Process management in R&D – Doom or salvation for creativity?

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KTH Industrial Engineering
and Management

Licentiate Thesis in Machine Design
Stockholm, Sweden 2012

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TRITA – MMK 2012:20
ISSN 1400-1179
ISRN/KTH/MMK/R-12/20-SE
ISBN 978-91-7501-576-7

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Academic thesis, which with the approval of Kungliga Tekniska Högskolan, will be presented for public review in fulfilment of the requirements for a Licentiate of Engineering in Machine Design. The public review is held at Kungliga Tekniska Högskolan, Brinellvägen 83/Gladan, at 14.00 on the 7th of December 2012.

Abstract

R&D organizations of today must constantly seek ways to become more efficient in order to stay competitive. To accomplish this many organizations turn to process management approaches such as lean product development. But how does the use of process management influence the creativity of the people in the organization? How will they manage both the creative search and exploration of future opportunities and the efficient exploitation of current offerings simultaneously? Previous research has shown that companies often fail in this quest and that exploration is at risk of being neglected in favour of exploitation where the feedback and return on invested work are more immediate.

This thesis sets out to study how the combination of exploration in terms of creativity, and exploitation in terms of process management, plays out at Scania, a developer and manufacturer of heavy trucks. The research builds on data collected by means of a questionnaire study where a large part of the R&D organization participated. The results reveal surprisingly positive relationships between process management and creativity. Firstly, the existence of clear routines showed a positive relationship with several aspects of ideation. The results, however, stress the importance of having dynamic routines where the organization is open to changing the existing routines when needed. Secondly, strong demands on delivery precision was positively related to the creation of novel ideas in the industrialization process. Thirdly, the use of continuous improvement efforts was positively related to aspects of creativity.

These results indicate that routinization can benefit creativity and that mangers should encourage the mapping and continuous improvement of routines. Furthermore, goals for innovation influence how much time is spent on exploratory activities. Managers with innovation aspirations should therefore make clear to the organization that innovation is an important part of the operations. Finally, managers and employees should formulate specific product innovation goals and demand high delivery precision also for deliverables of exploratory nature.

Keywords: creativity, efficiency, process management, R&D.

Acknowledgements

This thesis was made possible thanks to the help and support from a large number of people to whom I owe my gratitude.

First of all, I would like to thank all of those involved in making this industrial PhD position at Scania possible. I owe the fact that I have the best, most interesting job in the world to many people, for example Hasse Johansson, Johan Tingström, Peter Palmér, and Catharina Modahl-Nilsson who all played a part in the process of shaping this job position. And I believe there were many more involved that I do not even know about. Thank you for giving me this opportunity!

The journey then took off with Margareta Norell Bergendahl as my supervisor – a person who has inspired me since many years prior to my PhD journey. As Margareta moved on to new challenges at KTH, Mats Magnusson stepped in as my supervisor. I have learned so much from Mats, both in the field of innovation and about what it means to be a researcher. He has shown how you can get far with a strong sense of purpose and hard work. Thank you!

Many more at KTH have been involved in some way in my project. I would especially like to thank my secondary supervisor Jens Hemphälä and Jennie Björk for good feedback and encouraging words as my journey into the world of statistics took off. Susanne and Carl, thanks for being such great office mates. Thank you also to all the other members of the IPD team – past and present. It truly is a great place to work!

Blessed with two offices I also have a large number of people at Scania from whom I have continuously received encouragement and support. Thanks to Ragnar Glav and Johan Tingström, my industrial supervisors, for helping me balance the different worlds of academia and industry. Without you I do not think there would have been much research done as I would have been immersed in the world of projects and distracting fun at Scania. My managers, Anna Lidell Calner and Lars Dahlén, and previously Jonas Säfström, have given me all the freedom I could ever ask for, while at the same time never making me feel left aside or forgotten. Your

interest in my work has been one of the main drivers and motivators. Thanks also to Pernilla Zirath for all your help with administrative tasks and for your contagious positive way. The steering committee at Scania, which in addition to Lars Dahlén and my academic supervisors, includes Peter Palmér, Henrik Alfredsson and Håkan Johansson, has been another source of inspiration. The way you have shared your extensive experience from product development and the Scania organization has made a lasting impact on my project and my understanding for what my research may mean for Scania as an organization.

