-x' in our formula, because we are interested in density or redundancy. Finally, we sum across all *i*'s (all actors) in the network and divide this by the number of *i*'s to arrive at the average density for a network. The formula is depicted below.

$$Density = \sum_i \left\{ \left[\sum_j \left(\sum_q p_{iq} m_{jq} \right) \right] / N_j \right\} / N_i, \qquad q \neq i, j,$$

The value for a network will vary from 0 indicating low density to 1 indicating high density. For the example networks 1 and 2, this formula would result in a score of 0.24 and 0.43 for network 1 and 2 respectively, which fits much more closely with the intuitive notion. We obtained the results for this study by taking one minus the expression from our calculations of the average 'efficiency' scores for a given network that were calculated using UciNet VI (Borgatti, Everett, & Freeman, 2002).

Range. This study uses two dimensions to create a proxy for the degree of content diversity of a network. This measure gives an indication of the amount of communication between units as a proportion of the total communication. The measure is similar for both dimensions and is calculated as follows for unit membership:

$$Div_u = \sum_i^j \left(t_{ij} \left(1 - u_{ij} \right) \right) \Big/ \sum_i^j t_{ij} \ ,$$

where t_{ij} is the strength of the relation between person i and person j, and u_{ij} indicates whether person i and person j are a member of the same unit. The value for u_{ij} is dichotomous, either 0 (different unit) or 1 (same unit). The measure of functional diversity is:

$$Div_f = \sum_i^j \left(t_{ij} \left(1 - f_{ij} \right) \right) \Big/ \sum_i^j t_{ij} \ ,$$

where t_{ij} is the strength of the relation between person i and person j, and f_{ij} indicates whether person i and person j are a member of the same functional area. The value for f_{ij} is dichotomous, either 0 (different function) or 1 (same function).

Seniority. For our indication of seniority, we used the personnel data from the company. The company used a hierarchical scale ranging from 1 to 6. Each employee belonged to one of the six levels. Entry level university graduates started at 1 whereas the board of directors of the entire company reached 6. Each of the 6 levels were subdivided further in sub salary groups, but we did not have data on these subgroups. The respondents in our study ranged from level 1 to 5 and the respondents from outside the company, which accounted for 3% of the actors, were not included in this calculation. The average seniority of each network was thus calculated by taking the average of the hierarchical level of the members in each network.

Decision-maker involvement. The measure was operationalized by assigning each member of a network a value of 1 if that person was a member of the middle-line review team or the management team and a value of 0 if he or she was not. The degree to which decision-makers are involved in a network was subsequently calculated by dividing the number of decision-makers in a given network by the total number of people in a given network.

Tie strength. Once respondents listed the persons with whom they had discussed the ideas, we asked the respondents to indicate the intensity of their relation prior to the initial discussion for a particular proposal and the intensity of the discussion related to the proposal. Moreover, we also asked respondents to corroborate the nature of the discussion.

The data on the relation dimension 'prior to the initial discussion' was gathered by a 4 point likert scale question, which focused on the frequency with which somebody spoke to a certain person. The options were: more than once a week, between once a week and once a month, less than once a month, no prior contact. Based on the pre-testing of our interview, we focused on the frequency of communication dimension of prior relations. In the initial version of the interview we included emotional closeness next to communication frequency as a dimension, but each respondent interpreted emotional closeness rather differently and preferred frequency, because it was considered a more tangible criteria. This restriction thus limits the applicability of the results to some extent, although Reagans and McEvily (2003) found that "individuals were emotionally close to contacts with whom they communicated more frequently" and that results for both dimensions "were substantively the same" (p. 254).

The data on the discussion intensity was open-ended. Based on the results we grouped them into four categories: discussions less than 30 minutes, discussions between 30 and 90 minutes, discussions between 90 and 180 minutes and discussions of more than 180 minutes.

There were two questions on the nature of the discussions. First, respondents were asked to describe the nature and the reason behind the discussion. Second, the respondents were asked to indicate which aspects of the scientific, organizational and business were covered during the discussions with a particular person.

Control variables

Idea potential. One of the key alternative explanations for any network effect is that differences in network characteristics are caused by the unit of analysis rather than affecting the unit of analysis. For this study the most obvious alternative explanation is that 'successful' proposals were simply more promising to begin with. The problem was that we could not consult middle-line reviewers or management team members, because this would severely influence the process. Moreover, respondents also clearly indicated that they did not want their ideas to be reviewed before "it was ready". Finally, outside reviews were not allowed by the company for reasons of confidentiality.

We therefore asked the respondents 7 indirect questions relating to the characteristic of the idea (see appendix A). The questions had to be answered on a 5 point likert scale and focused on projected market opportunities, technical feasibility, competitor protection and internal funding chances. We only took the responses from interviews conducted in the initial month after the generation. On average we had 7 respondents per proposal. We dropped one of the proposals from this sample, because this proposal was not discussed prior to submission. For the indicator of *idea potential* we took the average of the 7 questions per proposal.

Newness. A second alternative explanation is the newness of the proposal. Some ideas may simply have been considered too incremental or radical to be considered appropriate. We therefore also included a question in which we asked respondents to rank the idea from 1 to 6 based on a classification originally developed by Booz, Allen and Hamilton (1982), which has been used repeatedly in product development research (Griffin & Page, 1996b).

3.6 Analysis

Considering the exploratory nature and small overall sample size we opted for independent samples t-tests. The tests were originally designed for experimental research and were used to make a comparison on a 'per condition' basis (Field, 2000). In our study the t-tests will be used to make a comparison on a 'per success' basis. Unlike a dependent

t-test, where the differences in pairs of scores are taken, we look at the difference in the overall means of two samples. So for example, we look at the difference in density between low and medium success networks. The 'samples' for each level of success in our study vary in size. We, therefore, took the pooled variance estimate t-test, which accounts for the difference in 'sample' size by weighting the variance of each sample (Field, 2000). Moreover, we corrected, where relevant, for the homogeneity of variances by performing Levene's test for equality of variances (Field, 2000).

In addition to the independent t-tests, we preformed a series of one-way ANOVA tests to test whether the means for the three success categories were significantly different where possible. An ANOVA test is an extension of the t-test that allows for a comparison across more than two outcome categories. Henceforth, we could not perform the ANOVA tests for the comparison in the refinement phase, because there were only two remaining outcome categories. Finally, we again corrected, where relevant, for the homogeneity of variances by performing the Levene's test and if necessary took the Welch F-ratio (Field, 2000).

CHAPTER 4

Network level results

4.1 Introduction

In this section we will present the network level results from our study. Before starting with the results on network structure and content, we present descriptive statistics and data regarding (ruling out) key alternative explanations that could explain differences in the characteristics of the networks.

After the initial introduction, we discuss the actual results starting with a brief summary of the relevant hypotheses. The data is presented in a table format in which we distinguish between the three phases identified earlier; initiation, development and refinement and three levels of success; low, medium, high. The results are combined with a reflection to existing literature and the qualitative findings. This main section is followed by a discussion of an interesting outlier. The chapter concludes with a discussion in which we combine the structure and content findings and the significance of the findings to existing literature.

4.2 Descriptive data

As we noted earlier, the data presented here covers 18 proposals. Five of these proposals were highly successful, which, as we noted in the methodology section, entails that they passed the second gate and were funded. Of the remaining proposals, five were labeled as medium successful, entailing that they passed the first gate, but not the second. The other eight proposals were labeled as low successful entailing that there was no interest from management and were, as such, dismissed at the first gate. An overview of the stage gate system employed by the focal firm and the extent to which low, medium and high success proposals made it through this system is provided below.

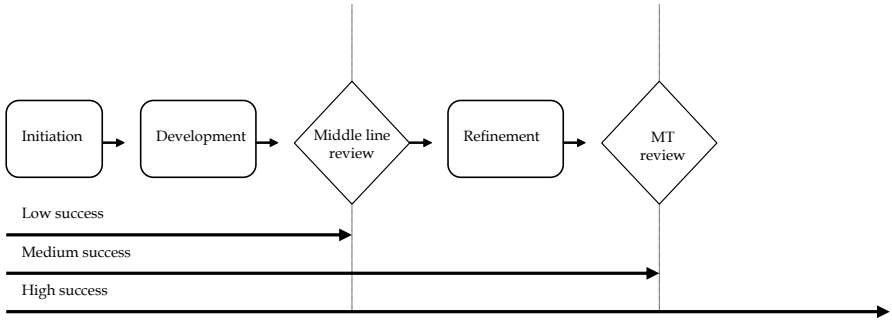

Figure 4.1 Front End Stage/Gate model

Initiation phase

The networks during the initiation phase, such as we defined earlier, show the people that were involved in the initial discussion of the idea to write a proposal on a given opportunity. These discussions often occurred during interdepartmental meetings, brainstorm sessions, personal work of scientist or attending conferences. To ensure that we took the right 'snapshot', we asked for detailed description of the idea and triangulated the data by asking different respondents. The detailed description guaranteed that when other respondents were interviewed, we were talking about the same proposal. If the triangulation led to conflicting stories we would confront the respondents, which solved most of the problems. In the remaining cases we took the majority view.

In our definition we specifically use the words: 'people that were involved in the initial discussion' and 'opportunity', based on our pre-test and initial data collection. The main reason was that during these discussions, it became clear that ideas and thus proposals often built on or are linked to existing ideas or projects and are rarely the product of a single person. The link with previous projects sometimes caused confusion when we approached respondents for an interview. Remarks such as "that is not only their idea, people in … have been working on related projects" were not uncommon. The initiation phase in this study thus refers to the intention to write a proposal on a given opportunity. The word intention is chosen deliberately, because it is not our intention to contribute here to the discussion on when an idea may be considered 'new'. Our findings also fit

with the remark made by Van de Ven (1986) that "a new idea, which may be a recombination of old ideas, a scheme that challenges the present order … or a unique approach which is perceived as new by the individuals involved".

Development phase

The development phase is the phase in which the initial idea is specified further resulting in a first draft. This is the phase during which social action is most prominent. In all but one of our cases the networks around a proposal included more than one person. On average, the networks consisted of over 14 people. This phase ends with, what Clark and Wheelwright (1993) label, a middle-line review. In our research context, these reviews were more of a readiness review than a formal go/no-go decision. However, this review was used to filter out the 'worst' proposals. Criteria included a check for overall company fit, general market potential and appropriateness of the proposal given the lab's speciality (lab fit).

Refinement phase

The refinement phase starts after the middle-line review. Seven proposals were rejected by the middle-line reviewers. These proposals were the low success proposals and you will therefore no longer find figures on these networks. The proposals that did make it through to the refinement phase focus on further detailing and supplementing the project proposal based on the 'mid-level reviews'. This included more accurate estimates of required resources, a more detailed plan of the technical approach and risks, and a more detailed plan of how the proposal would fit within the company and the existing project portfolio. This final phase officially ends with a senior management review. However, it was not uncommon for proposals to be turned down in a more informal manner, especially when during refinement it turned out that the proposal could not be sufficiently matched with an internal client/customer. In that case, people working on the proposals would often realize and be advised that the proposal had little chance. This was usually enough to trigger the people drop the proposals, because working on proposals was time consuming and not funded. As one respondent stated: "I'm not going to keep on working

on this proposal if the chances are so small, since I'm already booked in on other projects for over 120% of my time".

Data presentation

As we noted earlier, we held over 200 interviews to collect all the data. The majority of the people involved in the networks came from the two main research labs (72%). An additional 22% came from outside the two main research labs, but within the focal company. Only 6% of the people in the networks worked outside of the focal company. This low percentage of outsiders is not surprising given the confidential nature of the proposals.

An overview of the means for the different variables is presented below. The first table covers the data concerning the network structure and is split-up into three main rows, one for each phase. It is important to note that the exact contribution of each person was difficult to determine during the initiation phase. If we asked respondents to clarify how much each person contributed to the initial idea, they most often stated that it was not possible to determine who exactly contributed how much to the idea. The respondents repeatedly said that it was the result of "a combination of remarks by me and the others". As such, we can not report on the 'current intensity' dimension of tie strength. This also entails that we cannot calculate the density or the diversity of 'initiation networks'.

Table 4.1 Descriptive statistics on the network structure

Phase	Variables	N	Mean (std dev)
Initiation	Size	18	2.83 (0.99)
	Density	-	-
	Current intensity	-	-
	Past intensity	16	2.29 (0.95)
Development	Size	18	13.50 (8.75)
	Density	17	0.13 (0.11)
	Current intensity	17	1.74 (0.21)
	Past intensity	17	2.96 (0.56)
Refinement	Size	10	8.70 (3.80)
	Density	10	0.29 (0.12)
	Current intensity	10	1.72 (0.29)
	Past intensity	10	3.00 (0.43)

The second table covers the data concerning the network content.

Table 4.2 Descriptive statistics on the network content			
Phase	Variables	N	Mean (std dev)
Initiation	Unit range	-	-
	Functional range	-	-
	Seniority	18	2.10 (0.74)
	Decision-making involvement	18	0.17 (0.23)
Development	Unit range	17	0.61 (0.27)
	Functional range	17	0.15 (0.16)
	Seniority	18	2.09 (0.40)
	Decision-making involvement	18	0.09 (0.08)
Refinement	Unit range	10	0.62 (0.21)
	Functional range	10	0.19 (0.19)
	Seniority	10	2.29 (0.42)
	Decision-making involvement	10	0.22 (0.17)

Illustrative example

To illustrate the numbers above and the way in which we collected the data, we will discuss the network dynamics of one of the proposals from our data. Since the technological details of the proposal are confidential, we will focus on the network characteristics and use fictive names.

The proposal that we will discuss in more detail passed gate 1, but failed at gate 2. The proposal or the intention to write a proposal started during discussions between a junior scientist (Jim) and a senior scientist and department head (Nigel) on possible extensions of a recently funded proposal. Jim was not a direct subordinate of Nigel, but they knew each other from the introduction talks of Jim when he joined the lab a few months earlier. The extension focused on a major business opportunity, a so-called ‘holy grail’ within the company and industry, which might be met through the development of an experimental new type of technology. Nigel was aware that several more development orientated groups within the divisions had been working on this ‘holy grail’ for some years. As a result, Nigel contacted a few of these product developers to get their input and support. In the mean time, Jim talked with his department head who thought that this

proposal could be worked out further by a scientist (Mary) who had recently been transferred from another research lab. Because Mary was not directly familiar with the technology, she had extensive talks with Jim and conducted a literature survey. She was also just transferred from the location where most of the development orientated groups had worked on this 'holy grail' and as a result contacted these people. These discussions were always brief around 15-30 minutes and lasted 1-3 times. After some time Mary also contacted local senior scientists and business development managers. During this 'information gathering' period, Nigel had played a more background role focusing on local senior scientists. Jim was fairly actively involved throughout the information gathering process, but not in terms of 'networking'. By now, Mary had written a proposal, which had been discussed and presented before the middle line reviewers. The middle line team was enthusiastic, but did have some suggestions for improvement. After this presentation, Mary improved the proposal with the help of Jim, a business development manager and a few senior scientists and presented it before the management team. The MT thought that the risk of success was too big. They advised Mary to wait until more experimental results were known and possibly rewrite a proposal if this was appropriate in the future.

We were made aware of the work on the proposal during an other interview with Jim's and Mary's department head. The first points at which we collected data on this proposal was two months after the idea for the proposal was first discussed and one month after Mary had started working on the proposal. The initial interviews were with Jim and Mary. The subsequent 'contact' interviews (within two month) were with Nigel, Jim and Mary's department head, two developers at the UK site and a senior business developer at the Dutch site. After three months, the proposal was presented at the middle-line review and we re-interviewed Mary, Jim and Nigel and held 'contact' interviews with two additional senior scientists/department heads. After two months we emailed Mary and based on her suggestion scheduled a re-interview one month later (three months after the second interview with Mary) after the MT review. The re-interview was conducted with Mary alone at what point we learned that the proposal was turned down by the MT.

The example clearly shows the strong social dimension behind the development of proposals for new product development projects as suggested by Van de Ven (1986). However, the example also points to possible alternative explanations. Does the, for instance, newness of proposals play an important role? And what about the initial potential of a proposal? Is it not the case that more successful proposals affect the network, instead of the network affecting the proposal? We would, therefore, like to discuss three alternative explanations, namely initial potential, newness and decision-making process, and show that these factors, at least in our context, had no noteworthy influence.

4.3 Ruling out alternative explanations

Introduction

An important question in the social sciences in general and this study in specific is the question of causality. Is the idea or proposal affecting the network and thereby influencing the success or is the network affecting the idea or proposal and thereby the success? Does the, for instance, newness of proposals play an important role or the initial potential of a proposal? Is it not the case that more successful proposals affect the network, instead of the network affecting the proposal? We will be the last to claim that the network around a proposal is the sole determining factor of success. However, we would like to discuss three alternative explanations, namely initial potential, newness and decision-making process, and show that these factors, at least in our context, had no noteworthy influence.

Idea potential

Some critics may argue that success in this study is not the result of a particular kind of network, but rather the cause. The reasoning is that good ideas lead to big networks. Although reasonable, we have two arguments that refute this explanation. First, if more successful ideas would indeed be the result of more promising ideas to begin with then this would explain the difference in size, frequency of contact, seniority and decision maker involvement. However, this explanation does not explain why the ‘past intensity’

dimension of tie strength is high for both low and high success proposals, as we will show later on.

A second argument that refutes this alternative explanation is the data gathered on the potential of the initial ideas. If more successful ideas were indeed to start-out more promising than we expected to find, there would be significant differences between the potential of low, medium and highly successful ideas. The results are depicted in table 4.3 below.

Table 4.3 Idea potential [a,b,c]

Success	N	Low	N	Medium	N	High
Variables		Mean (std dev)		Mean (std dev)		Mean (std dev)
Overall potential	7	4.55 (0.24) [#]	5	4.49 (0.51)	5	4.78 (0.33) [#]

[a] The significance signs next to the label of the variable indicate the overall level of significance. We distinguish between the following three levels of significance: [°]sig. < 0,10 ; [°°]sig. < 0,05 ; [°°°]sig. < 0,01.

[b] The significance of the differences is calculated for all three pairs, 1 & 2, 1 & 3 and 2 & 3. If the differences are significant, this is indicated as follows:

For differences between group 1 & 2	For differences between group 1 & 3	For differences between group 2 and 3
- [*]sig. (one-tailed) < 0.10	- [#]sig. (one-tailed) < 0.10	- [†]sig. (one-tailed) < 0.10
- [**]sig. (one-tailed) < 0.05	- [##]sig. (one-tailed) < 0.05	- [††]sig. (one-tailed) < 0.05
- [***]sig. (one-tailed) < 0.01	- [###]sig. (one-tailed) < 0.01	- [†††]sig. (one-tailed) < 0.01

[c] The figures for low successful proposals are based on 7 cases, because one proposal only involved one person who did not discuss his or her idea with anybody.

The difference in overall potential between the three levels of success is not significant ($F(2, 14) = 0.95$, $p = 0.41$). The independent t-tests show that although slightly higher for highly successful ideas, the results are only significantly different between low and high success proposals at a 10% confidence interval level. The t-test results show no significant difference between low and medium success and between medium and high success.

Levels of newness

A second alternative explanation could be the newness of the proposal. Some ideas may simply be considered too incremental or radical to be considered appropriate. Research has, for instance, shown that getting support for radical innovation projects is often difficult in large firms, where internal cultures and pressures often encourage people to

pursue more low risk, immediate reward, incremental innovation projects (Dougherty et al., 1996).

If there were indeed a preference for more incremental or more radical proposals, then we would expect to find significant differences between the levels of newness of the proposals. The results are depicted in table 4.4 below.

Table 4.4 Idea newness [a,b,c,d]

Success	N	Low	N	Medium	N	High
Variables		Mean (std dev)		Mean (std dev)		Mean (std dev)
Newness	7	4.59 (0.74)	5	4.43 (0.45)	5	4.32 (0.77)

[a] The significance signs next to the label of the variable indicate the overall level of significance. We distinguish between the following three levels of significance: °sig. < 0,10 ; °° sig. < 0,05 ; °°° sig. < 0,01.

[b] The significance of the differences is calculated for all three pairs, 1 & 2, 1 & 3 and 2 & 3. If the differences are significant, this is indicated as follows:

For differences between group 1 & 2
- *sig. (one-tailed) < 0.10
- **sig. (one-tailed) < 0.05
- ***sig. (one-tailed) < 0.01

For differences between group 1 & 3
- #sig. (one-tailed) < 0.10
- ##sig. (one-tailed) < 0.05
- ###sig. (one-tailed) < 0.01

For differences between group 2 and 3
- †sig. (one-tailed) < 0.10
- ††sig. (one-tailed) < 0.05
- †††sig. (one-tailed) < 0.01

[c] The figures for low successful proposals are based on 7 cases, because one proposal only involved one person who did not discuss his or her idea with anybody.

[d] The newness of each proposal was based on the average of the answers to the 'Booz, Allen and Hamilton question' per network in which we used the ordinal scale as depicted in appendix A. We also considered the average newness using a different order in which we assumed that a repositioning is more difficult for a firm to undertake than a addition or improvement. The results of this t-test also showed that there was no significant difference between the different levels of success (see appendix B for the results)

The difference in newness between the three levels of success is not significant ($F(2, 14) = 0.24$, $p = 0.79$). Moreover, the t-test results show no significant differences between the different categories.

Decision-making process

The third and final alternative explanation we considered is the way in which decisions were made regarding the proposals. To account for this alternative explanation, we interviewed 10 of the 18 middle line reviewers and two 'ideation' support staff people. These interviews focused on the decision making process in general and five proposals in specific. The purpose of the interviews was to find out how proposals were introduced and discussed, the relation between middle liners and the proposal networks and details on the actual review process.

The ‘decision-making’ interviews started with the support staff people. These interviews were unstructured and focused on the overall process. From these interviews it became clear that proposals ‘entered’ the formal review process when submitted through the intranet site supporting the ‘ideation’ process. These submissions outlined the general idea, consumer benefit, competitor advantage and required technological capability. These submissions would subsequently be discussed during ‘middle line review team’ meetings. The voting for proposals in this process was initially based on the average scores of a proposal on a set of fixed criteria. However, the middle line team quickly abandoned this approach, because it was considered too rigid. Instead, middle liners would simply vote yes or no. If a proposal was considered promising, it was followed by either a presentation for the entire review team or a discussion between the submitter and one or more middle liners aimed at further improving the proposal.

Based on this overview, we selected five proposals that were, at the time of the interviews, recently reviewed by the middle line managers. In the interviews we asked the managers to indicate when they first heard of the proposals and if they knew who was involved in the process. Moreover, we asked what their relation was to that person or those people and if the idea was close to their personal expertise.