Many thanks to PIEp and ProViking for providing an excellent platform to meet and learn from other PhD students as well as enabling the participation in a number of courses by both funding and offering courses.

The following people also deserve a special acknowledgement as sources of inspiration and support; Magnus Mackaldener, Håkan Gustavsson, Erik Göras, Kent Johansson, Irene Eriksson, and Thomas Delvén at Scania, and Toshihide Itoh at Toyota Industries Corporation. Anna Karlsson, Sagar Behere, and Daniel Corin Stig, all PhD students I first met through work but who I now consider closer than just research colleagues. I would also like to thank all my friends, especially those at the Tiiisdag dinners for all the laughter, dinners served and reminders of what is really important in life. And, of course, my family, although too far away I always feel your support.

Finally, there is one person with whom I have discussed my work more than anyone and who has served as a support and source of energy when I have needed it the most. Thank you Gustaf! You always generously share your time and your enthusiasm. The way you believe in me helps me grow as a person and makes me brave. I hope you know that I have equal faith in you. Kärlek!

Katarina Lund

Stockholm, November 2012

List of appended papers

This thesis is based on three appended papers as listed below. In the text theses papers are referred to as Paper A, Paper B, and Paper C.

Paper A

Lund, K., Magnusson, M. (2011). Slack – a driver of innovation in R&D?, *Proceedings of the 12th International CINet conference*, September 11-13, Aarhus, Denmark

Paper B

Lund, K., Magnusson, M. (2012). The delicate coexistence of standardized work routines and innovation, *Proceedings of the 19th International Product Development Management Conference IPDMC*, June 18-19, Manchester, U.K.

Paper C

Lund, K. (2012). Creativity just in time? The effects of delivery precision in product development. *Proceedings of the 13th International CINet conference*, September 17-18, Rome, Italy.

List of additional publications

Lund, K., Tingström, J. (2011) Facilitating creative problem solving workshops: Empirical observations at a Swedish automotive company. *Proceedings of the International Conference on Engineering Design*, August 15-18, Copenhagen, Denmark.

Kihlander, I., Nilsson, S., Lund, K., Ritzén, S., Norell Bergendahl, M. (2011), Planning industrial PhD projects: Speaking both 'academia' and 'practitionese', *Proceedings of the International Conference on Engineering Design*, August 15-18, Copenhagen, Denmark.

Karlsson, A., Lund, K. (2012), Knowledge sharing in product development – Exploring the effects of power struggle and task conflict, *Proceedings of the International Design Conference – Design*, May 21-24, Dubrovnik, Croatia.

Hemphälä, J., Lund, K. (2012), Creative climate and continuous improvement – An empirical test of the dimensions in the CCQ, *Proceedings of the 13th International CINet conference*, September 17-18, Rome, Italy.

Contents

1 Introduction

What is the motivation behind writing a thesis on the topic of process management and creativity? In answering that question I would like to tell you about the time I met with Michael Kennedy, one of the big names in the lean product development community. Lean, in turn, is one of the most widespread process management approaches. During our meeting I asked him in what way engineers can be aided by the lean philosophy in order to be radically innovative. Michael Kennedy is a person with many years of consulting experience and the author of several books on the topic[1], yet his reply was hesitant and surprising. He said "I'm not sure that lean principles, the way we think about it, really adds value to that". Later on in our discussion, however, it became clear that lean principles in many ways can aid the creative process in product development. But his initial answer has since puzzled me, and has strengthened my belief that we know too little of how process management principles affect the exploratory nature of R&D. This thesis aims at taking a small step towards increasing our knowledge about how the two areas of process management and creativity, are related.

1.1 Background and motivation for study

The Research and development (R&D) organization is at the core of product innovation activities in many companies. The ideas given birth to in the R&D organization serve as the basis for a company's future survival. However, the generation of creative ideas has never managed to provide for a company without a purposeful process to turn those ideas into products and services. Before a company can profit on innovative ideas, it needs to turn those ideas into products and services to offer its customers. Companies face a large challenge in both exploring new possibilities for future customer offerings and exploiting the current offerings in a resource-efficient manner (March, 1991). R&D organizations in particular face this challenge. While their mission include generating new product specifications a large part of the work is highly structured with ever-increasing demands on

[1] Michael Kennedy is one of the authors behind books like Ready, Set, Dominate (Kennedy et al., 2008) and Product Development for the Lean enterprise (Kennedy & Ward, 2003).

efficiency, quality and cost. To address these demands, many companies started looking towards process management philosophies and methods in the management of R&D organizations (Hackman & Wageman, 1995). The main purpose of process management is to increase productivity in processes and product quality, and those effects are often readily evident (Adler, 1993b). But R&D has the task of both producing high-quality product specifications and to verify those and to build new knowledge to create the products of the future (Cohen & Levinthal, 1989; Kennedy, et al., 2008). Process management introduced as a sustained part of a company's philosophy will inevitably have effects beyond productivity. What happens, for example, with the company's creative ability as it focuses on process management? It brings us back to the question in the title: Process management in R&D – doom or salvation for creativity? Given the way the concepts in the title have been defined in this thesis the more general description of the central question results in: How will the adoption of process management in large mature R&D organizations, in terms of mapping, improving and adhering to processes, influence the creation of novel and useful ideas?[2]

While some argue that effective exploitation and flexible exploration can be combined in an organization the majority of the research done by organizational theorists claim that those two sides are antithetical (Boer & Gertsen, 2003). Yet, some companies do manage to combine both exploration and exploitation, reaching both high operation performance and innovation over time (Magnusson & Martini, 2008; O Reilly & Tushman, 2004). This issue has not yet been settled although it has been thoroughly discussed in literature by scholars approaching it from different perspectives (Adler et al., 2009). Perhaps the reason for that lies in the nature of the conflict. The tension between exploitation and exploration should rather be seen as a challenge that is inherent in the mission of an R&D organization and should thus be continuously managed rather than resolved (Magnusson, 2000). The discrepancy between earlier research findings and actual

[2] Definitions borrowed from Benner and Tushman (2003) and Amabile et al. (1996) For a more detailed description of definitions and concepts please refer to chapter 2. Theoretical exposition.

industry performance calls for research to be conducted in this field with fresh perspectives, such as approaching the challenge as a duality rather than a trade-off (Magnusson, et al., 2008). Viewing the two concepts separately, linked only by the employee or organization, gives more freedom in the analysis of how an organization can reach high levels of both exploration and exploitation. We still know too little of how R&D organizations should work, in terms of for example principles and work methods, to successfully combine these two aspects. Therefore, current research must seek to further study what principles and methods which can be used to aid R&D organizations in their aspirations to combine both exploration and exploitation.

1.2 Purpose of study

The overall purpose of this thesis is to explore the interrelationships between the use of process management approaches and creativity in R&D. The specific setting is that of an R&D unit in a large mature organization and the focus lies with the employees and the R&D team rather than on firm level analyzes. This study uses a wide array of variables to analyze the relationship between the concepts of exploration operationalized in a number of R&D performance outputs and exploitation represented by aspects of process management methods. This thesis, thereby, does not study innovation per se, but focuses on its antecedents. The results, however, give us strong implications of how a company's innovative ability can be affected by process management.

Furthermore, this thesis also aims at pointing out a direction for future studies in the field with the goal of moving from increased understanding to actionable knowledge.

1.3 Structure of thesis

This thesis summarizes the findings of the appended papers from three studies using an exploratory approach and points out a direction for future research. It is structured in six parts: Introduction, Theoretical exposition, Research approach, Summary of appended papers, Analysis and discussion, and Concluding remarks (Table 1).

Table 1: Chapter overview

Introduction	▪ Motivates the field of study and gives a brief introduction to the field.
Theoretical exposition	▪ Describes the current state of research in the field. ▪ Positions my research with respect to previous research ▪ Lists the research question
Research approach	▪ Includes a description of the case company and its history of innovation and process management ▪ Explains the considerations that have been taken into account to ensure scientific rigour ▪ Includes a discussion about research quality.
Summary of appended papers	▪ Highlights the main findings of each paper and summarizes their contribution to the thesis.
Analysis and discsussion	▪ Presents the findings and highlights what this thesis adds to our knowledge in the field. ▪ Discusses the findings and attempts to explain the results.
Concluding remarks	▪ Lists a number of research questions and challenges central for future research in the field. ▪ Presents a number of managerial implications.