The interviews showed no prior lobbying, little awareness of the ‘proposal network’ and a high level of consensus. First, ‘no prior lobbying’ refers to the fact that most middle liners did not become aware of proposals until they were discussed during a review meeting. Reviewers were only aware of proposals prior to meetings if the submitters were subordinates of them. Second, middle liners hardly knew who was exactly involved in the proposals. Middle liners were only capable of recollecting who were involved in the proposals for 72 % of the reviews. One middle line reviewer even admitted: “I didn’t know who submitted that proposal until I looked through the submission details, when you mailed me for this interview”. More interesting, reviewers were only capable of listing more than one name for 39% of the reviews. Finally, the reviewers were highly unanimous in their reviews of the proposals regardless of their personal interest or

expertise. The assessment of a proposal by a reviewer did not vary with his or her degree of interest or expertise for a given proposal.

These interviews show little reason to assume that personal interest, lobbying or status of a 'proposal network' played a significant role in the decision-making process. A possible explanation for the lack of 'political networking', which was found to be important in other studies (Eisenhardt & Bourgeois III, 1988), is the small nature of the proposals. These projects did not required major multimillion dollar investments or result in dramatic strategic redirections.

4.4 Network structure

Hypotheses

In the theoretical section on network structure, we distinguished between network level and dyadic level characteristics. The network level characteristics we discussed were size and density. In the hypothesis relating to size, we proposed that a proposal would benefit if the network of people working on a proposal would start out large, especially during the development phase, but diminish in size during the refinement phase (hypothesis 1). In the hypotheses relating to density, we proposed that a proposal would benefit if the network of people working on a proposal would move from a sparse (low density) to a dense structure (hypotheses 2a and b). For the dyadic level, we discussed two dimensions of tie strength, namely past intensity and current intensity. In the hypothesis on tie strength we proposed that both of these dimensions should be strong throughout the process (hypothesis 3).

Overall network results

The results for the network structure are depicted in the table below, where the columns represent the different levels of success and the rows represent the different phases. As we noted earlier, the low success proposals never pass the first gate. The bottom left box of the 3×3 table therefore does not contain values. As we noted above, the exact contribution of each person was difficult to determine during the initiation phase, we can

therefore not report current intensity or density of 'initiation networks'. We can, however, report on the 'past intensity' dimension of tie strength.

Table 4.5 Overall network structure [a,b,c]

Success		N	Low	N	Medium	N	High
Phase	Variables		Mean (std dev)		Mean (std dev)		Mean (std dev)
Initiation	Size$^{\circ\circ}$	8	2.63 (0.52) $^{\#\#\#}$	5	2.40 (1.52) †	5	3.60 (0.55) $^{\#\#\#,\dagger}$
	Density	-	-	-	-	-	-
	Current intensity	-	-	-	-	-	-
	Past intensity$^{\circ\circ}$	8	1.81 (0.84) $^{\#\#\#}$	3	2.06 (1.05) ††	5	3.18 (0.29) $^{\#\#\#,\dagger\dagger}$
Development	Size$^{\circ\circ\circ}$	8	6.75 (4.13) $^{***,\#\#\#}$	5	14.80 (2.86) ***,††	5	23.00 (9.00) $^{\#\#\#,\dagger\dagger}$
	Density$^{\circ\circ}$	7	0.06 (0.11) $^{***,\#\#}$	5	0.22 (0.07) ***,†	5	0.15 (0.07) $^{\#\#,\dagger}$
	Current intensity$^{\circ}$	7	1.69 (0.17) $^{\#\#}$	5	1.67 (0.31)	5	1.88 (0.10) $^{\#\#}$
	Past intensity$^{\circ}$	7	3.20 (0.52) **	5	2.42 (0.60) **,††	5	3.14 (0.12) ††
Refinement	Size	-	-	5	8.00 (3.56)	5	9.40 (4.34)
	Density	-	-	5	0.20 (0.10) †††	5	0.38 (0.03) †††
	Current intensity	-	-	5	1.64 (0.30)	5	1.80 (0.29)
	Past intensity	-	-	5	2.87 (0.46)	5	3.13 (0.41)

[a] The significance signs next to the label of the variable indicate the overall level of significance. We distinguish between the following three levels of significance: $^{\circ}$sig. < 0,10 ; $^{\circ\circ}$sig. < 0,05 ; $^{\circ\circ\circ}$sig. < 0,01.

[b] The significance of the differences is calculated for all three pairs, 1 & 2, 1 & 3 and 2 & 3. If the differences are significant, this is indicated as follows:

For differences between group 1 & 2
- *sig. (one-tailed) < 0.10
- ** sig. (one-tailed) < 0.05
- *** sig. (one-tailed) < 0.01

For differences between group 1 & 3
- $^{\#}$ sig. (one-tailed) < 0.10
- $^{\#\#}$ sig. (one-tailed) < 0.05
- $^{\#\#\#}$ sig. (one-tailed) < 0.01

For differences between group 2 and 3
- † sig. (one-tailed) < 0.10
- †† sig. (one-tailed) < 0.05
- ††† sig. (one-tailed) < 0.01

[c] The figures on density, current intensity and past intensity for low successful proposals are based on 7 cases, because one proposal involved one person who did not discuss his or her idea with anybody, the figure on past intensity for medium successful proposals is based on 3 cases, because two proposals were generated by one person.

Network size

The results for the 'initiation networks' from both the descriptive and the network structure table support the notion that 'idea initiation' has a strong social dimension. Table 4.1 in the descriptive section shows that all proposals regardless of their degree of success are on average initiated by 2.8 people. Looking at table 4.1 on the average size between the three levels of success, still confirms this picture. As we highlighted earlier, when respondents were asked: who generated the idea? We only encountered 2 out of 18 cases in which people cited themselves or only one person. In all other cases, people cited more than one person. Even if we asked respondents to single out one person, they most often refused and stated that it was impossible to determine who exactly came up with the idea, but that it was the result of "a combination of remarks by me and the others".

The ANOVA revealed that the difference in size between the three levels of success for the initiation phase was statistical significant ($F(2, 7) = 4.98$, $p = 0.04$). Moreover, the t-test results showed that the average size of the networks is nearly identical for low and medium successful proposals. However, the difference in size between high success proposals and low success proposals is strongly significant and the difference between high and medium success proposals is marginally significant at 10%. From the initiation to the development phase, we see a substantial overall increase in the number of people involved for all proposals. Looking at the ANOVA results for the difference between the three levels of success shows a strong significant effect of size ($F(2, 15) = 12.98$, $p < 0.00$). Moreover, the t-test results showed that low success proposal networks are clearly much smaller than medium and highly successful proposals. The difference between medium and highly successful proposals is also big and significant at the 5% interval level. From the development to the refinement phase, we see a substantial overall decrease in the number of people involved for both medium and high success proposals, but the results for the refinement phase do not show significant differences in size , which would suggest that the hypothesis is not supported for the refinement phase. However, we would argue that it is not the size itself that matters, but rather the degree of convergence. After all, a more elaborate proposal which builds on more diverse insights will still require more input than a more basic proposal. As a result, we used the very basic indication of convergence in size, explained in the methodology section. As a reminder, this measure ranges from 0 to ∞, where numbers approaching 0 are an indication of a high degree of convergence and numbers approaching ∞ signal the opposite. The results are depicted below.

Table 4.6 Network convergence from the development to the refinement phase [a]						
Success	N	Low	N	Medium	N	High
Variables		Mean (std dev)		Mean (std dev)		Mean (std dev)
Size convergence	-	-	5	0.53 (0.17) †	5	0.40 (0.11) †

[a] The significance of the differences is calculated for all three pairs, 1 & 2, 1 & 3 and 2 & 3. If the differences are significant, this is indicated as follows:

For differences between group 1 & 2
- * sig. (one-tailed) < 0.10
- ** sig. (one-tailed) < 0.05
- *** sig. (one-tailed) < 0.01

For differences between group 1 & 3
- # sig. (one-tailed) < 0.10
- ## sig. (one-tailed) < 0.05
- ### sig. (one-tailed) < 0.01

For differences between group 2 and 3
- † sig. (one-tailed) < 0.10
- †† sig. (one-tailed) < 0.05
- ††† sig. (one-tailed) < 0.01

We see here that the high success networks convergence stronger, but the difference is only significant at the 10% interval level. In short, the results support hypothesis 1a and partly support hypothesis 1b. The results confirm that larger networks in the initiation and development phase contribute to success. Moreover, the results show that 'network convergence' occurs. However, we only find marginal support that the degree of convergence from the development to the refinement phase contributes to success.

Density

A more detailed picture of the overall network structure is provided by the figures on density. As noted above, there is no data regarding the density during the initiation phase, only for the development and refinement phase.

The ANOVA result shows that the overall difference in density between the three levels of success is significant ($F(2, 14) = 5.07$, $p = 0.02$). Moreover, the t-test results show that there is a highly statistical significant difference between low success proposals and medium and high success proposals and a limited significant difference between medium and high success proposals. Looking at the numbers essentially shows an inverted U-shaped relation between success and the appropriate levels of density during idea development as shown in the figure below.

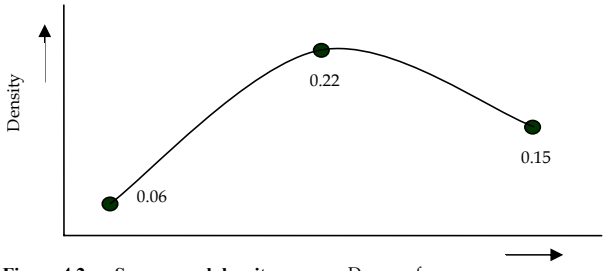

Figure 4.2 Success and density

The low successful networks are characterized by substantially lower levels of interaction among people relative to the medium and high success networks. The medium successful networks on the other hand are characterized by relatively high levels of mutual interaction. Finally, the average density of highly successful networks holds the middle ground.

The transition from the development to the refinement phase shows a slight decrease in density for medium success network, whereas high success network are characterized by a substantial increase of density. Moreover, the difference in the overall density between medium and high success networks is highly significant at the 1% interval level.

In short, the results do not provide support for hypothesis 2a stating that low density in the development phase contributes to success. Instead, the results show that a moderate degree of density during the development phase contributes to success. Furthermore, the results do provide support for hypothesis 2b stating that high density in the refinement phase contributes to success.

Tie strength

For the dyadic level, we considered two dimensions of tie strength, namely current intensity and past intensity. The results from the descriptive table show that the total intensity of interaction per relationship was around 50 minutes. In the interviews we asked the respondents to elaborate on the process. This revealed that these discussions were always brief around 15-30 minutes and took place 2 or 3 times. The discussions

were also always focused on personal know-how and were rarely supplemented by written documents or reports.

As we noted earlier, only one dimension of tie strength can be measured for the initiation phase, namely 'past intensity'. The ANOVA result for the overall difference in past intensity between the three levels of success is significant ($F(2, 13) = 2{,}98$, $p = 0{,}024$). Moreover, the t-test results show a clear significant difference between the past intensity of ties in the low and medium successful networks and highly successful networks. For the results of the development phase on 'past intensity', we see a limited statistically significant overall difference ($F(2, 7) = 3.25$, $p = 0.10$). However, the t-test results are stronger and counterintuitive. Both low and high success networks rely much more on 'close' colleagues, whereas the medium success networks rely on 'more distant' colleagues. 'Close' and 'more distant' refer here to the intensity of past interactions between two actors. The ANOVA result on current intensity also shows a limited statistically significant overall difference ($F(2, 8) = 3.06$, $p = 0.10$). The only significant difference found with the t-tests is between low and high success networks. However, the significance is small. Finally, the t-test results on both 'current intensity' and 'past intensity' in the refinement phase show no significant differences.

In short, the results provide mixed support for hypothesis 3. The results show that past intensity has a significant positive effect in the initiation phase, a mixed effect in the development phase (both low and high success networks were high) and no effect in the refinement phase. Moreover, current intensity has been found to have a positive effect during the development phase and no effect in the refinement phase.

4.5 Network content

Hypotheses

In the theoretical section on network content, we distinguished between network range, seniority and decision-making involvement. In the hypothesis relating to range (hypothesis 4), we proposed that a proposal would benefit from a network of people that

initially spans across many different units and functions, but diminishes in breath during the refinement phase. In the hypotheses relating to seniority and decision-making involvement (hypotheses 5 and 6), we proposed that a proposal would benefit if the network of people working on a proposal would either include senior people and decision makers in the initiation and development or in the refinement phase.

Overall network results

The results for the network content for all three phases and all three levels of success are depicted below. It is again important to note that since the exact contribution of each person was difficult to determine during the initiation phase, we cannot calculate the range, because this requires the 'current intensity' dimension of tie strength. We can, however, report on the composition of these networks in table below.

Table 4.7 Overall network content [a,b,c]

Success		N	Low	N	Medium	N	High
Phase	Variables		Mean (std dev)		Mean (std dev)		Mean (std dev)
Initiation	Unit range	-	-	-	-	-	-
	Functional range	-	-	-	-	-	-
	Seniority	8	1.98 (0.88) $^{\#}$	5	1.80 (0.54) ††	5	2.60 (0.47) $^{\#,\dagger\dagger}$
	Decision-making involvement $^{\circ}$	8	0.06 (0.18) $^{\#\#}$	5	0.15 (0.22)	5	0.35 (0.25) $^{\#\#}$
Development	Unit range $^{\circ}$	7	0.43 (0.25)	5	0.75 (0.17)	5	0.70 (0.26)
	Functional range	7	$^{**,\#}$	5	**	5	$^{\#}$
	Seniority	8	0.07 (0.16) *	5	0.25 (0.18) *	5	0.17 (0.10)
	Decision-making involvement	8	1.95 (0.49)	5	2.13 (0.23)	5	2.27 (0.36)
			0.07 (0.09)	5	0.10 (0.11)	5	0.11 (0.04)
Refinement	Unit range	-	-	5	0.59 (0.21)	5	0.65 (0.22)
	Functional range	-	-	5	0.21 (0.19)	5	0.16 (0.21)
	Seniority	-	-	5	2.21 (0.33)	5	2.37 (0.52)
	Decision-making involvement	-	-	5	0.16 (0.16)	5	0.28 (0.17)

[a] The significance signs next to the label of the variable indicate the overall level of significance. We distinguish between the following three levels of significance: $^{\circ}$sig. < 0,10 ; $^{\infty}$ sig. < 0,05 ; $^{\infty\infty}$ sig. < 0,01.

[b] The significance of the differences is calculated for all three pairs, 1 & 2, 1 & 3 and 2 & 3. If the differences are significant, this is indicated as follows:

For differences between group 1 & 2	For differences between group 1 & 3	For differences between group 2 and 3
- *sig. (one-tailed) < 0.10	- $^{\#}$ sig. (one-tailed) < 0.10	- † sig. (one-tailed) < 0.10
- ** sig. (one-tailed) < 0.05	- $^{\#\#}$ sig. (one-tailed) < 0.05	- †† sig. (one-tailed) < 0.05
- *** sig. (one-tailed) < 0.01	- $^{\#\#\#}$ sig. (one-tailed) < 0.01	- ††† sig. (one-tailed) < 0.01

[c] The figures on unit range and functional range for low successful proposals are based on 7 cases, because one proposal involved one person who did not discuss his or her idea with anybody.

Range

The overall difference of unit range between the three levels of success for the development phase is limitedly significant ($F(2, 14) = 3.16$, $p = 0.07$). The t-test results show that the unit range of medium and high success networks is significantly higher than the unit range of low success networks. The overall difference of functional range between the three levels of success is not significant ($F(2, 14) = 1.97$, $p = 0.18$). The t-test results show that the functional range of medium and high success networks is slightly higher than low success networks, but this difference is only significant at $p < 0.10$ between low and medium success networks. From the development to the refinement phase we see a slight decrease of the unit range, but still no significant difference between medium and high success networks. The functional range shows no real decrease from the development to the refinement phase and no significant difference between medium and high success networks. In short, the results provide partial support for hypothesis 5. The data shows that more successful networks do indeed have higher range. However, this holds true for both medium and high success networks. Moreover, the predicted decrease in range from development to refinement is limited and still shows little difference between medium and high success networks.

Seniority and decision-making involvement

The overall difference of seniority between the three levels of success in the initiation phase is not significant ($F(2, 15) = 1.81$, $p = 0.20$). The t-test results for level of seniority show that highly successful proposals are on average initiated by more senior personnel. The difference between the average seniority levels of medium and highly successful ideas is significant at the 5% interval level, whereas the difference between low and high is significant at the 10% interval level. The small statistical difference between low and high is mainly caused by one proposal in the low success group that was initiated by a very senior scientist. This case is however in more ways different from the 'average' low success proposals, but we will go into this in detail in the next section. Although the results for degree of decision-maker involvement in the initiation phase show a more straightforward incline from low to high success, the overall difference is only limitedly significant ($F(2, 15) = 2.84$, $p = 0.09$). The t-test results show that the difference is only

significant between low and high success proposals. Moreover, the ANOVA and t-test results for the development phase show no significant differences for both seniority ($F(2, 15) = 1.97$, $p = 0.37$) and decision-making involvement ($F(2, 8) = 0.74$, $p = 0.51$) at the overall level. Lastly, the t-test results for the refinement phase also show no significant differences between medium and high success proposals for both seniority and decision-making involvement. In short, the results provide very limited support for hypothesis 6 and 7, because the difference is only partly significant in the initiation phase.

4.6 Exception

As we highlighted in the discussion on seniority and decision-making, we would like to finish this section with a discussion on one proposal that in many way fits the description of a medium to high success proposal, but never advanced past gate 1. This example points to the importance of broad and appropriate support.

The table below shows how the proposal in question fits the description of a medium to high success proposal.

Table 4.8 Exception			
Success		Exception case	Medium - High
Phase	Variables	Mean (std dev)	Mean - Mean
Initiation	Size	2.00	2.40 – 3.60
	Density	-	-
	Current intensity	-	-
	Past intensity	2.00	2.06 - 3.18
	Unit range	-	-
	Functional range	-	-
	Seniority	4.00	1.80 - 2.60
	Decision-making involvement	0.50	0.15 - 0.35
Development	Size	11	14.80 - 23.00
	Density	0.18	0.22 - 0.15
	Current intensity	1.93	1.67 - 1.88
	Past intensity	3.53	2.42 - 3.14
	Unit range	0.41	0.75 - 0.70
	Functional range	0.07	0.25 - 0.17
	Seniority	2.70	2.13 - 2.27
	Decision-making involvement	0.18	0.10 - 0.11

The table shows that the proposal in question was initiated and developed by relatively senior staff in accordance with medium and high success networks. Moreover, the structure shows a medium level of density, relatively intense discussions and the reliance on close colleagues, which is in similar to medium and high success networks.

Based on the findings presented earlier, one might suggest that the low levels of diversity and small size of the network during initiation and development are an explanation of its failure. However, the qualitative data suggests that is not only the lack of broad input which played a role, but also the lack of appropriate input, because this proposal was initiated and developed by 'outsiders'. 'Outsiders' refers here to the location of the input.

As we noted in the methodology section, our data is collected from two central R&D labs. The initiative behind the 'creation' process was mainly launched from one of the two central labs. Most of the middle-liners were also located in this lab (15 out of 18). The proposal in questions was, however, initiated by a senior scientist during a discussion with an academic scientist. The proposal was subsequently further developed by the

group of this senior scientist, who did consult various people from other units, but all from the 'other' lab. The main purpose of the discussions was to incorporate and bundle different ideas that people had been working on which were related to the topic. Various business applications were also considered in the proposal. These applications were however barely discussed, which seems to be a noteworthy difference with medium and high success proposals. Some of these proposals were also as experimental and technological driven as the proposal in question, but the business side of these proposals was always discussed even if only with other scientists. It seems that herein lays a key difference. This proposal did not only get little broad business input from other scientists, but especially not from so-called business developers (most of which were again not located in the 'other' lab), who were responsible for contact between the labs and the business units. As a result, the 'exception' proposal seemed to lack a clear potential internal customer in the form of a division within the company that would be interested in developing a product that would incorporate this technology, which was one of the main reasons for rejecting the proposal.

This example does not only show that diversity of input is important, but that this should come from the right people on the right subject. The proposal did get substantial input from people from the 'other' lab, but mainly on technological issues and not from the lab where the decisions are made. One could subsequently debate whether this is a question of politics or sensemaking, but it is a utopia to assume that all senior managers in large multinationals have a similar vision on the appropriate product portfolio. We therefore propose that it is not only important to have senior personnel involved, but that they are located in the 'right' place and possess the appropriate knowledge. 'The right place' refers here to the location, division or function where the strategy is outlined and the decisions are taken regarding a specific proposal. We would not propose that the proposal would have been highly successful if it had had more appropriate input, but that it would at least have passed the middle line review.

4.7 Discussion: reflection on literature

Introduction

In section 4.4 and 4.5, we have discussed the quantitative results and the implications for the hypotheses for both network structure and content separately. In this section, we will reflect on how our findings relate to existing theories, especially in light of the qualitative findings. We will do so by starting with a discussion on structure and content separately. This however leaves unanswered questions, such as: What is the relation between structure and content? Why are some networks bigger than others? What can explain the lack of negative side effects of density? Why did density increase so sharply from development to refinement? How can strong ties and low density co-exist? By combining data on the content and structure, we try to answer these questions.

Structure: Network size

The results for size both concord and conflict, but more importantly extend existing theory. The results concord with the social network literature highlighting the need for large networks for creative insights (Burt, 2004; Perry-Smith, 2006; Perry-Smith et al., 2003). The results here even extend this literature by showing that not only large latent networks contribute to success, (indirectly through providing input) such as those studied by Burt (2004) and Perry-Smith (2006), but that large 'actual' discussion networks contribute to success. People in these networks do not only provide input, but are actively involved.

The hypothesis regarding the need to convergence to smaller networks during the refinement phase is only marginally supported. However, this would provide initial support for the arguments of TMT and NPD literature that smaller networks in the final phases of decision-making provide a better basis for coordination and teamwork. The results thereby extend the social network literature by highlighting the need for a shift over time from a larger to a smaller network.

The results regarding the size of the initiation networks conflict with the classic view of the creativity literature advocating the importance of the individual (Kurtzberg et al.,

2001). Our results also contradict with Burt's study (2004), which suggests that people are merely influenced by their network, but still generate ideas by themselves.

Structure: Density

The results for density, especially the high levels found in the refinement phase, confirm that density in an innovation context is important for its ability to facilitate coordinated action (Obstfeld, 2005; Reagans et al., 2001) and create a clear normative order within which people can optimize performance (Coleman, 1990). The results only provide partial support for the low density advocate's, such as Burt (2004) and Perry-Smith and Shalley (2003). The density during development is indeed not very high, but the results clearly show that both medium and high success networks are significantly denser than low success networks in the development phase. Moreover, the inverted U-shaped relation that is found in the development phase is inline with arguments made by Oh et al. (2006) and findings at the interorganizational level by Gilsing et al. (2006).

This raises three important questions. First, how can the findings from existing literature be matched with the findings in the context of this study? We propose that the temporal nature of the networks in this study might provide an explanation. All studies highlighted above and those in the theoretical section refer to network relations which are fairly stable over time, such as advice relations (Burt, 2004). The temporal nature of the networks described in this study makes it unlikely that the much cited negative effect associated with high density, namely information redundancy, is problematic. This would suggest that high density is optimal for the increased willingness to help, creation of trust and the development of a shared language. However, network researchers have (indirectly) pointed out that higher density leads to a loss of autonomy (Burt, 1997) and the social pressure to conform (Perry-Smith et al., 2003). High density can even lead to group think (Janis, 1972) and premature lock-in, a much cited problem in NPD literature (MacCormack, Verganti, & Iansiti, 2001; Thomke, 1997). The results from this study suggest that during the development phases of a proposal, too little may not build sufficient common ground to work from and too much may not leave enough room for key adjustments of the idea.

The important questions that remain are: Are the suggestions above supported by the qualitative data on the changes of the proposals? And how are these findings related to the data on network content? However, before going into these questions, we will finish the network structure section with the discussion on tie strength.

Structure: Tie strength

The data on the initiation networks supports the 'strength of strong ties' concept (Krackhardt, 1992) as opposed to the famous 'strength of weak ties' hypothesis of Granovetter (1973). Moreover, this is inline with the arguments of Cohen and Levinthal (1990) and the results of Moenaert and Souder (1996) who showed that frequent past interactions increased the effectiveness of interpersonal communication when dealing with complex R&D information. Moreover, the results for the development phase support the idea that "strong ties have greater motivation to be of assistance" (Granovetter, 1983, p. 209). Strong ties, in terms of past intensity seem to facilitate the innovation process over and above the effect of density in the development phase. Our results thereby support the view of Hansen (1999) and conflict with the results of Reagans and McEvily (2003).

A possible explanation as to why past intensity is important during the development phase is the temporal nature of the networks. In most network studies (Reagans et al., 2003), researchers look at stable working relations, which on average are at least one year old (Burt, 2004; Obstfeld, 2005; Reagans et al., 2003; Reagans et al., 2001). On the other hand, the networks in this stage of the study are only a few months old and the interaction is not very intense, making it difficult to facilitate the development of trust, cooperative norms and a shared language (Coleman, 1988; Krackhardt, 1999; Obstfeld, 2005; Reagans et al., 2003).

The question that remains is; how do our results fit into the search-transfer paradox of Hansen (1999)? Hansen argued that weak ties are useful for search benefits; where as strong ties are useful for transfer benefits. Most researchers have assumed that generating

ideas is identical to searching for knowledge (Obstfeld, 2005; Perry-Smith et al., 2003). However, in Hansen's study, searching for knowledge seems to be based on the assumption that a NPD team knows what it is looking for. This is not the case when generating an idea. The proposals we followed, especially the more successful ones, were initiated because people knew of each other that they were working on something that might be interesting. In a context where information is abundant, complex to comprehend and distributed asymmetrically, only strong ties can provide added processing capacity and appropriate levels of trust. Our results thus extend the Hansen's results by showing that the most successful networks use strong past ties to search and generate or initiate proposals in an R&D context.

A final noteworthy finding from our qualitative data on the intensity of the discussion revealed that the discussions focus on personal know-how and are only rarely supplemented by written reports. This confirms the view of Burt (2004), but again shows that the FE is distinctly different than actual project work, such as the process studied by Hansen (1999; 2002), where research has shown that codified knowledge is used much more readily.

Content: Range

What is not expressed by the range numbers noted above is the 'actual' change in the content of the proposals during the process; it merely shows the 'potential' change. The qualitative data does provide insight into this question and shows the following image. For the low success networks, it became clear from the discussion that one or two central players contacted various members from their department and occasionally some outsiders. During the interviews with the respondents it became clear that these proposals did not change as a result of the discussions. The technical discussions were more focused towards a validity check, whereas the business discussions focussed on selling the idea. There was not a real actual in-depth discussion, which explains why the ideas barely changed. For the medium success networks, we see much larger networks that span across many units. The technical discussions in these networks were aimed at the technical feasibility of the proposals. The basic idea behind the proposals did not change

significantly, but the proposals were often more refined in terms of technical specifications and market prospects than the initial idea. The high success networks mainly differ from low and medium success networks on this last issue. The proposals would not only be more refined and detailed, but the discussions also led to more fundamental changes. An example is a proposal for delivering health benefits through a new technology in an expensive line of food products. During the discussions this proposal did not only change by focusing on inexpensive food products, but also by focussing on different health benefits.

During the refinement phase, we saw little differences in almost all dimensions of the networks. It seems that this phase is truly a refinement phase in the literal sense of the word. A phase focused more on details than major changes. The results suggest that the fundament for success is created during the initiation and development phase and only to a limited extent in the refinement phase, which is again reflected in the qualitative data. Discussions during this phase were mainly focused on coordination and organization issues. Key issues were; who needed to be a member of the possible project, how would the project planning look, what was unclear for the middle-line reviewers.

More generally speaking, the results for the development and refinement phase from the descriptive table, the network content table and the qualitative data show clear support for the notion that diversity plays a key role in the networks around proposals. Table 4.2 in the descriptive section shows that 61% of the discussions around all proposals (regardless of their degree of success) is conducted by people from different units. Moreover, 17% of the discussions around all proposals (regardless of their degree of success) is conducted by people from different functions.

These results thereby provide an extension to existing literature on structure and creativity (Burt, 2004; Perry-Smith, 2006; Perry-Smith et al., 2003) by highlighting the importance of content, in the form of organizational membership, as a source of diverse insights. Moreover, the data also shows how input from members of different organizational units affects a proposal.

Content: Seniority and Decision-making involvement

The results provided limited support for hypotheses 6 and 7. The predicted importance of more senior people in the process was only found in the first phase. However, data from the interviews suggested that senior personnel did contribute significantly, especially during the further development of the proposal. To validate this claim we differentiated between those actors that were actively involved in 'networking' (the core) and those that were not (the periphery) and again tested whether the difference in the involvement of more senior personnel contributed to success. For the method of differentiating between core and peripheral actors we followed De Nooy et al. (2005, p. 57) by identifying key players based on their degree centrality (number of contacts)[3]. By calculating the degree of each player in a given network, we could asses the average and subsequently selected those players that had a degree larger than average. For the degree, we used valued data on the communication frequency, to ensure that we would not only identify the players with a high number of contacts, but also those that discussed the proposals most intensively.

[3] There are various other ways of identifying core-periphery structures in a given network, such as cliques, lambda sets, LS sets, k-cores (see Wasserman, S., & Faust, K. 1994. ***Social Network Analysis, Methods and Applications***. Cambridge: Cambridge University Press. or De Nooy, W., Mrvar, A., & Batagelj, V. 2005. ***Exploratory Social Network Analysis with Pajek***. Cambridge: Cambridge University Press. for an overview). However, all of these procedures have difficulty in identifying cores in so-called star networks, where there are only one or two central players. To ensure that the smaller networks could also be analyzed we used this 'larger than average degree centrality' procedure. It should be noted that the cores in the larger ('non-star') networks that could be identified by such procedures as cliques etc. show very similar results to those identified by the 'larger than average degree centrality' procedure.

Table 4.9 Seniority and Decision-making involvement in the core and periphery [a,b,c]								
Success			N	Low	N	Medium	N	High
Phase	Group	Variables		Mean (std dev)		Mean (std dev)		Mean (std dev)
Development	Core	Seniority	7	1.89 (0.57) $^{\#}$	5	1.97 (0.16) ††	5	2.31 (0.32) $^{\#, \dagger\dagger}$
		Decision-making involvement	7	0.03 (0.08) $^{\#}$	5	0.10 (0.14)	5	0.19 (0.21) $^{\#}$
	Periphery	Seniority	7	1.98 (0.66) *	5	2.20 (0.34) *	5	2.25 (0.42)
		Decision-making involvement	7	0.10 (0.13)	5	0.09 (0.13)	5	0.09 (0.06)
Refinement	Core	Seniority		-	5	2.10 (0.22)	5	2.14 (0.70)
		Decision-making involvement		-	5	0.17 (0.24)	5	0.18 (0.32)
	Periphery	Seniority		-	5	2.23 (0.43)	5	2.45 (0.63)
		Decision-making involvement		-	5	0.12 (0.14)	5	0.27 (0.22)

[a] The significance signs next to the label of the variable indicate the overall level of significance. We distinguish between the following three levels of significance: $^{\circ}$sig. < 0,10 ; $^{\infty}$sig. < 0,05 ; $^{\infty\infty}$sig. < 0,01.

[b] The significance of the differences is calculated for all three pairs, 1 & 2, 1 & 3 and 2 & 3. If the differences are significant, this is indicated as follows:

For differences between group 1 & 2
- *sig. (one-tailed) < 0.10
- **sig. (one-tailed) < 0.05
- ***sig. (one-tailed) < 0.01

For differences between group 1 & 3
- $^{\#}$sig. (one-tailed) < 0.10
- $^{\#\#}$sig. (one-tailed) < 0.05
- $^{\#\#\#}$sig. (one-tailed) < 0.01

For differences between group 2 and 3
- †sig. (one-tailed) < 0.10
- ††sig. (one-tailed) < 0.05
- †††sig. (one-tailed) < 0.01

[c] The figures on seniority and decision-making power for low successful proposals are based on 7 cases, because one proposal involved one person who did not discuss his or her idea with anybody.

The ANOVA results showed that there were no significant overall differences between the cores for both seniority ($F(2, 14) = 1.59$, $p = 0.238$) and decision-making involvement ($F(2, 14) = 1.89$, $p = 0.188$). However, trend analyses revealed that there was a limited linear component to both the seniority ($F(1, 14) = 3.00$, $p = 0.10$) and decision-making relationship ($F(1, 14) = 3.77$, $p = 0.07$), with higher involvement for the higher success levels than for the lower success levels. Moreover, the t-test results show that the difference in average degree of seniority between low and high success is significant at the 10% interval level and between medium and high significant at the 5% interval level. The t-test results for decision-making involvement show that the difference is only significant between low and high success proposals at the 10% interval level. The differences in the peripheries are much less pronounced. The ANOVA results showed that there were no significant overall differences between the cores for both seniority ($F(2, 14) = 0.45$, $p = 0.64$) and decision-making involvement ($F(2, 8) = 0.01$, $p = 0.99$).

Moreover, trend analyses revealed that there was no linear component to both the seniority ($F(1, 14) = 0.77$, $p = 0.40$) and decision-making relationship ($F(1, 14) = 0.02$, $p = 0.89$). Finally, the t-test results also showed almost no significant relations, besides the limited significant difference for decision-making involvement found between low and medium success networks.

These results combined with the findings, noted earlier, that more senior people are involved in the initiation phase thus show some initial support for the notion that senior personnel and, to a limited extent, decision makers are better at the encouragement of risk taking and identifying opportunities as suggested by Gupta et al. (1986) and Moenaert and Souder (1992). Our results contradict with the claims of Benner and Tushman (2003), who argue that early involvement would stifle creativity. A likely explanation for the benefit of seniority and decision-making influence in a R&D context other than pushing forward 'hobby horses', is the basis on which people are promoted. Career paths in R&D labs in general, and in our focal company in specific, are much like those found in a university setting. An academic moves up the hierarchical level by being a good academic (whatever that may be) and might one day become department head based on his academic performance. Similar situations are seen in R&D labs where people move up the organization, because they are good scientists not necessarily, because they're good managers. This is also evident from the lack of horizontal rotation of R&D scientists, whereas horizontal rotation between divisions is very common for commercial personnel; it's very uncommon for R&D specialists, unless the activities are highly related.

Moreover, an even more interesting finding regarding the role of seniority and decision-making involvement in these networks is not only a general tendency towards more senior and decision-making involvement in successful networks, but the difference regarding the location of seniority within these networks. The more senior actors in the medium networks are in the periphery, thus less (socially) involved. The more senior actors in the high success networks, on the other hand, are strongly involved. These results do not only support the idea that senior personnel assists in the encouragement of

risk taking and identifying opportunities, as highlighted earlier, but also in reducing the technical and market uncertainty (Roussel et al., 1991). Moreover, these results may also suggest that more senior people do not only receive more information as noted by Han (1996), but that they also have larger networks, which may be a second explanation (besides changing ideas) as to why more successful networks were larger. It is, however, important to note that the statistical results are rather limited and clearly require stronger support from future research.

4.8 Discussion: structure and content combined

Relation between structure and content

The data suggest that the answer to the question, posted earlier, on the relation between network structure and content cannot be answered as straightforward as it was posted. There seems to be a dynamic process in both the medium and especially the highly successful ideas, where structure and content influence each other. The process starts with discussing the proposals with more and more diverse actors. Subsequently these diverse insights are used to change/refine the proposals, especially in the case of high success proposals. These changes seem to have the added effect that the diverse actors that are consulted feel more committed/ ownership and therefore also start discussing the proposal with yet other people. However, the density seems to affect the degree of change of the proposals. Medium success networks quickly form a relatively dense clique, which seems to create a form of lock-in. This could also explain why the changes to medium proposals are more focused towards technical feasibility issues and less on the entire idea. The high success networks, on the other hand, lack such a dense clique, which seemed to leave room for more fundamental changes.

Network growth and tie strength

Next to 'change' as a driver of network size, we propose that tie strength and more specifically 'past intensity' is also a driver of network size. "The greater motivation to be of assistance" (Granovetter, 1983) associated with strong ties should therefore be seen more broadly to include not only input on the proposal itself, which is the benefit

highlighted by Hansen (1999) and Nicolaou and Birley (2003), but also 'the building of a network'. We thus propose that strong ties to colleagues from different units is a second mechanism through which networks can be built next to changes in the proposal, which was highlighted earlier.

The importance of autonomy

If we think back on the results discussed earlier, we essentially see medium success networks, which are large and diverse, but relatively dense, especially in the core. Add to this the low tie strength and we see a situation that contradicts with theory, but seems intuitively correct. The data suggests that high density in combination with low tie strength in temporary innovation networks creates a form of lock-in and loss of autonomy. This contradicts with the suggestions made (amongst others) by Perry-Smith and Shalley (2003), who proposed that weak ties and sparse (low density) networks would foster the autonomy necessary for creativity. In a complex innovation context, it seems crucial to discuss proposals relatively intensely with close colleagues from different units, to truly tap into diverse insights (Cohen et al., 1990; Moenaert et al., 1996; Uzzi, 1999), but not in a dense clique, which guarantees autonomy.

The benefit of strong ties and network range

We propose that the main difference with the results here and theory is caused by the source of diversity and again by the temporary nature of the networks. Classic network theories have argued that strong ties will lead to/ auto correlate with high density (Nicolaou et al., 2003). However, our results show that strong ties can, at least temporarily, exist within relatively sparse networks, which is in line with remarks made by Nicolaou and Birley (2003). Moreover, previous network theories have also argued that strong ties lead to redundant information (Hansen, 1999). However, our study suggests that as long as actors in a network possess different work related knowledge, strong ties can and are even better at conveying diverse or non-redundant knowledge than weak ties.

Increased density

The one major difference between medium and high success networks in the refinement phase, as we saw earlier, was the density. The question was; what could explain this difference? The unit range did decrease, but this cannot explain the increase in density, because both medium and high success networks have similar levels of range. Moreover, density during the development phase was even slightly higher for medium success networks and this difference turned around in favor of high success networks and increased significantly. A possible explanation discussed earlier is the degree of convergence, referring to the decrease in size of the networks. The convergence was stronger for high success networks compared to medium success networks. A second possible explanation is the high levels of past intensity for high success networks during the development phase. A third possible explanation, which became clear from the qualitative data on content, is the number of new people that were involved during the refinement phase. As a result, we used a very basic indication of the stability of the networks, by dividing the number of new people in the networks of each proposal by the total number of people in each network. This measure ranges from 0 to 1, where numbers approaching 0 are an indication of a high stability and numbers approaching 1 signal the opposite. The results are depicted below.

Table 4.10 Network stability from the development to the refinement phase [a]

Success	N	Low	N	Medium	N	High
Variables		Mean (std dev)		Mean (std dev)		Mean (std dev)
Member stability	-	-	5	0.36 (0.31) [†]	5	0.12 (0.13) [†]

[a] The significance of the differences is calculated for all three pairs, 1 & 2, 1 & 3 and 2 & 3. If the differences are significant, this is indicated as follows:

For differences between group 1 & 2
- [*]sig. (one-tailed) < 0.10
- [**] sig. (one-tailed) < 0.05
- [***] sig. (one-tailed) < 0.01

For differences between group 1 & 3
- [#] sig. (one-tailed) < 0.10
- [##] sig. (one-tailed) < 0.05
- [###] sig. (one-tailed) < 0.01

For differences between group 2 and 3
- [†] sig. (one-tailed) < 0.10
- [††] sig. (one-tailed) < 0.05
- [†††] sig. (one-tailed) < 0.01

The results indeed show that the number of new actors in high success networks is lower than in medium success network, however, only at the 10% interval level. Although the result is limited, this could be a possible explanation for the high level of density. Moreover, it could also be a benefit in its own right. Research on TMT turnover has

shown that group stability in decision making contributes to success (Krishnan, Miller, & Judge, 1997).

PART II:
HOW TO BUILD A NETWORK

CHAPTER 5

How to Build a Network in the FE

5.1 Introduction

Knowing which network structures enhance the effectiveness of the FE brings us to the more fundamental question: "how to build a network?". Since a network is built up out of dyadic relations we will use this second part of our study to shed more light on those relations. In doing so, we specifically pay attention to the influence of the formal structure of organizations, based on the assumption that this is an important means through which firms can act as a "focusing device" (Nooteboom, 1992) or "sensemaking system" (Weick, 1995). By structuring the labor force, a firm attempts to create sufficient focus in order to align mental categories to a level where there is sufficient absorptive and communicative capacity to cross cognitive distance enabling people to achieve a common goal (Nooteboom, 2002a). However, in doing so, formal structures "constrain some actors' abilities to form ties, or specific types of ties, and therefore confine the extent to which actors can shape or reshape their networks" (Lazega et al., 1997, p. 375).

The reason for looking at the relationship level is threefold. First, we are interested in the effect of the formal structure, because of the importance and ease through which it can be adapted to influence, amongst others, the communication patterns within a firm. Second, we are interested, because of the inherent paradox the formal structure can create in light of innovative efforts. As we have noted in the previous part, one of the key assumptions in network studies relating to innovation, including this study, is that diversity of information is a crucial prerequisite for creative or innovative acts. The source of these diverse insights is assumed to come from structural holes (Burt, 2004; Perry-Smith et al., 2003) or, in an organizational context, from relations that span across organizational boundaries (Cummings, 2004). However, certain key aspects of the organizational structure, such as the functional or divisional allocation of labor, are specifically designed to group people with related skills or tasks and ensure that people are 'focused'.

Moreover, organizations even strive to limit the number of identities that a member can legitimately claim (Lazega et al., 1997) for reasons of accountability and manageability. This however creates a tension in light of innovative efforts. Finally, we are more generally interested in the relationship level, because of the findings in the previous part, which showed the importance of strong ties, in terms of both current and past intensity, and the diversity of ties or, in other words, ties across units. This benefit of strong ties has also been advocated by previous research in other innovative contexts, such as knowledge transfer (Hansen, 1999; Reagans et al., 2003), university spin outs (Nicolaou et al., 2003) and inter-firm innovations (McEvily et al., 1999). However, without details on the way in which those networks are built up.

The issue we would therefore like to investigate further in this chapter is if we can explain what contributes to the tie strength of informal relations around project proposal initiatives. With this question, we build on social network literature related to network structuring and information seeking and apply this to a NPD context. We specifically go into the role of the organizational structure, the cognitive processes and network location on tie intensity.

5.2 Ability, Motivation and Opportunity

As we noted, the question behind this part of our study is: What influences the extent to which people contribute to the initiation, development and refinement of a project proposal in a NPD context? And even more general: What influences network or tie formation and intensity in general in a NPD context? Although not directly addressed, there are various more general studies that have bearing on this question. We have grouped these studies into three categories using Adler and Kwon's folk schema (2002), namely ability, motivation and opportunity. Adler and Kwon (2002, p. 24) use the interesting metaphor of television lawyer Perry Mason, who "teaches us that in cases where there is only circumstantial evidence, successful prosecution requires showing that the defendant had the requisite opportunity, motivation and ability." The 'crime' Adler and Kwon (2002, p. 24) refer to is the "gesture of social exchange …, which is, a crime

against homo economics and homo hierarchicus", similar to the 'crime' in this study. The extent to which ties form and become more intense and enduring could be the result of the ability that people have to understand one and other. Furthermore, regardless of ability, people need to be motivated to help each other. Lastly, given the ability and motivation, there should be an opportunity to form and strengthen ties.

Ability

An example of literature on how the ability to interact may influence tie strength comes from the sociological field relating to the structuring of network ties, which has focused on the 'homophily principle', a label introduced by Lazarsfeld and Merton (McPherson et al., 2001). The idea behind the principle is that "similarity breeds connection" (McPherson et al., 2001). In other words, people are more likely to have social ties to people similar to themselves on various sociodemographic attributes such as race, sex, religion, age etc., which results in personal networks with a high degree of homogeneity regarding those sociodemographic characteristics. Moreover, homophily does not only enhance the probability of tie formation, it also enhances the strength of interpersonal ties (Ibarra, 1995). Empirical evidence is found in various contexts. Early studies focused on small social groups such as those found in schools and neighborhoods. Over time these were supplemented by more large-scale studies, such as the 1985 'General Social Survey' focusing on the US population as a whole (Marsden, 1987). Recent work has also concentrated on the organizational context, such as the effect of gender differences in networking behavior (Aldrich, Elam, & Ray, 1996; Aldrich, Ray, & Dubini, 1989; Campbell, 1988; Ibarra, 1997).

A related argument is made by Cohen and Levinthal (1990), as discussed earlier, arguing that the ability to absorb knowledge is done through associating it with that what people already know and label this ability 'absorptive capacity'. They thereby stress the importance of prior related knowledge, which includes basic skills, a shared language, and knowledge of cutting edge scientific or technological knowledge. However, although the definition would suggest otherwise, in the actual operationalization of 'prior

knowledge', it is mainly understood as something that is the result of being active in certain basic or applied science domains.

Related yet slightly different argument on the importance of absorptive capacity is found in literature on team performance that has also highlighted that the "mere presence of expertise" is not sufficient in software development teams, but that the coordination and integration of such expertise is crucial (Faraj et al., 2000; Sheremata, 2002). However, Faraj and Sproull (2000) go further than Cohen and Levinthal (1990) by not only advocating the need of being active in related science domains, but also the importance of being familiar with each others experiences and skills. The importance of which is likely to be even more important in a NPD setting where information is highly tacit and complex (Borgatti & Cross, 2003; Dougherty, 1992; Dyer et al., 2000; Teece, 1996; Von Hippel, 1994).

Motivation

The motivational aspect of ties is a common theme in social network research. On the relationship level, Borgatti and Cross (2003) grouped studies related to this topic under the header 'cost'. This includes research that stressed the importance of physiological safety (Edmondson, 1999), trust (Nooteboom, 2002b; Nooteboom, Berger, & Noorderhaven, 1997) and reciprocity (Argote, McEvily, & Reagans, 2003), some of which were addressed earlier. A key issue, in asking people for help, lies with the interpersonal risk of losing face when asking people for help and admitting ones ignorance regarding a specific question or the risk that one will never be rewarded. Moreover, the informal nature of the interaction studied for this research makes norms of reciprocity especially important. Whereas help on project work will most likely be repaid directly, help on project proposals may very well never lead to any direct form of repayment. This makes the perception of reciprocity an important determinant of the contributions that can be expected.

Opportunity

Sufficient ability and motivation "are even more valuable when coupled with opportunity" (Argote et al., 2003, p. 575). In this respect, Borgatti and Cross (2003), highlighted earlier, addressed the importance of accessibility. A person working on a proposal may wish to consult a particular expert, but may have difficulty in getting access. The classic reason could be the difference in hierarchy or time or a combination of both. A high marketing manager may not only have a very busy schedule, but also a personal secretary that would be difficult to 'pass'. A second key dimension influencing opportunity is the effect of physical proximity. It is related to homophily, but takes the perspective that physical proximity increases the probability of serendipitous interaction (Borgatti et al., 2003).

In the following part of the theoretical section, we discuss the hypotheses, which are divided in two ways. First, we distinguish between the role of content aspects, specifically unit and function co-membership, seniority, prior knowledge and joint project work, and the role of structural aspects, specifically tie strength, 'Simmelian ties' and tie centrality. Second, we distinguish between types of ties. We will indicate for each hypothesis whether it applies to all relations or only those between units.

5.3 Content

Co-membership

In work environments, formal structures are designed to coordinate individual and collective action (Blau, 1957). These formal structures are designed to provide people with the opportunity to specialize and provide access to and responsibility over relevant resources, thereby increasing a firm's efficiency. Various ways exist in which firms organize their labor, including a division of labor across functional areas, geographical markets, business units and even combinations in the form of so-called 'matrix' organizations. Moreover, people are, especially in larger firms, often not only assigned to specific functions or business units, but even further subdivided and assigned to specific units within those functions.

The assignment of people to specific functions, divisions or units creates the possibility for those members to form ties within those units for two reasons. First, people are most often assigned to a specific organizational role based on their capacities. Organizational members of the same unit or function will therefore often share a set of common skills, beliefs and norms, which will increase the ease of communication and improve the predictability of behavior (Ibarra, 1995). This builds on the 'ability' argument. Second, people who are a member of the same function or unit are more likely to be co-located than members from different functions or units, which will also contribute to tie formation, since people "are more likely to have contact with those who are closer to us in geographic location than those who are distant" (McPherson et al., 2001). This builds on the 'opportunity' argument.

The downside of unit co-membership is redundancy. Although there is an ability and opportunity to interact, there is a question of motivation, a point not directly addressed by Adler and Kwon (2002). When working on a new idea or proposal the added value of input from somebody in your own unit may be limited. Advice within units could be a form of validation or legitimation (Cross, Borgatti, & Parker, 2001). However, network literature assumes that the real value of ties in a creative and innovative comes from their diversity (Burt, 2004; Perry-Smith, 2006), which will be limited for ties within units. The benefit of opportunity and ability resulting from co-membership will thus be neutralized by the lack of motivation. We would therefore propose that there is no real effect of co-membership in situations where people are working on new ideas.

Hypothesis 1a: Co-membership of functions and units between people will positively affect past intensity.

Hypothesis 1b: Co-membership of functions and units between people will have no affect on current intensity.

It should be noted that, especially in large firms, co-membership on the functional level does not necessarily imply co-location. Moreover, co-membership of functions in large firms will also not necessarily mean that people will share a great deal of expertise. Large R&D labs will often have many different specialties that are hardly related. The same can be said for marketing departments which may well be responsible for completely different geographical regions, product lines and customer bases. One would therefore expect co-membership of units to have a much stronger effect than co-membership of functions.

> *Hypothesis 1c: Unit co-membership will have a stronger effect on past intensity than functional co-membership.*

Seniority and decision-making power

Seniority has been identified as a second aspect of organizational structure that can influence the extent to which ties are created or maintained. Lazega and Duijn (1997) conducted a study within a US corporate law firm on the advice networks of lawyers and found that similarity in seniority was found to positively impact tie intensity. Dissimilarity, on the other hand, was found to negatively impact tie intensity, a finding supported by empirical evidence from Han's study (1996). Lazega and Duijn (1997) concluded that in uncertain situations people might prefer advice from peers for reasons of face-saving or accountability, which builds on the motivation argument. Others have labeled this the need for psychological safety (Edmondson, 1999), but more on this later. The question that arises is if one would expect to find the same need for face-saving or accountability in an NPD context. Research has suggested that an NPD context is highly uncertain and ambiguous (Kim et al., 2002), one would thus expect that the negative effect of dissimilarity would be equal if not stronger.

An additional reason from the opportunity perspective not mentioned by Lazega and Duijn (1997) is the so-called 'glass ceilings' between different levels of seniority especially in larger firms. Although an equivalent of an 'officers mess' will not be found

in most modern day firms, it is not uncommon for the people within units to lunch, sit or socialize with those in similar positions.

As we advocated in part 1, decision making power can play a role in much the same way as seniority. The difference may lay in the fact that interaction with decision makers has a more specific role, because these people may be directly responsible for a person's job appraisal or promotion. However, the information benefits regarding key information on the strategic technological and market directions of firms are largely similar, because decision makers tend to be in more senior positions and more senior people generally have decision-making power. We would therefore propose:

> *Hypothesis 2a: Dissimilarity in seniority and decision-making power between people will negatively affect past and current intensity.*

Continuing on the point of 'glass-ceilings', it is also common for more senior people and especially for decision makers to be a member of management teams or other teams within or across units, which could enhance tie strength. This is supported by findings from Burt's creativity study who found that senior managers "could more often reach directly out of their own social cluster into others" (Burt, 2004, p. 18) and is also supported by the findings in the more general study of Stevenson (1990) and Han (1996). On the other hand, seniority often comes at the price of an increase in workload and thus constrains ones availability of time. We would therefore propose that high seniority and decision-making power has a positive effect on the past intensity, but a negative effect on current intensity.

> *Hypothesis 2b: Higher average seniority and decision-making power of a relation will positively affect past intensity.*

> *Hypothesis 2c: Higher average seniority and decision-making power of a relation will negatively affect current intensity.*

Absorptive capacity

McPherson et al. (2001) noted that cognitive processes can form an important source of homophily next to the organizational structures listed above. McPherson et al. (2001) build on research by Carley (1991) who focuses on 'constructuralism', which assumes that people who share knowledge with each other are more likely to interact. They advocated that people would associate with similar others for ease of communication and shared cultural tastes, which is an ability argument. On the other hand, previous research (Burt, 2004; Perry-Smith, 2006), including this study, has shown that in a creative or innovative context a certain degree of diversity is desirable. This builds on the idea of an optimal level of cognitive distance (Nooteboom, 1999; Wuyts et al., 2005), large enough to ensure that there is sufficient cognitive distance, yet small enough to be able to effectively build on each others diverse knowledge (i.e. absorptive capacity).

In this study we use people's project profiles as approximations of people's absorptive capacity. These project profiles refer to records kept on employees showing which employee worked on which project and for how many hours. These profiles can reflect a person's role within a R&D lab, like a specialist who is dedicated on one specific project or a generalist working on many different projects involving many different people. Moreover, these records can also show the extent to which people share knowledge specifically resulting from joint membership of a project. We will deal with both sources of absorptive capacity below, starting with the general ability to learn.

Prior related knowledge

Cohen and Levinthal (1990) stressed the importance of in-depth knowledge and exposure to a variety of knowledge bases to facilitate the ability of 'learning to learn' and create a prior related knowledge base. This would lead one to assume that people who work on many different projects gain unique knowledge specifically related to projects and from the other members in the project. Moreover, project experience can serve as a source of procedural knowledge (know-how) as opposed to declarative knowledge (know-what). Team literature has shown that actors who have worked on NPD projects in the past will have developed routines for the combination of tacit knowledge (Madhavan et al., 1998)

and, hence, communicate more easily. By working with others, people develop a general ability to learn from others. Cohen and Levinthal (1990) used the term "learning to learn" to refer to this aspect of absorptive capacity. In the creative literature, Amabile (1996) referred to these skills as "creativity relevant skills" and considered them to be crucial next to "domain-relevant knowledge". Finally, as for high seniority, a broad knowledge base could also create or strengthen the for innovation important inter-unit ties, as opposed to unit co-membership.

> *Hypothesis 3a: Broad project experience will positively affect past and current intensity.*

Joint project work

Whereas exposure to different knowledge bases can enhance the generic ability to absorb new knowledge, project work could also enhance the specific exchange opportunities between two people. The likelihood that two people will form or strengthen a tie can be increased through joint project work for two reasons. First, from an opportunity perspective, project co-membership will increase the frequency with which people interact; thereby increasing the probability that people will form or strengthen a tie. Second, from an ability perspective, project co-membership will enhance people's shared knowledge base, which has been found to increase the likelihood that they will interact (Carley, 1991). Moreover, if people have worked specifically with other people on the same project, the routines of how to integrate individual stocks of tacit knowledge are more specific to the personalities of the project members (Madhavan et al., 1998). These actors are thus also likely to be more willing and able to cooperate.

However, as we noted above, from an innovation perspective a certain degree of diversity is desirable. It permits the capacity to make novel linkages and associations (Burt, 2004; Perry-Smith, 2006). Although it is likely that people will form ties if they have worked together, it is questionable whether people working on new creative ideas or proposals will actually use these ties for advice if there is little 'new' to learn. Although not directly, empirical research by Moenaert and Souder (1996) does show a positive effect

of experience similarity on the comprehensibility of information between R&D and marketing. We would therefore propose that whether people will actually use 'joint project work' ties, when working on new ideas or proposals, depends on whether it involves people from the same unit. If people are from the same unit, the added value is limited, unlike interunit ties, where there is a different knowledge base to tap into. Accordingly we propose:

> *Hypothesis 3b: Joint project work between two people correlates positively with past intensity.*

> *Hypothesis 3c: Joint project work between two people will positively affect current intensity of interunit ties.*

5.4 Structure

Past intensity

As we discussed in part 1, literature on tie strength generally distinguishes between weak and strong ties. Both types have their benefits. Weak ties are associated with access to novel information (Granovetter, 1973) or resources at a low cost in terms of time and effort. Strong ties, on the other hand, are easily available (Granovetter, 1983) and are associated with trust (Reagans et al., 2003), mutual understanding (Gilsing et al., 2005) and "are more likely to be governed by the norms of reciprocity" (Argote et al., 2003).

We also noted that tie strength is a multidimensional construct. The most commonly cited dimensions were identified by Granovetter (1973), who suggested that tie strength is a combination of amount of time, emotional intensity, intimacy and reciprocal services. In this section, we will concentrate on the potential effect of 'past intensity' on 'current intensity' and 'tie centrality'. Past intensity, as we defined it earlier, refers to a combination of emotional closeness and frequency with which people have talked to each other in the past. So put differently, we are interested in how the extent of interaction

between two people in the past will affect the intensity with which they will interact when developing an idea or proposal.

Research has suggested that the cooperative behaviour associated with strong ties follows from norms of mutual gain and reciprocity and are assumed to grow over time (Argote et al., 2003; Granovetter, 1973; Rowley et al., 2000). In situations such as those found in the front end of the NPD context, uncertainty and ambiguity, regarding the type and extent of potential pay-offs, are high. Contributing to a proposal could lead to status benefits or even ensure that people become a member of the future project team. On the other hand, a proposal could also be rejected, which will prevent any direct pay-off and may even lead to negative status effects. In a purely 'transactional' relation one would therefore assume that people would only contribute to a minimum level, purely out of a form of generalized reciprocity (Adler et al., 2002) or a general form of politeness. However, in a situation where people have built up a strong bond in the past, people will be motivated to provide more help, because of the trust and norms of reciprocity. The importance of paying attention to the level contextual uncertainty was also highlighted by Granovetter (1983). He concluded, based on work of the economic Boorman, that the importance of strong ties increases if the level of employment security drops and thus the uncertainty increases in a labor market.

Additional benefits of strong ties include psychological safety (Edmondson, 1999), as discussed earlier. Strong ties can ensure that people do not fear the risk of losing face, reputation and acceptance, because the proposal they had contributed to was considered too simple or farfetched. Psychological safety can also mitigate the risk of 'spill-over' and competition (Bogenrieder et al., 2004; Reagans et al., 2003), ensuring that people will not fear the fact that others may misuse their contribution for their own benefit without rewarding them. A second benefit of strong previous ties is that actors have had a chance to assess the quality of the information provided by each other (Nooteboom, 1999) and increase the effectiveness of interpersonal communication (Moenaert et al., 1996). Lastly, strong ties also ensure the reliability of information under conditions of uncertainty (Ibarra, 1995).

The downside associated with strong ties in creative and innovative contexts is the extent of newness. Strong ties, in terms of frequent interaction, are assumed to lead to redundant information, because the cognitive distance is small, an idea which is deeply-rooted in social network literature after the seminal work of Granovetter (1973) on the "strength of weak ties". The redundancy of information is assumed to increase further as the duration of a tie endures (Wuyts et al., 2005). The negative benefits association with strong ties was reiterated by, amongst others, Perry-Smith and Shalley (2003) for a creative context, although the subsequent empirical support was mixed (Perry-Smith, 2006).

Concluding, we would propose that in the FE of an NPD process the extent to which people have built up a strong bond in the past will positively contribute to the frequency with which two people will interact on any given proposal. This leads to the following hypothesis:

> *Hypothesis 4: Strong ties in terms of past intensity will positively affect current intensity.*

Simmelian ties

As noted in the part 1, various researchers have highlighted that dense networks contribute to, amongst others, an increased willingness to help (Reagans et al., 2003) through reputation and group norm effects. One might, therefore, assume that such effects would also manifest themselves at the relationship level and could explain why certain ties are stronger or more enduring than others. The concept of density is, however, a network level construct and as such not directly applicable to the relationship level. A comparable construct at the relationship level is referred to as 'Simmelian ties', the importance of which was first highlighted by Simmel (1950), but readdressed by Krackhardt (1999), both whom might have been inspired by Algernon's famous words in Oscar Wilde's 'The importance of being earnest': "In married life, three is company and two is none".

Technically speaking, 'Simmelian ties' refer to ties which are embedded in cliques or at the very least triads. In layman's terms this refers to a situation in which two people do not only directly interact, but also both interact with at least one third person in common. In Krackhardt's (1999) article on 'Simmelian ties', he discusses three key differences between triads and dyads, namely reducing individuality, reducing bargaining power and moderating conflicts. In light of our study, the ease of conflict resolution is most important. In a dyadic relation, disagreement about, for instance, the appropriate technology or market application of a project could lead to escalation of conflicts or the hardening of positions. The idea of the third party is that he or she can "reformulate and present the concerns of the other parties without the harsh rhetoric and emotional overtones" (Krackhardt, 1999, p. 185). A triad can thus ease the interaction between two people and help align views. It is worth nothing that according to Simmel (1950), additional third persons beyond the first only marginally modifies group behavior.

An additional benefit of triads over dyads, not directly mentioned by Krackhardt (1999), is the motivational effect it might have through an increased willingness to help and psychological safety. The group norm effect will not only resolve any potential conflict, but may also create a feeling of a social obligation to help more extensively in much the same way as found in dense networks and strong ties. In the context of the development of a proposal, people may also feel more committed to an initiative and have a sense of ownership. Furthermore, the feeling of psychological safety is also likely to increase due to the group norms associated with triads and will thus contribute in much the same way as it does for strong ties. We would thus propose that ties that are surrounded by 'common third persons' are more likely to be stronger in terms of current intensity, because of the moderation of conflict, the social obligation, the enhanced feeling of commitment and ownership and the psychological safety.

> *Hypothesis 5: Joint friends surrounding a relation between two people will positively affect current intensity.*

Tie centrality

The final structural aspect discussed here is related to the previous point on commitment and ownership, namely centrality. A good indication of the extent to which people feel committed to a proposal is the number of actors with which they discuss that particular proposal. Centrality thus refers here to the unvalued degree centrality of people in the proposal networks. This number can be a sign of the enthusiasm a person has for a given topic. It could also be a sign of the lack of expertise that a person has. However, even if a person lacks expertise, it will not automatically lead to a large number of contacts if people have no motivation to contribute to a proposal.

On the other had, centrality can also be a sign of the relevance of ones expertise regarding a given proposal and therefore an interesting source of information that people turn to. In this situation, people may not feel especially committed to a particular proposal. However, these people are experts to some extent and thus must have an above average level of interest for the topic in general.

In the FE of an NPD process we would therefore propose that the average degree centrality of two people in a given proposal network will positively influence the frequency with which these people interact on any given proposal. This leads to the following hypothesis:

Hypothesis 6: Central ties will positively affect current intensity.

In short, our framework builds on existing literature starting with the assumption that the ability, motivation and opportunity play a key role to explain tie strength and similarity and are summarized in the table below.

Table 5.1 The effect of organizational content and network structure on the tie intensity

Tie dimension		**Content**					
	Type of tie	Co-membership (hypo 1a&b)	Co-membership (hypo 1c)	Sen & Dec-mak difference (hypo 2a)	Sen & Dec-mak level (hypo 2b & c)	Project experience (hypo 3a)	Joint project work (hypo 3b & c)
Past intensity	All ties	Positive	Positive	Negative	Positive	Positive	Positive
	Interunit ties	-	-	-	-	-	-
Current intensity	All ties	No effect	-	Negative	Negative	Positive	-
	Interunit ties	-	-	-	-	-	Positive

Tie dimension		**Structure**		
	Type of tie	Past intensity (hypo 4)	Simmelian ties (hypo 5)	Tie centrality (hypo 6)
Past intensity	All ties	-	-	-
	Interunit ties	-	-	-
Current intensity	All ties	Positive	Positive	Positive
	Interunit ties	-	-	-

CHAPTER 6

Methodology: mapping relations

In order to test our hypotheses we used the data collected for the project proposals including archival data from the company. The main difference between these analyses and the previous analyses is the way in which the variables were used and, related to this point, the statistical method.

6.1 Unit of analysis

As indicated in the previous part, this study attempts to understand how social networks play a role in the NPD process. More specifically for this part of the study, we are interested in which people contribute to the initiation, development and refinement of a project proposal in a NPD context? And what influences tie formation and intensity in general in a NPD context? The unit of analysis for this part of the study is therefore formed by the ties that constitute the networks described in the previous part. As we described earlier, the FE of the NPD process provides an especially interesting context to study various dimensions of tie intensity and endurance, because the process is lacks any formal funding and is highly uncertain and ambiguous.

6.2 Data

The data used for the second part of this study is based on the network data collected for the first part. This data is supplemented by additional archival data, next to the archival on the organizational location and seniority of contacts. The additional data concerned project membership data, which was available for R&D scientists. This last data source refers to the internal hour-registration system that every scientist had to use to indicate how many hours he or she had worked on a particular project. It is similar to the hour-

registration system used by consultants. We obtained data from this system over the last two years prior to the start of our network data collection.

As we will explain later, we performed two regressions. In the first regression, we take current intensity as the dependent variable and perform an ordinal logistic regression. For this analysis, we do not analyze the relations for each phase separately, because little is know about the small sample properties of logistic regressions (Pampel, 2000, p. 30). Moreover, it would violate the rule of a minimum 'variable-to-case' ratio of 1-10 (Pampel, 2000). In the first regression we test three models (next to the baseline model). The total number of relations for the first model was 475. In the second model we only included the relations for which we had the project data described above. The total number of relations for the second model was 321. In the third model we took an additional sub sample of the sample used in model 2 and now only considered interunit ties. This resulted in a total of 195 relations. It is important to note that for these analyses we used a subset of all relations by only using those for which we had data on the tie intensity, namely the development and refinement phase.

For the second ordinal logistic regression, we take past intensity as the dependent variable and again test three models (next to the baseline model). In the first model we used the entire set of relations for all three phases. We did however correct for double relations by filtering those out. 'Double relations' refers to relations between people that were present in more than one phase or network. This resulted in a final n of 385 (the total number of relations is 475). In the second model we again only included the relations for which we had the project data. The total number of relations for the second model was 256. In the third model we again took an additional sub sample of the sample used in model 2 and now only considered interunit ties. This resulted in a total of 133 relations.

6.3 Variables

The variables used for this analysis were based on the structured questions from the interviews relating to the networks around project proposals. The main purpose of the structured questions was to provide us with quantitative indicators of various dimensions of the networks. The indicators were, if possible, adopted from previous research. In the remaining cases, we designed indicators specifically for this study. In the overview that follows we discuss each variable and the way in which it was used for this analysis.

Dependent and independent variables

Current intensity. See chapter 3 on page 60 for more details on this variable.

Past intensity. See chapter 3 on page 60 for more details on this variable.

Co-membership. In this analysis we considered two dimensions of organizational co-membership, namely functional and unit co-membership. The measure is a basic dichotomous measure where 1 indicates that two people belong to the same function or unit and 0 indicates that two people belong to different functions or units.

Seniority and decision-making power. For these variables we considered 2 aspects, namely the average and the difference. For seniority we used the personnel data from the company, which, as we explained in chapter 4, is an ordinal scaled variable ranging from 1-6. For decision-making power we used a basic dichotomous variable where a value of 1 is assigned to members of the middle-line review team or the management team and 0 is assigned to all other actors. The average was subsequently calculated by taking the average of the two people making up each relation. The difference in seniority and decision-making power was calculated using the following basic formulas:

$$Hdiff_{i,j} = \sqrt{\left((H_i - H_j)^2\right)},$$

where $Hdiff_{i,j}$ is the difference in seniority between person i and j, and H_i and H_j refer to the seniority of person i and j respectively, and

$$Ddiff_{i,j} = \sqrt{\left((D_i - D_j)^2\right)},$$

where $Ddiff_{i,j}$ is the difference in decision-maker level between person *i* and *j*, and D_i and D_j refer to the decision-maker level of person *i* and *j* respectively.

Specialization level. Based on the project data obtained from the internal hour-registration system mentioned earlier, we calculated the degree to which a R&D worker was specialized. From our discussions and interviews it became clear that there were R&D workers that worked the majority of their time on one project and those that spread their time over a wide-range of projects and activities. The basic formula we used for the degree of specialism was:

$$S_i = A_i / (1 + 0{,}5 \log n_i),$$

where A_i is the proportion of *i*'s largest project (the number of hours of *i*'s largest project divided by the total amount of project time of *i*),

$$A_i = \max p_i / \sum_i p,$$

and n_i refers to the total number of projects *i* worked on. Max p_i refers to the number of hours of the largest project of *i*, and $\sum_i p$ to the sum of all hours that *i* worked on.

This formula covers the idea that working on more projects provides a broader knowledge base, but controls for people who work 95% of their time on one project and the other 5% on 9 other projects. These people are clearly much more specialized than people working on 10 projects each for 10% of their time. Moreover, based on our initial analysis and the discussions with the company, we also learned that we needed to adjust the calculations on the dataset for two reasons. First, we needed to take the *log* function of n_i and multiply the result with 0.5, because the average number of projects per year per person was around 5 with a maximum of 30 projects. If we did not correct for this high number we would not find a difference between actors working on 3 projects and those working on 30 projects. Second, the dataset also contained several project numbers persevered for general work not related to any specific project, examples include

meetings with business partners, discussions with outside people and so on. The project numbers were mainly used by people in more managerial positions. Based on our discussions, we labeled these hours as general and excluded these specific project numbers from the dataset. The degree of specialism for these people was calculated as follows:

$$S_{total} = S_i \left(\sum_i p \Big/ \sum_i p + p_{gen} \right),$$

where p_{gen} refers to the number of hours a person worked on the aforementioned 'general' projects. The value for this measure varies from 0 to 1, where values approaching or equaling 1 are a sign of high specialization and where values approaching or equaling 0 are a sign of low specialization. If we now use this measure to calculate the degree of specialization of the two people noted above we can see the effect. Take person A and B, who have both worked 1600 hours in year t, on a total of 10 projects distributed in the following manner:

	Project 1	Project 2	Project 3	Project 4	Project 5	Project 6	Project 7	Project 8	Project 9	Project 10
Person A	5 hrs	5 hrs	8 hrs	24 hrs	1520 hrs	8 hrs	5 hrs	3 hrs	7 hrs	15 hrs
Person B	140 hrs	160 hrs	150 hrs	135 hrs	160	155 hrs	120 hrs	160 hrs	160 hrs	160 hrs

Table 6.1 Specialization level

With the measure, outlined above, we could calculate that person A has a specialization score of 0.63 and person B a score of 0.07. The example is clearly idealized, but does show the effect. Based on S_{total} we could subsequently calculate the average specialization of the people involved in a relation.

Joint project work. In order to determine the extent to which people had jointly worked on projects, we used the hour-registration system to construct affiliation matrices. We constructed an affiliation matrix for both the number of joint projects as well as the number of joint hours. This resulted in two basic indicators, namely the number of joint projects and the number of joint hours that two people had participated in.

Tie centrality. To explain current intensity, we considered the relative centrality of a tie within in each network. This was calculated as follows. First, for each network, we calculate the degree centrality of each person within that network (simply the number of ties of a person). Second, we calculate the relative degree centrality of each person in a network by dividing a person's degree centrality by the highest degree centrality found of any person in that network:

$$Cenrel_i = c_i / \max c ,$$

where c_i refers to the degree centrality of person i and where max c refers to the maximum degree centrality of any person in a given network and can range from 0 to 1, excluding 0, including 1. Based on this relative centrality indicator we can calculate the average relative degree centrality of each relation in the following way:

$$AverageCen_{ij} = \frac{Cenrel_i + Cenrel_j}{2} .$$

This outcome is subsequently dichotomized by assigning a value of 1 to all relations with an average centrality equal or larger than the average centrality of all relations and a value of 0 to all relations with an average centrality smaller than the overall average, which is expressed in the following way:

$$DichAveCen_{ij;x} = AverageCen_{i,j} \geq \left[\frac{\sum_{i,j} AverageCen_{i,j}}{x} \right],$$

where $\sum_{i,j} AverageCen_{i,j}$ is the sum of all $AverageCen_{i,j}$ values in network x and where x refers to the number of i,j relations in network x.

The problem with this measure is that a relation between two players with an average relative degree centrality will be considered equally as central as a relation between one highly central player and one very peripheral player. To solve this problem, we calculate the difference in relative degree centrality of each set of two players.

$$DiffCen_{ij} = \sqrt{\left(Cenrel_i - Cenrel_j\right)^2} .$$

This measure is also dichotomized by assigning a value of 1 to all relations with a difference in centrality equal or larger than the average difference of all relation and a

value of 0 to all relations with a difference in centrality smaller than the overall difference. This can be expressed in the following way:

$$DichDiffCen_{ij;x} = DiffCen_{ij} \geq \left[\frac{\sum_{i,j} DiffCen_{ij}}{x} \right],$$

where $\sum_{i,j} DiffCen_{ij}$ is the sum of all $DiffCen_{ij}$ values in network x and where x refers to the number of i,j relations in network x.

By subsequently multiplying the dichotomized average centrality with 1 minus the dichotomized difference in centrality we come to an indicator where central relations are assigned a 1 and peripheral relations or relations between central people and peripheral people are assigned a 0. In mathematical terms this indicator is expressed in the following way:

$$TieCen = DichAveCen_{ij;x} \times \left(1 - DichDiffCen_{ij;x}\right).$$

Joint friends. To assess whether a particular relation is surrounded by one or more 'mutual friends', we use a relative indicator that accounts for the size of ego networks. A 'mutual friend' (or joint alters) refers here to a situation in which two people who discuss a proposal, each discuss the same proposal with the same other person (alter).

This indicator is calculated in the following way. First, we used the 'Simmelian ties' routine in the social network analysis program UciNet VI (Borgatti et al., 2002) to calculate for each relation in a given network the number of "Simmelian ties" or mutual friends (Krackhardt, 1999). The problem with this number is that it tells us little about the relative importance of a particular relation to each actor. More importantly, this number also does not account for the theoretical notion that the "differences between triads and larger cliques" are minimal (Krackhardt, 1999). This point is illustrated by considering the following two relations in networks A and B.

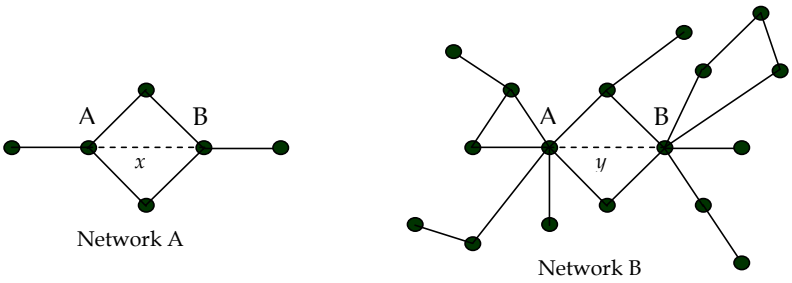

Figure 6.1 **Joint friends**

Both relation *x* and *y* are surrounded by two mutual alters. However, the number of other people A and B talk to in network 1 is much smaller than the number of other people A and B talk to in network 2. The impact of the mutual alters on relation *x* is thus likely to be stronger than the impact of the mutual alters on relation *y*, where person A and B talk to many more people. We, therefore, adjusted this number by taking the degree centrality of the two actors involved in a relation into account. This can be expressed in the following manner:

$$Simrel_{ij} = \frac{Simmel_{ij} / c_i + Simmel_{ij} / c_j}{2},$$

where $Simmel_{ij}$ refers to the number of Simmelian ties surrounding the relation *ij* and c_i refers to the degree centrality of person *i*. As a result, the value of this indicator ranges from 0 to 1. The added benefit of this adjustment is that the indicator makes relations more easily comparable across different sized networks, because a relation can always reach the maximum value regardless of network size.

Control variables

Three network level control variables were incorporated in the regression models on current intensity. More specifically, we incorporated the proposal potential, the network density and network size. Controlling for the potential of a proposal takes into account the likelihood that people are more motivated to work on a more promising proposal and might explain part of the reason why people interact more intensively. Controlling for the density and size of a proposal takes into account the likelihood that the overall size and density of the network in which a relation is embedded could increase the motivation and social pressure to interact more intensively.

Idea potential. See chapter 3 on page 61 for more details on this variable.

Network density. See chapter 3 on page 57-59 for more details on this variable.

Network size. See chapter 3 on page 57 for more details on this variable.

6.4 Analysis

To test the hypotheses regarding current and past intensity, we used ordinal logistic regression models or ordered logit models (ORM). We have chosen this method for two reasons. First, our dependent variables for the various analyses have four outcome categories, and are thus bounded, making ordinary least squares (OLS) analysis inappropriate (Washington & Zajac, 2005). Second, there is a clear rank between the four outcomes categories, making ORM desirable over multinomial logistic regression (McNamara & Bromiley, 1997).

In logistic regression the non-linear dependent variable is transformed into a linear variable by taking the natural logarithm of the odds, where odds refers to the ratio of the probability that an event occurs relative the probability that it does not occur (Pampel, 2000). The principal is the same for the logistic regression techniques used in this study with the exception that the outcome variable is not dichotomous, but ordinal. For the ORM's on current and past intensity, we distinguished between four different outcome categories. The function has this form (Contractor & Kundu, 1998):

$$Logit(P_1) = Log\left(\frac{(P_1)}{1-(P_1)}\right) = \alpha_1 + \beta_k \chi_{jk}$$

$$Logit(P_1 + P_2) = Log\left(\frac{(P_1 + P_2)}{1-(P_1 + P_2)}\right) = \alpha_1 + \beta_k \chi_{jk} \qquad etc.,$$

where P_1 is the probability of the dependent variable to fall in category 1 and $(P_1 + P_2)$ is the probability of the dependent variable to fall in category 1 or 2 etc. Moreover, α_1 refers

to the intercept of the model, X_{jk}'s refers to the independent variables and β_k's are the estimated coefficients.

The basic equations for the regression on current and past intensity are

$$Y_{2k} = \alpha_2 + \beta_k Y_{1k} + \beta_k X_{jk} + ... + \varepsilon_{2k}$$

$$Y_{1k} = \alpha_1 + \beta_k X_{jk} + ... + \varepsilon_{1k}$$

, where α_1, α_2 are the intercepts, the *Y*'s and *X*'s are, respectively, the dependent and independent variables and ε_1, ε_2 are the error or disturbance terms. The equations show that the dependent variable past intensity (Y_{1k}) is used as independent variable ($\beta_k Y_{1k}$) in the current intensity regression model. However, these equations do not have to be fitted in a simultaneous equation or structured equation model, but can be estimated separately, because these two equations form a recursive or triangular model (Gujarati, 2003). If current intensity was also used as an independent variable in the past intensity regression equation than we would need to apply a two stage least square model or equivalent models for categorical dependent variables.

To test the appropriateness of fitting an ordinal regression model to the data, we performed a test for the "proportional odds assumption" (Long & Freese, 2006, p. 197). The test the assumption, we used was an approximate LR test using the *omodel* procedure in Stata described by Long and Freese (2006). This test checks whether the models rightly assume that the probability curve for all the logits are parallel. The LR test generates a Chi-square statistic and a p-value, which, if it is large, indicates that the proportional odds assumption is valid. It should be noted, however, that violations of the "proportional odds assumption" are frequent (Long et al., 2006) and not necessarily problematic (Contractor et al., 1998). Nevertheless, if the p-value is significant than alternative models might be used to check the validity of the ordinal regression models, such as the 'stereotype logistic regression' or the 'multinomial logistic regression' model which do not require the coefficients to be completely identical across outcome categories. The stereotype model might be preferred over the multinomial model, because

it is a compromise between restricting the coefficients to be identical across all outcomes, which is the case in the ordinal model, and allowing the coefficients to vary by outcome category, which is the case in a multinomial model and makes the interpretation more straightforward than in a multinomial model (Long et al., 2006).

Since the dataset was obtained from the network level data, there is a potential problem of non-independence (Jensen, 2003) or within-cluster dependence among the observations (Washington et al., 2005). Williams (2000) notes: "This phenomenon is often referred to as overdispersion or extra variation in an estimated statistic beyond what would be expected under independence. Analyses that assume independence of the observations will generally underestimate the true variance and lead to test statistics with inflated Type I errors." In such situations, observations within a cluster should not be treated as independent, but the clusters themselves are independent (Gutierrez & Drukker, 2006). To account for this 'within-cluster' dependence of the networks and or proposals, we employed the robust estimator function in Stata using the robust procedure. Williams (2000) explains that the between-cluster variance estimator in this procedure is an unbiased estimator of the variance of a linear statistic. This estimator increases the accuracy of the assessments of the sample-to-sample variability of the parameter estimates even when the model is mis-specified (Gutierrez et al., 2006). This results in an increased standard error of estimates and thereby provides a more appropriately conservative test of the hypotheses (Washington et al., 2005). For more details on the estimator and the way in which it is calculated in Stata see Williams (2000) or Rogers (1993).

For model fit we used the measure of goodness of fit employing a chi-square statistic. For the predictive ability of the models we took the Nagelkerke pseudo-R square, which can be obtained by using the *fitstat* command in Stata. Pseudo-R square ranges from 0 to 1 and can be interpreted like a normal R square, although the values of pseudo-R square tend to be lower than R square values for models that fit the data well (Ibarra, 1993).

For multicollinearity issues, we used the *collin* procedure in Stata to assess whether data collinearity might be a concern in the dataset (Washington et al., 2005). The procedure calculates amongst others the variance inflation factor (VIF) and the tolerance level for each variable, which, according to Menard (1995) and Belsey et al. (1980), should not be greater than 10 (VIF) or below 0.1 (tolerance levels).

CHAPTER 7

Relationship level results

7.1 Introduction

In this chapter we will present the relationship level results from our study. The results for current and past intensity both start with the descriptive statistics tables followed by the tables with the ordinal logistic regression results. After each regression table, we discuss the implications for the hypotheses and finish both parts with a brief discussion on the implications for theory. The chapter concludes with a general discussion on the results and the link with existing literature.

7.2 Current intensity

The descriptive statistics regarding the current intensity dimension of tie strength are depicted in table 7.1 below.

Table 7.1 Descriptive Statistics[a] for current intensity

Variable	Mean	S. D.	1	2	3	4	5	6	7
1. Functional co-membership	0.82	0.39							
2. Unit co-membership	0.32	0.47	.33						
3. Past intensity	2.93	1.01	.31	.55					
4. Current intensity	1.74	0.86	.15	.10	.09				
5. Seniority difference	0.63	0.67	-.12	-.05	-.19	-.13			
6. Seniority average	2.25	0.55	-.11	-.26	.05	-.15	.32		
7. Joint project hours	114.88	374.24	.07	.26	.21	.07	-.07	-.09	
8. Joint project numbers	0.85	1.58	.11	.24	.26	.01	-.06	-.09	.33
9. Joint 'friends'	0.3	0.24	.17	.00	-.05	.36	.02	.06	-.03
10. Tie centrality	0.23	0.42	.16	.02	-.03	.46	-.07	-.05	-.05
11. Decision maker average	0.17	0.32	.06	-.09	.10	-.13	.22	.49	-.09
12. Decision maker difference	0.25	0.48	-.01	-.04	.00	-.13	.39	.34	-.09
13. Specialization level average	0.26	0.14	-.12	.09	-.09	.12	-.14	-.29	.13
14. Network size	17.64	9.13	-.03	-.11	.05	.03	-.09	.16	-.11
15. Idea potential	4.68	0.35	.03	-.02	.20	.06	-.02	.26	.04
16. Network density	0.22	0.11	.05	-.01	-.02	-.03	.05	.06	-.01

Variable	8	9	10	11	12	13	14	15
9. Joint 'friends'	-.07							
10. Tie centrality	-.01	.41						
11. Decision maker average	.01	.14	-.05					
12. Decision maker difference	.01	.12	-.02	.71				
13. Specialization level average	-.25	.06	.10	-.27	-.15			
14. Network size	-.07	-.05	.03	-.12	-.11	.05		
15. Idea potential	-.03	.15	.01	.16	.13	-.02	.21	
16. Network density	-.02	.52	.10	.18	.18	.02	-.25	.23

[a] Correlations greater than .11 absolute are significant at the .01 level.

For the statistical analysis on current intensity, we performed ordinal logistic regressions on four models. The first model is our baseline model where we used the three control variables as explanatory variables on the entire set of relations. In the second model, we again used the entire set of relations, but now include all independent variables excluding those on absorptive capacity. In the third model we included the project data, as described in the methodology section, as independent variables. In the fourth and final model we took an additional sub sample of the sample used in model 2 and now only considered interunit ties. As a result of focusing on interunit ties, we no longer included unit and function co-membership as independent variables.

The results for the four-level ordinal logistic regression are depicted in table 7.2. We could reject the hypothesis that the non-intercept parameters were zero for model two, three and four (p<.000) and therefore concluded that the explanatory variables, as a set, aided in predicting current intensity. The baseline model with only the explanatory variables did was not significant in predicting the current intensity.

Table 7.2 Results from the Four-Level Ordinal Logistic Regression Analysis[a,b,c,d] for current intensity

	Model 1 (baseline)	Model 2 (all ties)	Model 3 (ties with project data)	Model 4 (interunit ties with project data)
Functional co-membership		-0.451	0.478	
		(0.317)	(0.611)	
Unit co-membership		0.027	0.300	
		(0.273)	(0.367)	
Seniority difference		0.012	0.092	0.233
		(0.159)	(0.215)	(0.287)
Seniority average		-0.559*	-0.608*	-0.557
		(0.224)	(0.301)	(0.393)
Decision maker average		-0.235	-0.059	-0.523
		(0.355)	(0.411)	(0.504)
Decision maker difference		-0.633*	-1.159***	-1.755***
		(0.270)	(0.335)	(0.520)
Past intensity		0.301**	0.146	0.403*
		(0.118)	(0.158)	(0.187)
Joint 'friends'		4.281***	5.090***	4.802***
		(0.631)	(0.826)	(1.160)
Tie centrality		1.607***	1.835***	1.611***
		(0.232)	(0.317)	(0.397)
Specialization level average			-1.377	-0.413
			(1.216)	(1.388)
Joint project numbers			0.017	0.375**
			(0.073)	(0.133)
Joint project hours			0.000	-0.003
			(0.000)	(0.002)
Network size	-0.007	-0.012	0.007	-0.038
	(0.011)	(0.012)	(0.016)	(0.023)
Idea potential	0.460	0.837*	1.330**	0.842
	(0.263)	(0.354)	(0.442)	(0.498)
Network density	-0.990	-7.009***	-8.302***	-10.249***
	(0.875)	(1.394)	(1.710)	(2.353)
Observations	500	475	321	195
Wald chi-square	3.27	142.38***	106.12***	70.23***
Degrees of freedom	3	12	15	13
Nagelkerke R-square	.008	.367	.431	.446

[a] Unstandardized coefficients, standard errors in parentheses; * p < .05, ** p < .01, *** p < .001 two-tailed

[b] Note that we do not analyze the relations for each phase separately, because little is know about the small sample properties of logistic regressions (Pampel, 2000, p. 30) and it would violate the rule of a minimum 'variable-to-case' ratio of 1-10.

[c] Note that none of the variables listed were found to have tolerance levels below 0.38 or VIF values greater than 2.7, indicating that the model does not suffer from collinearity issues.

[d] Note that results of the LR test indicated that model 2 and 4 had p-values > .40 and model 3 had a p-value of .04. Although model 3 is not significant at the 0.1 level, we nevertheless ran a stereotype logistic regression and multinomial logistic regression. The results are highly consistent with the results in table 7.2 and lead us to have a high degree of confidence in the validity of the classification and construction of the variables.

The control variables are introduced first in model 1 of table 7.2, the so-called 'baseline' model. The model is not significant. Idea potential and network density are, however, significant in model 2, 3 and 4, as one would expect. Idea potential has a positive influence and density has a negative influence.

Based on ability and opportunity arguments, we hypothesized that unit and function co-membership would have no influence on the current intensity (hypothesis 1b). Consistent with hypothesis 1b, unit and function co-membership did not influence the current intensity dimension of tie strength in either model 2 or 3. Thus, we conclude that hypothesis 1b is supported for current intensity.

Based on motivation and opportunity arguments, we hypothesized that dissimilarity of seniority and decision-making power between people would negatively affect current tie intensity (hypothesis 2a) and that higher average seniority and decision-making power would negatively affect current intensity (hypothesis 2c). Consistent with hypothesis 2c we found that higher average seniority negatively influenced current intensity ($p<.05$), in both model 2 and 3. Contrary to hypothesis 2a, difference in seniority did not influence current intensity in any of the models. As for decision-making power, we did not find any support for the effect of the average level of decision-making power. However, we did find negative significant effects of the difference in decision-making power in all models. The results show that the negative effect of decision-making power is especially strong in model 3 and 4, suggesting that the barrier between decision-makers and non-decision-makers is especially strong within the lab. Thus, we conclude that both hypothesis 2a and 2c are partially supported for current intensity.

On the basis of ability and opportunity arguments we hypothesized that people's knowledge base could affect current tie intensity. More specifically, we hypothesized that broad project experience would positively affect current intensity for all ties (hypothesis 3a). Furthermore, we hypothesized that joint project work between two people would positively affect the current intensity between those people, but only for interunit ties (hypothesis 3c). The results show no support for the effect of broad project experience or

the effect of the number of joint hours. On the other hand, the results do show a highly significant positive effect ($p<.01$) for the number of joint projects. Thus, we conclude that there is no support for hypothesis 3a and partial support for hypothesis 3c regarding current intensity.

In the section on the effect of strong ties based on previous interaction, we hypothesized that strong past ties would positively affect current tie intensity (hypothesis 4). Strong past intensity did indeed have a significant positive effect in model 2 and 4. However, the positive influence in model 3 was not significant. Thus, we found partial support for hypothesis 4 regarding current intensity.

The fifth hypothesis was built on the presumed effect of Simmelian ties in relations. Based on motivational arguments from social network research related to this topic, we hypothesized that 'joint alters' surrounding a relation would positively affect current tie intensity (hypothesis 5). Consistent with this hypothesis, we found that 'joint friends' have a strong positive influence on current intensity in all models. We thus conclude that hypothesis 5 is supported regarding current intensity.

The last hypothesis regarding current intensity was focused on centrality. In this section we hypothesized that relations who were more centrally involved in the networks would positively affect the current tie intensity (hypothesis 6). Consistent with this hypothesis, we found that tie centrality has a strong positive influence on current intensity in all three models. We thus conclude that hypothesis 6 is supported.

Conclusion current intensity

The first general conclusion regarding the hypotheses is the strong significant effects of structural explanatory variables in all three models. The positive effect of strong past intensity was hypothesized and to be expected, but is not inline with previous research, which has assumed that strong ties lead to redundant information (Granovetter, 1973; Perry-Smith et al., 2003). Our results may be an indication that the benefit associated with 'old friends', such as psychological safety (Edmondson, 1999), information quality

and reliability (Granovetter, 1983; Ibarra, 1995; Nooteboom, 1999) and communication effectiveness (Moenaert et al., 1996) outweighs the possible adverse effects of a lack of diversity. Our results are robust, since the positive effect was primarily found in model 1, which includes all ties, and only to limited extent in model 3, which only includes interunit ties. If previous research was right than the positive effect should have been stronger for interunit ties instead of weaker, which we found. The results in this study thus extend the work of Perry-Smith (2006), who looked purely at idea generation, by showing that in the further development and refinement of creative thoughts people rely on strong ties.

The effect of 'joint friends' or Simmelian ties, on the other hand, is more interesting. These results show that the effects of density are also present at the relationship level and not only in the form of control, which was the main focus of Krackhardt (1999). Secondly, the most intuitive result is the strong positive effect of 'tie centrality'. The results are in line with the results for 'joint friends' and support the idea of a strong core group of people working on proposals. The result is, however, independent of 'joint friends' (we checked for multicollinearity).

The hypotheses regarding content aspects show few significant results. The only significant results are found for 'hierarchical average', 'decision maker difference' and joint project work. The results for hierarchical average are inline with the hypothesis and previous research (Han, 1996). It should, however, be noted that the results do not hold for interunit ties. The strong negative results for 'decision maker difference' are, on the other hand, found in all models including model 4 focusing on interunit ties. The results suggest that peers are considered more approachable when interacting both within and across units. The results for the effect of absorptive capacity show support for the hypothesis that joint project work can increase the intensity with which people interact across units. On the other hand, we do not find a significant effect for the importance of a broad project experience. These results therefore provide evidence that project membership does not increase communication intensity around proposals through a broad knowledge base and 'learning to learn', as suggested by Cohen and Levinthal (1990) and

Levitt and March (1988), but more directly by providing people with an opportunity to have knowledge of relevant people outside of their unit.

7.3 Past intensity

The descriptive statistics regarding the past intensity dimension of tie strength are depicted in table 7.3 below.

Table 7.3 Descriptive Statistics[a] for past intensity

Variable	Mean	S. D.	1	2	3	4	5	6	7
1. Functional co-membership	0.82	0.39							
2. Unit co-membership	0.31	0.46	.33						
3. Past intensity	2.88	1.04	.31	.55					
4. Seniority difference	0.62	0.66	-.12	-.05	-.19				
5. Seniority average	2.23	0.56	-.11	-.26	.05	.32			
6. Joint project hours	92.91	343.12	.07	.26	.21	-.07	-.09		
7. Joint project numbers	0.64	1.43	.11	.24	.26	-.06	-.09	.33	
8. Decision maker average	0.17	0.31	.06	-.09	.10	.22	.49	-.09	.01
9. Decision maker difference	0.25	0.48	-.01	-.04	.00	.39	.34	-.09	.01
10. Specialization level average	0.26	0.14	-.12	.09	-.09	-.14	-.29	.13	-.25

Variable	8	9
9. Decision maker difference	.71	
10. Specialization level average	-.27	-.15

[a] Correlations greater than .11 are significant at the .01 level.

For the statistical analysis on past intensity, we again performed ordinal logistic regressions on three models. In the first model we used the entire set of relations for all three phases. We did however, as noted earlier, correct for double relations by filtering those out this resulted in a final n of 385 (the total number of relations is 500). In the second model we included the project data, as described in the methodology section, as independent variables. In the third model we took an additional sub sample of the sample used in model 2 and now only considered interunit ties. As a result, we no longer included unit and function co-membership as independent variables.

The results for the four-level ordinal logistic regression are depicted in table 7.4. We could reject the hypothesis that the non-intercept parameters were zero for all three models (p<.000) and therefore concluded that the explanatory variables, as a set, aided in predicting past intensity.

Table 7.4 **Results from the Four-Level Ordinal Logistic Regression Analysis[a,b,c,d] for past intensity**

	Model 1 (all ties)	Model 2 (project data)	Model 3 (interunit ties & project data)
Functional co-membership	0.514	0.163	
	(0.267)	(0.591)	
Unit co-membership	3.470***	3.638***	
	(0.307)	(0.380)	
Seniority difference	-0.819***	-0.716***	-0.626*
	(0.164)	(0.222)	(0.263)
Seniority average	1.274***	1.241***	1.530***
	(0.205)	(0.288)	(0.351)
Decision Maker average	0.962	1.506	2.090
	(0.878)	(1.031)	(1.188)
Decision Maker difference	-0.378	-0.853	-0.581
	(0.460)	(0.529)	(0.648)
Specialization level average		-1.106	-0.560
		(0.953)	(0.928)
Joint project numbers		0.260	-0.071
		(0.172)	(0.218)
Joint project hours		0.000	0.004*
		(0.001)	(0.002)
Observations	385	256	163
Chi-square	155.08***	132.68***	45.53***
Degrees of freedom	6	9	7
Nagelkerke R-square	0.467	0.542	0.287

[a] Unstandardized coefficients, standard errors in parentheses; * p < .05, ** p < .01, *** p < .001 two-tailed

[b] Note that we do not analyze the relations for each phase separately, because little is know about the small sample properties of logistic regressions (Pampel, 2000, p. 30) and it would violate the rule of a minimum 'variable-to-case' ratio of 1-10.

[c] Note that none of the variables listed were found to have tolerance levels below 0.26 or VIF values greater than 4.2, indicating that the model does not suffer from collinearity issues.

[d] Note that results of the LR test indicated that the models have significant p-values. As a result we ran a stereotype and multinomial logistic regression, but excluded decision maker variables because of data problems. The results are broadly consistent with the results in table 7.3 and lead us to have a high degree of confidence in the validity of the classification and construction of the variables.

Based on ability and opportunity arguments, we hypothesized that unit and function co-membership would positively influence past intensity (hypothesis 1a). Moreover, given that unit co-membership, unlike function co-membership, often implies co-location, we also hypothesized that unit co-membership would have a stronger positive effect than function co-membership (hypothesis 1c). Consistent with hypothesis 1a, unit co-membership did have a strong positive influence on the past intensity dimension of tie strength (p<.000) in both model 1 and 2. However, the effect of function co-membership

was also positive, but only significant at the 0.054 interval level. As a result, we found support for hypothesis 1c that the effect of unit co-membership is stronger than the effect of function co-membership. Thus, we conclude that hypothesis 1a is partly supported and 1c is fully supported.

Based on motivation and opportunity arguments, we hypothesized that dissimilarity of seniority and decision-making power between people would negatively affect current intensity (hypothesis 2a) and that higher average seniority and decision-making power would positively affect past intensity (hypothesis 2b). Consistent with hypothesis 2a, we found that a difference in seniority had a strong negative influence on past intensity in all three models. Moreover, we also found that higher seniority had a strong positive influence on past intensity in all three models. However, we found no support for either the effect of the average level of decision-making power or for the difference in decision-making power in any of the models. Thus, we conclude that we found partial support for both hypothesis 2a and 2b.

On the basis of ability and opportunity arguments we hypothesized that people's knowledge base could affect past intensity. More specifically, we hypothesized that broad project experience would positively affect past intensity for all ties (hypothesis 3a). Furthermore, we hypothesized that joint project work between two people would positively affect the past intensity between those people (hypothesis 3b). Contrary to hypothesis 3a, we found no support for the effect of broad project experience. The results, however, do show support for the positive effect of joint project work in model 3, as we saw earlier in the previous regression model. Thus, we conclude that there is no support for hypotheses 3a and partial support for hypothesis 3b.

Conclusion past intensity

Since past intensity can by definition not be influenced by the interaction on behalf of the proposals, structural variables were not relevant. The content variables did, however, explain a great deal of the variation in past intensity. For all ties, we found that, inline with the hypotheses and previous research, unit co-membership is a strong explanatory

variable for past intensity. Moreover, inline with the hypothesis, the effect was also stronger than the effect for function co-membership. Although expected, this effect was not explicitly found in previous research and thus extends that line of research.

The less well documented effect of hierarchical average and difference is also in line with the hypotheses and previous research (Han, 1996). The results show that seniority is an important source for the strengthening of ties including those that span across units. These results thereby suggest that the hierarchical structure of a company does not only serve the role of a focusing device, as argued in classic management literature (Blau & Scott, 1963), but can also contribute to the internal cohesion within a company. The effect for decision-making power is absent.

Finally, if we look at the results for the effect of absorptive capacity, we again see support for the hypothesis that joint project work is a source for the strengthening of ties that span across units. Moreover, we again do not find a significant effect for the importance of a broad project experience. These results therefore again provide evidence that project rotation enhance communication intensity directly by bringing people into contact, as opposed to indirectly through a broad knowledge base and 'learning to learn', as suggested by Cohen and Levinthal (1990) and Levitt and March (1988).

7.4 Discussion

The results for current intensity showed strong significant results for the structural explanatory variables and only to a limited extent for the effect of the formal organizational structure. An interesting result was the importance of past intensity. Although inline with the hypothesis, it conflicted with previous research, which has assumed that strong ties lead to redundant information and would not be useful in an innovative context (Perry-Smith et al., 2003). Our results seem to indicate that the benefits of strong ties, such psychological safety, information quality and reliability and communication effectiveness, outweigh the adverse effects. It is also interesting to view these results in light of the dimensions of an advice network that were identified by Cross

et al. (2001). The study identified five potential dimensions, namely solutions, meta-knowledge, problem restructuring, validation and legitimation. One might expect that 'old friends' would be especially important to provide meta-knowledge (get a referral) and validation (getting support, boosting ones confidence). However, these dimensions refer to more low intensity interactions as opposed to problem restructuring. The positive effect on current intensity would thus suggest that 'old friends' do more than only 'setting us up' or 'patting our back'.

The results for past intensity showed the strong influence of the formal structure of the organization. The division of labor into units and seniority had a clear and strong influence. The most interesting result, although expected, was the effect of joint project work on the past intensity. The results show that project rotation within a firm can be an important source of social cohesion across units. Previous research in NPD literature has also advocated the benefits of job rotating systems (Griffin & Hauser, 1996a), but not with the specific purpose of 'building' networks. Although rotation has limitations resulting from the lack of required specialist knowledge and training, rotation policies can provide people within a firm the opportunity to build a network than extends across organizational boundaries, which may be especially important for newly recruited organizational members.

If we combine the results for current and past intensity, we see two interesting contradictions. First, there is a distinct difference in the effect of average seniority. For current intensity, higher seniority has a negative effect, whereas for past intensity it has a positive effect. These results are inline with the hypotheses and the possible explanation could be the time pressure of managers noted earlier. The results confirm previous research (Stevenson, 1990), which found that seniority has a positive effect in general on the formation of ties. However, in the FE, during the development of project proposals, contact with and between more senior people negatively effects the extent of the contributions. Linking this with the results from the previous section provides additional insights. The results here suggest that although more senior people contribute to success in the initiation and development phase, these contributions are more likely to the take the

form of ‘encouragement of risk taking’, ‘opportunity identification’ (Moenaert et al., 1996) or coordinating between the R&D scientists that do the actual in-depth problem solving and proposal writing.

The second contradiction found between the results for current and past intensity is the effect of a difference in decision-making power. The results show that there is a strong negative effect for current intensity, but non for past intensity. A possible explanation is that the decision-making role is not as prominent in ‘every day’ work as it is in the ‘ideation’/FE process. The ‘decision-making barrier’ noted earlier seems to depend on the type of work. When working on a task for which somebody is assessed by a group of which the particular person is a member seems to hinder the intensity. A possible reason is that the positive or negative effect of a decision makers’ opinion is more short term and directly noticeable in the FE process as opposed to the more long term effect of job appraisals and promotions. This explanation would also fit with the findings that the negative effect is especially strong for interaction across units. In those situations the direct effect of a go/no-go decision is clear, but the indirect effect on job appraisals of a line manager from another unit is rather diffuse. The results here are thus also inline with the results in favor of ‘old friends’ highlighting that the importance of psychological safety (Edmondson, 1999) and face-saving (Lazega et al., 1997) outweighs the potential benefit one could have from getting input or support from multiple decision-makers.

Summing up, the results confirm previous research (Lazega et al., 1997; Stevenson, 1990) on the influence of the formal structure on informal communication patterns. Moreover, the results show that although the division of labor in functions and units leads to ‘non-diverse’ ties, other formal structures, such as hierarchical levels, project membership and decision-making teams, can contribute to the formation of ‘boundary spanning’ ties.

The most obvious limitation of the results presented in this chapter and the second part of this study is the indirect link with success. We have therefore refrained from making suggestions regarding the effect of explanatory variables on success. However, the results

do provide some clear findings regarding the way in which networks are 'built' in a R&D context and specifically around project proposals. This last aspect also forms the most significant contribution of this study, because previous work on network structuring has focused on more enduring and stable working relations as opposed to the ad-hoc more instrumental interactions covered in this study.

CHAPTER 8

Discussion and Conclusion

8.1 Introduction

This research was divided into two parts. First, we looked at the influence of social networks on the acceptance of new product proposals in the front end of the new product development process. This was covered in part 1. This part consisted of three chapters of which the first covered the theoretical framework, the second the methodological approach and the third the results. Second, we looked at the extent to which the formal organizational structure influences the intensity with which people discuss project proposals in a NPD context. This was covered in part 2 and also consisted of three chapters outlining the theoretical framework, the methodology and the results respectively.

8.2 Key findings

It is not our intention to claim that 'networking' is the sole determining factor affecting the development and success chances of ideas. However, the importance of the role of 'networking' in NPD literature has been lacking and this study was aimed at filling this gap. By providing an in-depth study of the process, we have not only demonstrated that networking is an important part of the FE process, but have also shown the importance of a dynamic process that evolves over time. Our data confirmed existing views on the importance of large and diverse networks in the initial phases and extended existing insights by showing the importance of strong ties, increased density and the importance of involvement of senior management. The results suggest that relying on strong ties does not only provide more information, but can also help to increase the density over time thereby creating the necessary consensus. Moreover, in this process senior management plays a key role, by pushing people's imagination and providing an extensive and diverse network that can supply crucial information. The data on the relation level added to these

insights by showing that people interact more intensively with 'close friends' in dense cliques. This suggests that the positive effects associated with such relations, such as psychological safety and communication effectiveness, outweighs the possible adverse effects advocated in existing literature, on the potential lack of diversity. Furthermore, the results also showed the positive effect of the number of joint projects, as opposed to no effect of broad project experience. The results thereby extended existing literature by showing that project co-membership can increase communication intensity around proposals not through a broad knowledge base and 'learning to learn', as suggested by Cohen and Levinthal (1990) and Levitt and March (1988), but directly by providing people with an opportunity to interact with people outside of their unit.

8.3 Summary of the chapters

Chapter two

The first theoretical chapter (chapter two) started with a brief introduction on the two general benefits that can be derived from a network, namely information and coordinated action, following with a discussion on the specific aspects characterizing the FE. These specific aspects are the 'uncertainty and ambiguity', the 'tacitness and complexity', the 'cognitive distance' and the 'process view'. Based on literature we thereby identified three phases, initiation, development and refinement. The four key aspects do not only characterize the FE process, but also highlight the difference between this study and previous studies on the influence of social networks on creativity. Based on these four key aspects we build the theoretical framework that consists of a series of hypotheses that are divided in those that cover the structure of a network and those that cover the content of a network. Aspects of network structure that are considered in this study are network size, density and tie strength, aspects of network content that are considered in this study are network range, level of seniority and extent of decision maker involvement. The hypotheses propose that a network around a proposal should originate from people that are strongly tied to each other and include senior people. Moreover, the networks should evolve during the development phase into a large, diverse and strongly tied network with low density including senior personnel and decision makers. Finally, during the

refinement phase the networks should convergence into smaller, denser and less diverse networks, still based on strong ties and including senior personnel and decision makers.

Chapter three

The first methodological chapter (chapter three) covers the unit of analysis, the setting from which we collected our data, details on the data collection methods and procedures and the operationalization of our variables. The unit of analysis for this first part of the study was the network around a proposal. The data was collected from two large R&D labs in a large multinational in the fast moving consumer goods industry by means of interviews. Over 200 semi structured interviews were conducted on 18 proposal networks over a period of fourteen months. The dependent variable for this part of the study was the success of a proposal defined as the extent to which a proposal made it through the stage gate process employed by the multinational for new product proposals. The main independent variables followed from the hypotheses. The main challenge in the operationalization was caused by density for which we employed a measure that was based on the Burt's efficiency measure (Burt, 1992), which allowed us to compare the density of network from different size. We additionally considered the idea potential and newness to control for the effect that the initial attractiveness or newness may differ between low, medium and high success and as such influence the network characteristics.

Chapter four

The first results chapter (chapter four) presents the findings from our study on the influence of social networks on the proposal acceptance of product proposals in the FE. The chapter starts with a brief description of the three phases of the FE mentioned above, followed by the descriptive statistics for both network structure and content. The chapter continues with a discussion on three alternative explanations, namely idea potential and newness (mentioned earlier) and the decision-making process all of which did not vary systematically between low, medium and high success ruling out their potential effect.

The actual results showed that more successful networks of people initiating a proposal are bigger and consist of stronger ties and more senior personnel. The results for the

development phase showed that more successful networks were much larger and more diverse. Moreover, the density also varied significantly showing an inverted 'u-shape' between success and density. Lastly, both low and high success networks consisted of ties that were much stronger in terms of past intensity than the ties in medium success networks. The results for the refinement phase only showed a significantly higher level of density for high success networks.

The two main results sections are followed by the discussion of a proposal that in many ways resembled the characteristics of more successful proposals, but was rejected at the first gate. The exception showed that diversity and seniority of input is only useful if coming from the right people on the right subject. The chapter concludes with two sections in which we discussed the results in relation to existing theory. The key findings extending the existing models of Perry-Smith and Shalley (2003) and Burt (2004) are the need for networks to convergence in size from development to refinement, the importance of moderate levels of density during development and high levels during refinement, the importance of strong ties during all phases and, finally, the importance of seniority and decision-makers even during the initial phase. The second section discusses issues that transcend the boundary between network structure and content. Findings from the structured questions combined with the more open ended discussions on the evolution of ideas suggests that network growth as witnessed in the more successful networks was achieved through a combination of changes to the proposal as well as relying on strong ties. Moreover, the findings suggest that less dense networks, which span across units, can facilitate important changes to the direction of a proposal and prevent a proposal from being locked in prematurely. Finally, the findings suggest that a possible explanation for the increase in density during the final phase is in part caused by strong ties in the previous phase and member stability; in other words, not adding too many new people to a network in the final phase.

Chapter five

The second theoretical chapter (chapter five) focuses on the influence of the formal organizational structure on the intensity with which people discuss proposals in the FE

and on tie intensity in general in R&D labs by using the analogy of 'ability, motivation and opportunity'. Based on these three key aspects we built a theoretical framework that consists of a series of hypotheses that cover the organizational structure (content), such as organizational membership and seniority, and the network structure (structure), such as the extent to which people knew each other (past intensity) and the centrality of a discussion. The hypotheses thereby distinguished between the effects on the intensity that people interact in general and the intensity of interaction specifically regarding the development of proposals. Functional and unit co-membership, average level and similarity of seniority and decision-making power and project experience were thereby assumed to positively influence interaction in general. Interaction specifically related to proposals was hypothesized to positively be influenced by similarity of seniority and decision-making power and project experience, but, unlike interaction in general, also by the extent of previous interaction, relation centrality, and surrounding 'third parties'.

Chapter six

The second methodological chapter (chapter six) mainly focuses on the methodological difference between part one and two, being the unit of analysis, the operationalization of various constructs and the statistical analysis. The unit of analysis for this part of the study is the relations that form the networks described in part one. The analyses are split in two parts. The first and main part takes 'current intensity' as dependent variable; the second part takes 'past intensity' as dependent variable. The independent variables follow from the hypotheses. Additionally, three control variables were added to account for network level effects including the idea potential, size and density. This chapter concludes with a discussion on the ordinal logistic regression techniques employed in this part of the study, including the method for testing the "proportional odds assumption", the corrections for "within-cluster" dependence and the method for detecting collinearity issues between the independent variables.

Chapter seven

The second results chapter (chapter seven) presents the findings from the second part of our study on the influence of the organizational structure on the intensity with which

people interact in the FE and on behalf of project proposals in specific. The chapter starts with a discussion of the results from the regression on interaction on project proposals in specific (dependent variable: current intensity) followed by a discussion on the results from the regression on interaction in general in the FE (dependent variable: past intensity).

The results on current intensity showed the negative effect of the average level of seniority and the negative effect of decision maker difference. Moreover, the results show the strong positive effects of joint project work, past intensity, joint friends and tie centrality. The results thereby extended existing theory by showing that the positive effects associated with past intensity and joint friends, such as psychological safety and communication effectiveness, outweighs the possible adverse effects of a lack of diversity as argued by advocates of the 'structural hole' (Burt, 2004; Perry-Smith et al., 2003) and 'weak tie' argument (Granovetter, 1973; Perry-Smith et al., 2003). Moreover, the results also showed the positive effect of the number of joint projects on the intensity of interunit ties, but no effect of broad project experience. The results thereby extended literature by showing that communication intensity around proposals is not increased through a broad knowledge base and 'learning to learn', as suggested by Cohen and Levinthal (1990) and Levitt and March (1988), but more directly by providing people an opportunity to interact with people outside of their unit.

The results on past intensity showed the positive effect of unit co-membership, seniority average and joint project work and the negative effect of seniority difference. The results thereby extend existing theory by showing that the positive effect of average seniority and unit co-membership and the negative effect of seniority difference does not only enhance tie formation in general, but also tie intensity specifically in an R&D context. Moreover, the results again showed the positive effect of the joint project work and again no effect of broad project experience. The results thereby again extended literature by showing that project co-membership also increases communication intensity in general.

8.4 Contribution to the literature

This study focuses on social networks in the FE of the NPD process and the results therefore have bearing on the NPD literature and social network literature. Regarding the NPD literature and specifically the stream focusing on the FE we noted in the introduction that while there is a clear acknowledgement of the fuzziness of the FE, most of the studies in this stream advocate a high degree of formalization of the process and take a top-down, organizational perspective (Reid et al., 2004). A noteworthy exception is the theoretical study by Reid and the Brentani (2004) highlighting the importance the individual plays in bringing information from the environment into the organization. Information sharing between individuals is thereby considered crucial in the FE. We build on this last study by taking a social perspective and an in-depth look at the social structure in which ideas surface and develop further into project proposals. The importance of the social dimension of the front end of the new product development (NPD) process was already identified early on by, amongst others, Fleck (1979), Allen (1977) and Van de Ven (1986). However, these early studies did not go into great detail regarding the characteristics and mechanisms of this social process.

Our perspective is not only different from most innovation studies because of the in-depth social perspective, but also because our description of the FE puts more emphasis on the adaptive effects originating from proper networks of proposals during the FE. Whereas the traditional view of the front end is characterized by a selection perspective, our description thus emphasizes the adaptive effects of the networks of ideas (Hodgson, 2001; Lewin & Volberda, 1999).

The considerations above have subsequently led to the development and testing of the appropriateness of the first theoretical framework, which focused on how the structure and content of the network of a proposal, and its dynamics, affect the success of this adaptation process. We thereby built on recent developments in social network literature (Burt, 2004; Perry-Smith, 2006; Perry-Smith et al., 2003) that have focused on the initial phase of the FE process. The resulting framework and results thus address the gap between the social network literature, focusing on idea generation, and the NPD

literature, focusing on idea selection, by developing and testing the appropriateness of a framework on the FE of the NPD process that concentrates on the transition from idea initiation to selection. We have thereby specifically gone into the tradeoff between sparse networks, associated with novel information and autonomy and dense networks, associated with in-depth information and coordinated action.

The first part of this research extends and contributes to existing literature in four ways. First, by building on recent trends within the social network literature we went beyond a pure structuralist view of networks (Adler et al., 2002) by developing and finding support for a dynamic network perspective, which has thus far hardly been applied in the context of creativity and innovation (Perry-Smith, 2006). We distinguished three phases in the FE and found that the structure and content of the network of the proposal should change throughout the FE for the network to contribute to the quality of the proposal. Second, we developed a theoretical framework that builds on a broad base of literature including literature on behavioral decision-making (Daft et al., 1986; Mintzberg et al., 1976; Weick, 1995), creativity (Kurtzberg et al., 2001; Lubart, 2001), cognitive distance (Cohen et al., 1990; Nooteboom, 1999), social networks (Burt, 1992; Coleman, 1988) and innovation (Dougherty, 1992; Moenaert et al., 1996). Third, we disentangled the discussion on density from tie strength by following Reagans and McEvily (2003, p. 245) who state that "network structure can affect knowledge transfer independent of the effects of common knowledge and tie strength" and provided empirical support for doing so. Lastly, we improved classic network measures to make them more applicable to small networks that vary in size thereby contributing to methodological literature in the social network stream.

For the second part of this research we build on social network literature related to network structuring and information seeking and applied this in a NPD context leading to a theoretical framework in which we focused on the relationship level of the networks surrounding the above mentioned project proposals. We thereby looked at how different aspects of the formal organizational structure influence the intensity of interaction in general in an R&D setting and specifically around project proposals. The second part of

this research thereby built on literature on social structures (Granovetter, 1973; Krackhardt, 1999; McPherson et al., 2001), absorptive capacity (Cohen et al., 1990) and relational risk (Bogenrieder et al., 2004; Edmondson, 1999) and thereby specifically focused on the tradeoff between the benefit of diversity and the benefit of psychological safety, motivation and trust in a NPD context. Previous research had addressed the influence of formal organizational structures, such as unit and divisional co-membership (Han, 1996; Lazega et al., 1997; Stevenson, 1990) and hierarchical levels (Han, 1996; Stevenson, 1990) on tie formation, but had not focused on the effect on the intensity of interactions. Moreover, previous research had not looked at tie intensity of temporary relations and networks, but instead more on routine interactions involved in carrying out a job (Han, 1996) and, as a result, could also not take the effect of the network structure on tie intensity into account. We thereby found that people interact more intensively with 'close friends' in dense cliques and showed the positive effect of the number of joint projects, as opposed to an effect of broad project experience. Finally, previous research had paid little attention to interaction in innovative contexts characterized by uncertainty and ambiguity, complexity and diversity of information.

The aim of the second part is to extend the insights from previous literature to interaction in general in a NPD context and specifically to temporary relations aimed at coalition formation around proposals in the FE. The second part of this research thereby extended and contributed to existing research in three ways. First, we extended existing frameworks on the influence of the formal organizational structure by focusing on tie intensity in both temporary as well as stable working relations, do so in an innovative context, and thereby include the role of the network structure and people's absorptive capacity. This allowed us to test and extend the theoretical assumptions of Stevenson (1990) for the effect of the formal organization on collective action within organizations. Second, we extended existing theoretical insights by developing a theoretical framework that built on the need for ability, motivation and opportunity (Adler et al., 2002) and drew on a broad base of literature including literature on social structures (Granovetter, 1973; Krackhardt, 1999; McPherson et al., 2001), absorptive capacity (Cohen et al., 1990) and relational risk (Bogenrieder et al., 2004; Edmondson, 1999). Lastly, we used project

membership data and constructed a new way to assess the extent of people's absorptive capacity thereby contributing to methodological literature in the knowledge management stream.

8.5 Managerial relevance

This study has managerial implications. Most importantly, managers acting in accordance with this framework should encourage idea generating employees to discuss these ideas with others before submitting the idea for review. Moreover, they should not hesitate to give some direction to the idea with an eye on company requirements. More generic actions that management can take to improve the FE process include: reconsider recruitment policies, make more effective use of project or job rotating systems, create peer networks and develop guidelines for proposals that stimulate networking.

First, company recruitment could take the networking potential of employees involved in idea generation and development into consideration. This implies that such employees could be recruited because of their extensive existing network in the scientific or organizational world or for their networking skills. Research on this last topic is limited, but initial work indicates that, for example, self-monitoring individuals, who have the willingness and ability to monitor and control their self-expression in social situations, are better in networking (Kilduff & Tsai, 2003). Testing of such character traits could be made part of the psychological tests that are now commonly used in recruitment or assessment procedures.

Second, the benefits of project or job rotating systems in a R&D and NPD setting have been advocated in previous research (Griffin et al., 1996a), but not with the specific purpose of 'building' networks. The degree of rotation could vary from regular project rotation to specific functional or unit relocations. A more structured approach to project rotation could be an easy to implement way of ensuring that 'well-connected' senior personnel comes into contact with 'fresh' university talent. Instead of relying on established project teams, managers may be well informed to rotate the members of these

regularly. A more far-reaching method of creating 'boundary spanning' ties is to selectively rotate personnel across organizational boundaries. Although rotation across functional areas has limitations resulting from the lack of required specialist knowledge and training, rotation within functions but across units can not only give scientists and product developers a broader frame of reference and access to both technical as well as managerial knowledge, but more importantly, help build valuable relations.

Third, management of R&D labs or NPD facilities should instead of inviting highly senior managers to give their view on the strategic direction of a firm focus more on bringing lower level business developers into contact with their R&D scientists or product developers. Although the creation of an open culture towards higher management is undoubtedly important, the reality is that the time pressure on senior management is high. Creating personal networks at lower levels can in such situation be much more effective and can facilitate a dialogue between different functions within a firm instead of one way top-down communication. It will also mitigate the seniority and decision-maker barrier found in the second part of this study.

Lastly, management should create guidelines for the submission of ideas for new projects that stimulate information gathering. Idea suggestion systems such as Shell's Game Changer, IBM's alphaWorks could employ guidelines for the submission of a proposal by, for instance, asking for evidence of input from a number of different experts both inside and outside the company and at least basic management input. Management should thereby switch from a focus on 'gate management' to a focus on 'idea development management'.

8.6 Limitations and suggestions for future research

We will be the last to claim that 'networking' is the sole determining factor affecting the development and success chances of ideas. However, the importance of networking in new product development literature was lacking and this study has aimed at filling this gap. However, our study has various limitations. First, the most obvious limitation is the

number of proposals. The research design and time required to collect the data left us with few other options, but the statistical techniques to analyse the data are clearly hampered by the number of proposal that can be monitored using this research design. An interesting way to overcome this problem for future research is to combine or replace the interview approach with the collection of email data.

This method of using email exchanges to map social interaction is relatively new, but shows interesting results (Kossinets & Watts, 2006; Loch, Tyler, & Lukose, 2003) and could be a means to increase the number of proposals or initiatives that can be followed. In such a research design, interaction between people in the network is identified on the basis of email exchanges, for which fully automated software programs exist. Key in such a design will be to filter out those email exchanges that relate to a specific initiative. This could be done by scanning for keywords in email headers or even in the actual text body. Email data provide some clear advantages. First, there is no interviewee bias. People will not over- or underestimate certain relations. Second, there is no problem with reactive measurement, which refers to the influence of interviewers mapping a network on the dynamics of the network. This would require that there is no reasonable connection between the use of the email data for such a study and the knowledge of such use by the participants in the networks around initiatives. The obvious disadvantage of email data is the construct validity. Measuring social interaction by mapping email exchange will not cover all social interaction relating to a project proposal. Furthermore, emails that do not contain the key words or phrases may not be detected. To ensure that email exchange is a good proxy for social interaction, researchers should conduct the research in a setting that relies heavily on email exchange, such as the software industry.

A second limitation was that the data was collected within a single firm. This has clear implications for the external validity of the findings. We can for instance not assess to what extent the findings found in this study are influenced by the industry in which the firm operated, the organizational structure, the design of the review process or the organizational culture. Future research could thus extend the framework of part one by conducting the research in industries that are more technology driven or more market

driven. Although the involvement of current customers or people from marketing units may be desirable in market driven industries, it may frustrate the generation of ideas in more technology driven industries (O'Connor, 1998). Other issues surrounding more technology driven ideas are the higher levels of uncertainty and ambiguity, the need to overcome internal cultures pressuring people to pursue low risk, incremental innovations (Dougherty, 1992) and the difficulty to convey more complex ideas to decision makers (Reagans et al., 2003). These issues may imply that appropriate levels of tie strength may vary according to the degree of technology-push or market-pull of an industry.

Other limitations include the measure of success, the exact moment of initiation, the operationalization of tie strength, interaction effects and the randomness of 'past ties'.

- Regarding the measure of success, one could argue that although successful proposals were successful in obtaining funding, they may not have market success. Through experience and market analyses, manager's insight in technology, markets and project team abilities will create some degree of correlation between their gate decisions and market success. However, a future research design could focus on this correlation between front-end assessments and actual market success more explicitly, although it will be challenging to control for external effects occurring throughout the actual development process such as market and technology developments.
- Regarding the initiation, we needed to rely on the recollection of respondents to determine when an idea first came up. In the cases where the intention to write a proposal on a certain subject came up during a discussion it was reasonably easy to establish the moment and involvement of people, because we could triangulate. However, in the two cases where the scientists reported that the idea came up during 'personal' work, it is difficult to determine whether these ideas were not in fact triggered by a discussion even if only on the "fringe of consciousness" (Dasgupta, 1994).
- Regarding the operationalization of tie strength, it is important to note that tie strength in this study covered intensity and duration of ties, but not aspects such as emotional closeness, reciprocity and scope (Gilsing et al., 2005; Granovetter, 1973).

However, as we indicated before, prior literature indicates that tie intensity does correlate substantively with emotional closeness (Reagans et al., 2003).

- Due to the limited number of proposals that we collected in the current research set-up, we could not take interaction effects into account in study one. Future research could, for instance, take the interaction between range and tie strength into account. The effect of unit range on success might, for instance, be positively mediated by tie strength, because exchanging diverse insights is only possible when people take time to understand bridge their cognitive gap.
- The 'past intensity' ties analyzed in the second part were clearly not randomly selected from all ties that exist between people in an R&D context, but referred only to ties that people use for developing proposals. The implications therefore only apply to ties that are related to proposal development and other temporary, high uncertainty initiatives or action plans.

Extensions to related literature

Extensions not directly related to specific limitations could link this research with findings from other streams of research. First, one interesting link could be made with research on organizational learning by specifically considering the effect of perceived relational risk of organizational members, such as psychological safety (Edmondson, 1999) or lock-in or spill-over risk (Bogenrieder et al., 2004), on the degree of social interaction in the FE. This might imply that in organizations with a competitive culture, strong ties and a larger power base are more important. This extension could also be dynamic by not only considering the networking effect on the idea, but also on the people involved. Building on the 'interactionist' perspective advocated by Woodman et al. (1993), it would be interesting to see how, for instance, 'networking experience' on previous ideas influences people's motivation and networks on new ideas. Second, related to the effect of relational risk is the effect of perceived group and organizational identity experienced by members of organizations and specifically how this effect might influence the findings in the second part of this study. Ashforth and Mael (1989) have, for instance, argued that "the very fact that groups exist" in an organization leads to group conflict. These authors have argued that the tendency for people to identify with so-called

'in-group members' and differentiate from out-group members can lead to much conflict if the subunits are highly differentiated and if the subunits are clearly bounded. Moreover, this is assumed to be further enhanced if there is an absence of a strong organizational identity. The positive effect of unit co-membership or the negative effect of seniority difference might, for instance, have been less strong in organizations with a stronger organizational identity or less clearly bounded subunits or hierarchical levels. Extensions based on social identity research could thus look more closely at how the extensiveness of the division of labor in a firm influences the intensity of interunit ties and how this is mitigated by the organizational and personal identity. Third, a final interesting extension to other streams of literature could consider the role of traits or skills besides 'self-monitoring'. Such a study could consider which traits add to a persons networking skills, besides 'self-monitoring'(Kilduff et al., 2003), if these traits or skills can be developed through training, how these traits could best be measured in recruitment procedures and, finally, what the optimal mix of traits would be in an NPD context.

Extensions in light of industry trends

We would like to conclude this chapter with a brief discussion on a few industry trends and their potential impact on the organization of the FE. First, the trend of multinationals to not only market and sell 'home-made' products abroad, but also produce and in some instances even develop new products for local or global markets. Eppinger and Chitkara cite a Deloitte Research study which showed that 48% of the surveyed North American and Western European manufacturers had set-up engineering operations outside of their home region (2006). Although an increased level of internationalization of companies can be a source of diverse information benefits, it also puts strains on the ease of internal communication, more specifically, because of an increased geographical distance and an increased level of cultural linguistic distance. Second, a related trend is the increasing degree of cooperation in innovation, in the form of alliances, joint ventures, co-development, often grouped under the header 'open innovation' and nicely illustrated in a recent article on Proctor and Gamble's "connect-and-develop strategy" (Huston & Sakkab, 2006). This trend poses similar opportunities in terms of diverse information benefits, but also creates challenges regarding communication across geographical

locations and across organisational cultural boundaries and the risk of spill-over. The degree of geographical dispersion may vary in extensiveness, but previous research has shown that even poorly designed facilities can create formidable barriers frustrating effective communication among researchers (Allen, 1977). The differences in organizational cultures may also vary, but will surely impact the tacit dimension of communication. Third, the increased usage of electronic communication devices, such as email, ip-telephone, videoconferencing and so on. Clear benefits of these communication devices are their speed, relative low cost and availability. They have been particularly useful in bridging the communication gap between geographically dispersed people. One might, therefore, argue that the geographical dispersion associated with an increased internationalization of and cooperation between companies, as noted above, may well be mitigated by these communication devices. However, there is also an increased risk of (un)intended spill-over. Emails containing confidential information could, for instance, be forwarded to other recipients that were not intended by the original sender or even intercepted by competitors. Moreover, highly tacit and complex information is not easily transferred through electronic communication devices (Desouza, 2003). Summing up, we would conclude that the increased internationalisation, cooperation and digitalization of communication put a strain on the exchange of information and to the building of networks that are appropriate to support decision making in the FE of the NPD process. These developments thus pose specific challenges for the organization of the FE and would be an interesting venue to address in future research.

APPENDIX A

The Idea

Assuming that the idea will make it to the end could you answer the following questions:

- **Could you classify to what type of product this idea could lead, if you had to choose from the list below:**

    1. **New to the world** (New technology that creates an entirely new market)
    2. **New to the company** (New technology that, for the first time, allows Unilever to enter an established market)
    3. **Additions to existing product lines** (New technology that supplements this company's established technologies)
    4. **Improvements in / Revisions to existing products** (New technology that provides improved performance or greater perceived value and replaces existing products)
    5. **Repositioning** (Existing technology targeted to new markets or market segments)
    6. **Cost reductions** (New technology that provides similar performance at lower cost)

- **How big is the market this idea could potentially tap into?**

Niche market				Mainstream market	No opinion
☐	☐	☐	☐	☐	☐

- **How big could the market share be as a result of this technology?**

Small share				Big share	No opinion
☐	☐	☐	☐	☐	☐

- **How technological advanced is this idea in terms of the speed with which competitors could copy or imitate the idea?**

Easy to substitute				Difficult to substitute	No opinion
☐	☐	☐	☐	☐	☐

- **What is the technical feasibility of the idea?**

Low feasibility				High feasibility	No opinion
☐	☐	☐	☐	☐	☐

- **In your opinion, how enthusiastic do you think the categories or lab management will be with this idea? And could there be a difference between different categories or between categories and lab management?**

	Highly skeptical				Very enthusiastic	No opinion
Middle line team	☐	☐	☐	☐	☐	☐
FRC management	☐	☐	☐	☐	☐	☐
Category …	☐	☐	☐	☐	☐	☐

APPENDIX B

Newness based on the following alternative answer order: 'New to the world' = 6, 'New to the company' = 5, 'Repositioning' = 4 (was 2), 'Additions to existing product lines' = 3 (was 4), 'Improvements in / Revisions to existing products' = 2 (was 3) en 'Cost reductions' = 1.

Table B.1 Idea newness using alternative answer order [a,b,c]

Success	N	Low	N	Medium	N	High
Variables		Mean (std dev)		Mean (std dev)		Mean (std dev)
Newness	7	4.11 (1.10)	5	3.94 (0.75)	5	3.86 (1.08)

[a] The significance signs next to the label of the variable indicate the overall level of significance. We distinguish between the following three levels of significance: °sig. < 0,10 ; °° sig. < 0,05 ; °°° sig. < 0,01.

[b] The significance of the differences is calculated for all three pairs, 1 & 2, 1 & 3 and 2 & 3. If the differences are significant, this is indicated as follows:

For differences between group 1 & 2
- *sig. (one-tailed) < 0.10
- **sig. (one-tailed) < 0.05
- ***sig. (one-tailed) < 0.01

For differences between group 1 & 3
- #sig. (one-tailed) < 0.10
- ##sig. (one-tailed) < 0.05
- ###sig. (one-tailed) < 0.01

For differences between group 2 and 3
- †sig. (one-tailed) < 0.10
- ††sig. (one-tailed) < 0.05
- †††sig. (one-tailed) < 0.01

[c] The figures for low successful proposals are based on 7 cases, because one proposal only involved one person who did not discuss his or her idea with anybody.

Both the ANOVA and the t-tests showed no significant difference between the various success levels ($F(2, 14) = 0.10$, $p = 0.90$).

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Summary

An effective 'front end' of the new product development process is important for the innovative performance of firms. The front end (FE) is the process during which ideas are born and further developed, ending with the go/no-go decision for the start of a project and is generally considered to be an integral part of the new product development process (NPD) (Khurana et al., 1998). Because of its importance, many firms put effort into organizing the front end of their product development process (Kim et al., 2002). Typical examples include IBM's 'alphaWorks' and Shell's 'GameChanger' suggestion and review system. The dominant view behind such endeavors and in existing literature is that firms should collect as many ideas as possible, organize an effective review and selection process, and provide appropriate feedback to idea submitters (Wheelwright et al., 1992).

Although there is a clear acknowledgement of the fuzziness of the FE, most of the solutions cited in previous literature advocate a formalization of the process and assume that decision makers make consistent choices that maximize the value for the firm and that result from systematic assessments of all alternatives in comparison to predetermined criteria. Although some studies have advocated a more social perspective, the general focus on formal structures has led to an under appreciation of the social processes involved in decision-making on new product development projects. In contrast, we specifically develop and test the appropriateness of a social network perspective on the FE. We study how the social network of an idea, i.e. the people discussing the idea with each other, including the dynamics of that network, affect the adoption of the idea by the firm. We also investigate how these social networks are built up and how this is effected by both the formal organizational and network structure itself.

The research is thereby split into two parts. The first part focuses on the networks surrounding project proposals in the FE and is based on the idea that networks of employees surrounding a proposal affect the quality of that proposal and its chances of adoption. Our perspective is based on the view that proposals are adapted and improved

before they are actually reviewed by management. In the second part, we focus on the relationship level of the networks surrounding the above mentioned project proposals. We thereby focus on how different aspects of the formal organizational structure influence the intensity of interaction in general in an R&D setting and specifically around project proposals. Both parts consisted of three chapters, a theoretical, methodological, and results chapter.

The first theoretical chapter focused on the two general benefits that can be derived from a network, namely information and coordinated action and how these benefits play a role in the three phases identified in the FE. Based on the specific nature of the FE, we build our theoretical framework consisting of a series of hypotheses. In these hypotheses we propose that a network around a proposal should originate from people that are strongly tied to each other and include senior people. Moreover, the networks should evolve during the second (development) phase into a large, diverse and strongly tied network with low density including senior personnel and decision makers. Finally, during the last (refinement) phase the networks should convergence into smaller, denser and less diverse networks, still based on strong ties and including senior personnel and decision makers.

The unit of analysis for this first part of the study was the network around a proposal. The data to explore the appropriateness of the theoretical framework was collected from two large R&D labs in a large multinational in the fast moving consumer goods industry by conducting over 200 semi-structured interviews over a period of fourteen months leading to an eventual sample of 18 proposal networks. The dependent variable for this part of the study was the success of a proposal defined as the extent to which a proposal made it through the stage gate process employed by the multinational for new product proposals. The main independent variables followed from the hypotheses. We additionally considered the idea potential, newness and decision-making process to control for the effect that the initial attractiveness, newness or the decision-making process may differ between the proposals and as such influence the network characteristics.

The results chapter presents the findings on the influence of social networks on the proposal acceptance in the FE and starts with a brief description of the three phases, followed by the descriptive statistics and a discussion on three alternative explanations, namely idea potential and newness (mentioned earlier) and the decision-making process all of which did not vary systematically with success ruling out their potential effect. The results extended existing models of Perry-Smith and Shalley (2003) and Burt (2004) by showing the need for networks to convergence in size from development to refinement, the importance of moderate levels of density during development and high levels during refinement, the importance of strong ties during all phases and, finally, the importance of seniority and decision-makers even during the initial phase. Moreover, the findings from the structured questions combined with the more open ended discussions on the evolution of ideas suggests that network growth as witnessed in the more successful networks was achieved through a combination of changes to the proposal as well as relying on strong ties. Moreover, the findings suggest that less dense networks, which span across units, can facilitate important changes to the direction of a proposal and prevent a proposal from being locked in prematurely. Finally, the findings suggest that a possible explanation for the increase in density during the final phase is in part caused by strong ties in the previous phase and member stability; in other words, not adding too many new people to a network in the final phase.

The theoretical chapter for part two of the study focuses on the influence of the formal organizational structure on the intensity with which people discuss proposals in the FE and on tie intensity in general in R&D labs by using the analogy of 'ability, motivation and opportunity'. Based on these three key aspects we formulated a series of hypotheses wherein we distinguish between the effects on the intensity that people interact in general and the intensity of interaction specifically regarding the development of proposals. Functional and unit co-membership, average level and similarity of seniority and decision-making power, and joint project work and experience were thereby assumed to positively influence interaction in general. Interaction specifically related to proposals was hypothesized to be positively influenced by similarity of seniority and decision-making power, and joint project work and experience, but, unlike interaction in general,

also by the extent of previous interaction, relation centrality, and surrounding 'third parties'.

The methodology for the second part was to a certain extent similar to part one, the difference was the unit of analysis, the operationalization of various constructs and the statistical analysis. The unit of analysis for this part of the study is the relations that form the networks described in part one. The analyses are split in two parts. The first and main part takes 'current intensity' as dependent variable; the second part takes 'past intensity' as dependent variable. The independent variables follow from the hypotheses. Additionally, three control variables were added to account for network level effects including the idea potential, size and density. This chapter concludes with a discussion on the ordinal logistic regression techniques employed in this part of the study.

The results for the second part of our study on current intensity showed the negative effect of the average level of seniority and the negative effect of decision maker difference. Moreover, the results show the strong positive effects of joint project work, past intensity, joint friends and tie centrality. The results thereby extended existing theory by showing that the positive effects associated with past intensity and joint friends, such as psychological safety and communication effectiveness, outweighs the possible adverse effects of a lack of diversity. Moreover, the results also showed the positive effect of the number of joint projects, but no effect of broad project experience thereby showing that communication intensity around proposals is not increased through a broad knowledge base and 'learning to learn', but more directly by providing people with an opportunity to interact with people outside of their unit.

The results on past intensity showed the positive effect of unit co-membership, seniority average and joint project work and the negative effect of seniority difference. Moreover, the results again showed the positive effect of the joint project work and again no effect of broad project experience. The results thereby extend existing theory by showing that the positive effect of average seniority and unit co-membership and the negative effect of seniority difference does not only enhance tie formation in general, but also tie intensity

specifically in an R&D context. The results thereby again extended literature by showing that project co-membership also increases communication intensity in general.

The contribution of the first part of this dissertation to NPD literature is that we develop and test the appropriateness of a dynamic social network perspective of the FE process and in doing so put more emphasis on the adaptive effects originating from networks, as opposed to the classic selection perspective advocated in existing literature. The first part contributes to social network literature by developing and finding support for a dynamic network perspective, which has thus far hardly been applied in the context of intraorganizational creativity and innovation (Perry-Smith, 2006). Moreover, we disentangled the discussion on density from tie strength and provided empirical support for doing so and improved classic network measures to make them more applicable to small networks that vary in size.

The second part of this dissertation mainly contributes to social network literature by extending existing frameworks on the influence of the formal organizational structure by focusing on tie intensity in both temporary as well as stable working relations, do so in an NPD context, and thereby include the role of the network structure and people's absorptive capacity. This allowed us to test and extend the theoretical assumptions of Stevenson (1990) for the effect of the formal organization on collective action within organizations. The contribution to the NPD literature is that we provide insight into temporal communication patterns unlike the more stable communication patterns studied in previous literature, such as the R&D-Marketing communication.

One of the managerial implications of this study is that managers acting in accordance with the 'adaptive' framework should encourage idea generating employees to discuss these ideas with others and create guidelines stimulating this. Managers should not hesitate to give some direction to the idea with an eye on company requirements and could ask for evidence of input from a number of different experts both inside and outside the organization. Management should thereby switch from a focus on 'gate management' to a focus on 'idea development management'. Other more generic managerial actions

include: reconsidering recruitment policies, making more effective use of project or job rotating systems and creating peer networks. Recruitment could, for instance, recruit people, because of their extensive existing network in the scientific world or for their networking skills. Moreover, management could vary the degree of rotation from regular project rotation to specific functional or unit relocations with the specific purpose of 'building' networks. Such a more structured approach to project rotation could be an easy to implement way of ensuring that 'well-connected' senior personnel come into contact with 'fresh' university talent. Finally, management of R&D labs or NPD facilities should instead of inviting high-ranking senior managers to give their views on the strategic direction of a firm focus more on bringing lower level business developers into contact with their R&D scientists or product developers. Creating personal networks at lower levels can mitigate the seniority boundaries found in this study and can facilitate a dialogue between different functions within a firm instead of one-way top-down communication.

Finally, this study has also created some interesting new questions that could be addressed in future research. More specifically, future research could extend the framework of part one by conducting the research in industries that are more technology driven or more market driven. Another extension could specifically consider the effect of perceived relational risk of organizational members on the degree of social interaction in the FE. This extension could also be dynamic by not only considering the networking effect on the idea, but also on the people involved. It would be interesting to see how, for instance, 'networking experience' on previous ideas influences people's motivation and networks on new ideas. An extension could also consider which traits add to a person's networking skills, if these traits or skills can be developed through training, how these traits could best be measured in recruitment procedures and, finally, what the optimal mix of traits would be in an NPD context. An interesting data collection technique for these future extensions could be the use of email exchange data. This method of using email exchanges to map social interaction is relatively new and has some limitations. However, the results are interesting and such a data collection technique could be a means to

increasing the number of proposals or initiatives that can be followed and prevent interviewee bias and reactive measurement problems.

Nederlandse samenvatting

Een effectieve 'front end' van het productontwikkelproces (NPD) is belangrijk voor de innovatieve prestaties van bedrijven. De front end (FE) is het proces waarbij ideeën worden geboren en verder ontwikkeld, en dat eindigt met ja/nee beslissingen over de start van productontwikkelprojecten op basis van die ideeën. Dit proces wordt algemeen geschouwd als een integraal onderdeel van het gehele productontwikkelproces (Khurana et al., 1998). Vanwege het belang van het FE steken veel bedrijven energie in het organiseren van het proces (Kim et al., 2002). Typische voorbeelden zijn de 'alphaWorks' en 'GameChanger' suggestie- en beoordelingssystemen van IBM en Shell. De dominante visie achter zowel deze initiatieven als de literatuur is dat bedrijven zoveel mogelijk ideeën zouden moeten verzamelen, dat ze vervolgens een effectief beoordelingssysteem moeten organiseren om de ideeën te filteren en tenslotte feedback moeten verzorgen naar de indieners van de ideeën (Wheelwright et al., 1992).

Hoewel er in de literatuur een duidelijke onderkenning van de ambiguïteit en onzekerheid van het FE proces is, pleit het merendeel van de aangedragen oplossingen voor een verdere formalisatie van het proces. Verder veronderstelt het merendeel van de literatuur dat beslissingsbevoegde personen consistente besluiten nemen die de waarde voor het bedrijf maximaliseren en dat deze besluiten zijn gebaseerd op een systematische evaluatie van alle alternatieven gebruikmakend van vooropgestelde criteria. Hoewel sommige studies een meer sociaal perspectief hanteren, heeft de sterke focus op formele structuren geleid tot een onderwaardering van de sociale processen die een rol spelen bij de besluitvorming omtrent productontwikkelprojecten. Daarentegen ontwikkelt en test deze studie een sociaal netwerk perspectief van het FE waarbij we kijken hoe het netwerk rond een idee, dat wil zeggen de mensen die een idee bespreken met elkaar inclusief de dynamiek daarvan, bijdraagt aan de adoptie kansen van het idee in een bedrijf. Verder onderzoeken we hoe de netwerken van ideeën worden opgebouwd en wat daarbij de invloed is van zowel de formele organisationele als de netwerk structuur.

Het onderzoek is in twee delen opgesplitst. Het eerste deel richt zich op de netwerken rond ideeën voor nieuwe projectvoorstellen in het FE en is gebaseerd op het idee dat netwerken van mensen rond een idee van invloed zijn op zowel de kwaliteit als de adoptie kansen van dat idee. Ons perspectief is gebaseerd op het idee dat projectvoorstellen worden aangepast en verbeterd voordat ze daadwerkelijk worden beoordeeld door het management. Het tweede deel richt zich op het relationele niveau van de netwerken rond de eerdergenoemde ideeën. De nadruk ligt daarbij op hoe verschillende aspecten van de formele organisatiestructuur van invloed zijn op de intensiteit van interactie in het algemeen in een R&D omgeving en specifiek rond projectvoorstellen. Beide delen bestaan uit een theoretisch, methodologisch en resultaten hoofdstuk.

Het eerste theoretische hoofdstuk concentreert zich op de twee generieke voordelen die uit een netwerk te verkrijgen zijn, namelijk informatie en coördinatie voordelen en het belang van deze voordelen in de drie fasen van het FE. Op basis van de specifieke kenmerken van het FE wordt er een theoretisch raamwerk opgebouwd bestaande uit een serie hypothesen. In deze hypothesen veronderstellen wij dat een netwerk rond een projectvoorstel in de eerste 'genererende' fase opgebouwd moet zijn uit sterke bestaande relaties en een redelijk aantal hogergeplaatste personen. Verder zouden deze netwerken gedurende de tweede 'ontwikkel' fase moeten evolueren naar een groot en divers netwerk bestaande uit sterke bestaande relaties met zowel een redelijk aantal hogergeplaatste als beslissingbevoegde personen waarbij er beperkt onderling wordt gecommuniceerd. Tenslotte zouden netwerken gedurende de derde en laatste 'verfijn' fase moeten convergeren naar kleinere, hechtere en minder diverse netwerken, maar nog steeds opgebouwd uit sterke bestaande relaties met zowel een redelijk aantal hogergeplaatste als beslissingbevoegde personen.

De eenheid van analyse voor het eerste deel van deze studie was het netwerk rond een projectvoorstel. De data is verzameld bij twee grote R&D laboratoria van een grote multinational in de consumentenindustrie (fast moving consumer goods). Middels ruim 200 semi-gestructureerde interviews gedurende 14 maanden is data verzameld met

betrekking tot netwerken rond 18 projectvoorstellen. De afhankelijke ('te verklaren') variabele voor dit deel van deze studie was het succes van een projectvoorstel gedefinieerd als de mate waarin een voorstel de beslissingspunten van het evaluatie-(funnel-)systeem voor projectvoorstellen gehanteerd door de multinational passeerde. De onafhankelijke (verklarende) variabelen volgen uit de hypothesen. Verder zijn de verschillen in het potentieel en de nieuwheid van projectvoorstellen meegenomen evenals de aard van het beslissingsproces om te bepalen of dit van invloed was op de netwerkkarakteristieken.

Het resultaten hoofdstuk geeft de bevindingen weer van de invloed van sociale netwerken op de adoptiekansen van projectvoorstellen in het front end en begint met een korte beschrijving van de drie fasen, gevolgd door de descriptieve statistieken en een discussie ten aanzien van de drie alternatieve verklaringen (potentieel, nieuwheid, beslissingsproces), die geen van drie systematisch varieerde met succes. De resultaten droegen bij aan de bestaande modellen van Perry-Smith en Shalley (2003) en Burt (2004) door het belang aan te tonen van sterke bestaande relaties, van de betrokkenheid van hooggeplaatst en beslissingsbevoegd personeel in de eerste fase, van semi-hechte netwerken in de 'ontwikkel' fase en hechte netwerken in de 'verfijn' fase en van convergentie van de netwerken van de 'ontwikkel' naar de 'verfijn' fase. Bovendien kwam uit de combinatie van de gestructureerde en open vragen naar voren dat het groter worden van de netwerken van zeer succesvolle ideeën het gevolg was van zowel bouwen op bestaande relaties als veranderingen in de markt of technologische applicatie van de projectvoorstellen. Verder bleek dat in semi-hechte en diverse netwerken alternatieve (deel-)oplossingen langer werden meegenomen en bovendien bijdroegen aan de veranderingen in de richting van projectvoorstellen. Tenslotte suggereerden de bevindingen dat een mogelijke verklaring voor de toegenomen hechtheid van zeer succesvolle netwerken in de laatste fase deels veroorzaakt zou kunnen worden door in de 'ontwikkel' fase te bouwen op sterke bestaande relaties en leden stabiliteit. M.a.w. het is beter om weinig nieuwe mensen te betrekken bij de discussies in de laatste fase.

Het theoretische hoofdstuk voor het tweede deel van dit proefschrift focust op de invloed van de formele organisatiestructuur op de intensiteit waarmee mensen in het front end projectvoorstellen bespreken en de intensiteit waarmee mensen over het algemeen communiceren in R&D labs. Ten aanzien van de intensiteit van 'projectvoorstel' discussies veronderstelden we dat overeenkomst in senioriteit, beslissingsbevoegdheid, gezamenlijke projectwerk, een brede projectervaring en een hoge mate van relatie-centraliteit, gemeenschappelijke discussiepartners en een sterke bestaande band positief bijdroegen. Ten aanzien van generieke discussies in R&D labs veronderstelden we dat de intensiteit hoger was tussen mensen uit dezelfde functionele richting en onderzoeksgroep, bij gemeenschappelijk projectwerk en brede projectervaring, tussen hooggeplaatstere mensen en bij een overeenkomst in senioriteit en beslissingsbevoegdheid.

Het methodologie hoofdstuk van het tweede deel was in sommige opzichten gelijk aan het eerste deel, behalve ten aanzien van de eenheid van analyse, de operationalisatie van verschillende variabelen en de statistische analyse. De eenheid van analyse voor dit deel van het proefschrift waren de relaties waaruit de netwerken van het eerste deel bestonden. De analyses waren opgesplitst in twee delen. Het eerste en belangrijkste deel neemt de discussierelaties als afhankelijke variabele, het tweede deel neemt de generieke discussies als afhankelijke variabele. De onafhankelijke variabelen volgen uit de hypothesen. Verder werden er drie controle variabelen meegenomen van het netwerkniveau, namelijk: projectpotentieel, netwerkgrootte en hechtheid. Dit hoofdstuk sluit af met een discussie met betrekking tot de ordinale logistische regressie techniek die werd gebruikt voor dit deel van het proefschrift.

De resultaten met betrekking tot de intensiteit van 'projectvoorstel'-discussies toonden het negatieve effect van de senioriteit van discussie partners en het negatieve effect van een verschil in beslissingsbevoegdheid. Verder toonden de resultaten het positieve effect van gemeenschappelijk projectwerk, sterke bestaande banden, relatie-centraliteit en gemeenschappelijke discussiepartners. De resultaten droegen bij aan bestaande theorie door werd aangetoond dat de psychologische veiligheid en communicatie-effectiviteit, die worden geassocieerd met sterke bestaande banden en gemeenschappelijke discussie

opweegt tegen de potentiële negatieve effecten van een gebrek aan diversiteit. Verder toonden de resultaten het positieve effect van het aantal gezamenlijke projecten, maar geen effect voor brede projectervaring wat suggereert dat communicatie-intensiteit rond projectvoorstellen niet wordt bevorderd door een brede kennis basis en een 'leren-te-leren' capaciteit, maar meer direct door mensen van verschillende afdelingen met elkaar in contact te brengen. De resultaten met betrekking tot de intensiteit van generieke discussies toonden het positieve effect van het behoren tot dezelfde functionele richting en onderzoeksgroep, hoge senioriteit en gezamenlijk projectwerk. Verder vonden we weer geen effect voor brede projectervaring en vonden we een negatief effect voor een verschil in senioriteit. Daarmee droegen de resultaten bij aan bestaande theorie door aan te tonen dat het positieve effect van behoren tot dezelfde onderzoeksgroep en een hoge senioriteit en het negatieve effect van een verschil in senioriteit niet alleen relatie formatie binnen reguliere afdelingen van bedrijven positief beïnvloed, maar ook de intensiteit van relaties in een R&D omgeving. Verder toonden de resultaten weer het positieve effect van het aantal gezamenlijke projecten en weer geen effect voor brede projectervaring wat suggereert dat ook generieke communicatie in een R&D omgeving een meer direct effect heeft door mensen van verschillende afdelingen met elkaar in contact te brengen.

De bijdrage van het eerste deel van dit proefschrift aan de productontwikkelliteratuur is dat we een dynamisch sociaal netwerk model hebben ontwikkeld en dat we de bruikbaarheid ervan hebben getest op het front end proces. We plaatsen daarmee meer nadruk op het adaptieve effect dat uit kan gaan van netwerken in tegenstelling tot de, in de literatuur gangbare, selectie benadering. De bijdrage van het eerste deel aan de sociaal netwerk literatuur wordt gevormd door het ontwikkelen en toetsen van een dynamisch netwerk model dat tot op heden niet in de context van intraorganisationele creativiteit en innovatie is toegepast (). Verder splitsen we de discussie over densiteit van de discussie over relatie sterkte en dragen daarvoor empirische steun aan. Tenslotte is de bestaande berekenmethode voor densiteit aangepast en daarmee geschikt gemaakt om de densiteit van netwerken van verschillende grootte te vergelijken. De bijdrage van het tweede deel van dit proefschrift aan de sociaal netwerk literatuur wordt gevormd door deels bestaande

modellen over de invloed van de formele organisatiestructuur toe te passen op communicatie intensiteit in zowel tijdelijke als bestaande relaties in een R&D omgeving en daarbij de netwerkstructuur en de leercapaciteit mee te nemen. Dit stelde ons in staat om de theoretische assumpties van Stevenson (1990) met betrekking tot de effecten van de formele organisatie op collectieve initiatieven binnen bedrijven te toetsen en verder uit te bouwen. De bijdrage aan de productontwikkelliteratuur wordt gevormd door het inzicht dat verschaft wordt ten aanzien van tijdelijke communicatie patronen in tegenstelling tot de meer stabiele communicatiepatronen die in eerdere studies onderzocht zijn, waaronder studies van R&D en marketingcommunicatie.

Een van de managementimplicaties van deze studie is dat mensen die ideeën ontwikkelen door managers die handelen volgens het adaptieve raamwerk gestimuleerd moeten worden om ideeën met anderen te bespreken en hier richtlijnen voor op te stellen. Managers zouden niet terughoudend moeten zijn om hun visie op het idee te geven met een oog op de eisen vanuit het bedrijf en om te vragen om ondersteunend bewijs van andere experts zowel binnen als buiten de organisatie. Het management zou daarbij moeten switchen van een nadruk op 'beslissingsmanagement' naar een nadruk op 'idee-ontwikkel-management'. Andere meer generieke managementimplicaties zijn: het aanpassen van het wervingsbeleid, effectiever gebruik van project en job-rotatie systemen en het creëren van 'peer networks'. Het wervingsbeleid zou mensen op basis van bijvoorbeeld hun persoonlijke netwerken in de academische wereld kunnen aantrekken of op basis van hun netwerk capaciteiten. Verder zou het management de mate waarin werknemers roteren tussen functies kunnen aanpassen met het oog op het opbouwen van persoonlijke netwerken. Een rotatiemechanisme met een dusdanig doel zou een relatief makkelijke methode zijn om goede 'genetwerkte' veteranen in contact te brengen met jong universitair talent. Tenslotte zou het management van R&D labs of productontwikkelafdelingen niet hooggeplaatste managers van de marketingafdelingen moeten uitnodigen om hun visie op de strategische richting van het bedrijf te geven, maar liever de aandacht kunnen richten op het in contact brengen van marketers op junior of middelmanagement niveau met hun onderzoekers of productontwikkelaars. Deze persoonlijke netwerken op lagere hiërarchische niveau's kunnen de drempel die wordt

geassocieerd met het benaderen van topmanagers omzeilen en een dialoog op gang brengen tussen verschillende functionele afdelingen binnen een bedrijf in plaats van eenzijdige top-down communicatie.

Tenslotte heeft deze studie ook enkele interessante vragen opgeleverd voor toekomstig onderzoek. Toekomstig onderzoek zou het model uit het eerste deel bijvoorbeeld kunnen toepassen in andere industrieën die meer technologie- of marktgedreven zijn. Een andere uitbreiding zou specifiek kunnen gaan over de invloed van de door werknemers gepercipieerde relationele risico's op de communicatie-intensiteit in het front end. Deze uitbreiding zou ook een dynamische component kunnen hebben door niet alleen het netwerkeffect mee te nemen, maar ook het leereffect van mensen over de tijd. Het zou bijvoorbeeld interessant zijn om te zien hoe 'netwerkervaring' opgedaan tijdens het uitwerken van eerdere ideeën van invloed is op de netwerkstructuur en motivatie rond nieuwe ideeën. Een uitbreiding van het bestaande model zou ook na kunnen gaan welke persoonlijkheidseigenschappen bijdragen aan 'netwerkcapaciteiten', of deze capaciteiten verder ontwikkeld kunnen worden middels trainingen, hoe deze eigenschappen het best gemeten kunnen worden in wervingsrondes en wat de optimale mix van persoonlijkheidseigenschappen zou zijn in een productontwikkelcontext. Email gegevens zou daarbij een interessante data bron kunnen zijn. De methode om email verkeer te gebruiken om sociale netwerken in kaart te brengen is relatief nieuw en heeft enkele limitaties. Daarentegen zijn de resultaten van andere studies veelbelovend en biedt de methode het voordeel dat veel meer projectvoorstel-netwerken in kaart zouden kunnen worden gebracht zonder dat de mate van succes en de perceptie van respondenten van invloed is op de kwaliteit van de data.

About the author

Robbert Cornelis (Bob) Kijkuit was born in 1980 in Delft, The Netherlands. He finished his secondary education in Vlaardingen in 1998. In 2002, he received his Master's degree in Business Administration at RSM Erasmus University after which he started as a Ph.D. candidate in the Management of Technology and Innovation Department within the same university. His research focus is on the role of social networks in NPD contexts. Robbert Cornelis (Bob) Kijkuit has given presentations on this subject at conferences in both Europe and United States. He has also stayed at the University of Michigan, Ann Arbor, USA during the winter semester of 2005 participating in the graduate school program, which was made possible by funding from NWO (Netherlands Organization for Scientific Research) and the Trustfonds Erasmus University. His work has appeared in conference proceedings and a paper, on which the theoretical chapter of part one was based, has been accepted for publication in the Journal of Management Studies. During his Ph.D. candidacy, Bob (co)taught two Bachelor thesis courses, provided guest lectures in the 'Innovation Management' M.Sc. program as well co-supervised various M.Sc. theses. As of February 1st 2007, Bob will start working as a Business Analyst for Shell Energy Europe part of the Gas and Power Division of Shell Ltd in Den Haag (The Netherlands).

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Social Networks in the Front End

The Organizational Life of an Idea

An effective front end (FE) of the new product development (NPD) process is important for innovative performance in companies. To date the NPD literature has mainly focused on the selection process of ideas and very little on the processes that take place before selection. This study aims to fill this gap by focusing on the social dynamics around ideas for new products in the FE. We do so by conducting a longitudinal in-depth study on the social dynamics around 18 ideas. In the first part of this study we focus on the social network of an idea, i.e. the people discussing the idea with each other, and the effect on the adoption of that idea. The results confirm existing views on the importance of large and diverse networks and extend existing insights by showing the importance of strong ties, increased density and involvement of senior management. In the second part we look at how the social networks in the FE are built up and how this is affected by both the formal organizational and network structure itself. The results for this part show that people working on a creative initiative interact more intensively in triads with 'close friends' and people they have previously worked with in projects, suggesting that the positive effects associated with such relations, such as psychological safety and communication effectiveness, outweighs the possible adverse effects of a lack of diversity. Implications for management could include stimulating employees to use social networks to further develop ideas possibly introducing formal guidelines, using project-rotation to build networks and reconsider recruitment policies

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