2 Theoretical exposition

Digging deep into the literature on process management and its links to creativity I soon realized that much of the literature is based on anecdotal evidence from a few companies and the peer-reviewed scientific body of literature is far exceeded by books. These books often present the way Toyota or other companies have implemented process management and how this has led to the company's success. Nevertheless, these books are often insightful, not to mention inspiring, and show compelling proof of the positive effects of introducing process management to reach both exploratory and exploitatory performance. The theoretical exposition I present here will draw upon both books, scientific articles and other publications to outline the existing research which this thesis builds upon.

2.1 Theoretical framework

The theoretical exposition aims at positioning the present study in relation to previous research. It also aims at shining light on the different definitions and views of concepts central to this study. In addition, it will point out the contribution of this research to our present body of knowledge.

This thesis positions itself in the intersection of three research areas. These research areas consist of operations management, creativity, and R&D management. While these research areas are all individually rather well-developed the intersections of these different streams of literature, and their combination, are far less explored (Figure 1). It is in those intersections that this thesis seeks to contribute.

Figure 1. An ARC diagram (Blessing & Chakrabarti, 2009) illustrating the research areas most relevant to this thesis. This thesis focuses on the intersections between the areas rather than each specific area.

The research area of creativity focuses on activities with the aim of producing new and useful ideas and the social psychology associated with such activities (see e.g. Amabile, 1996). Creativity is of essence to R&D organizations as the realization of creative ideas is what ultimately leads to innovations (Amabile, et al., 1996). Understanding organizational creativity also means understanding the social systems in which creative actions occur (Woodman et al., 1993). Ultimately, understanding better what social situations and interplay that encourages or hampers creativity can help shape organizations more prone towards innovation. The area of operations management on the other hand focuses on converting raw material or other inputs into goods or services in an efficient and effective manner (Slack et al., 2004). Although operations management as a field has its origin in production (Slack, et al., 2004), many other parts of an organization, R&D included, include production-like operations. The two areas of creativity and operations management can be seen as having two different aims. Creativity pairs itself with other activities with the purpose of exploration, whereas operations management is more concerned with exploitation aspects. R&D management on the other hand must handle both these purposes as the mission of R&D includes managing both exploration of future areas, as well as exploiting current customer offerings (March, 1991) (Figure 2).

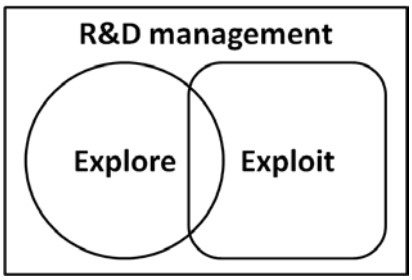

Figure 2. The two aims that R&D management has to handle.

The trade-off between exploration and exploitation has been extensively researched over a long period of time and can be traced back to e.g. works by Thompson (1967) where the paradoxical combination of reducing uncertainty and increasing flexibility simultaneously is discussed. Different paradigms of R&D management have attempted to deal with handling the demands of both exploration and exploitation in different ways. In the mid

1960s R&D organizations started to place more interest on both the long term and the short term of R&D activities as opposed to mainly reacting on ideas from the market (Nobelius, 2002). This was later paired with an increased cost control and cost reduction and R&D organizations started to more extensively review and improve their product development processes (Nobelius, 2002). In the 1980s the interest in speed to market increased and the Japanese automotive industry was largely used as a benchmark (Clark & Fujimoto, 1989). Other attempts to combine product innovation with productivity holds forward aspects like adaptable processes which integrates continuous improvements, a customer focused view, and front-loading of projects (Cooper & Edgett, 2008)

Despite the extensive research and available approaches of how to handle the challenge no consensus has been reached and companies still struggle with how to handle both exploration and exploitation. Some of the reasons for this may lie in the lack of consensus of how to define the concepts of exploration and exploitation (Li et al., 2008). Some define exploration as the conduction of research projects, whereas exploitation is defined as the conduction of product development projects (Garcia et al., 2003). Others take on a more generalized definition in terms of local versus distant technology search activities (Benner & Tushman, 2002). Yet others separate the development for new customer sets or products from the development for existing customer sets or products (Mom et al., 2007).

This thesis makes use of the definitions of exploration and exploitation as described by Levinthal and March (1993) and March (1991). They define exploration as the pursuit of new knowledge, search, and experimentation, and exploitation as the use and development of things already known by refinement and implementation. Given that search and experimentation are part of exploration it is reasonable also to include creativity as an inherent part of such activities since creative, i.e. novel and useful, ideas are often the result of such activities. This thesis also integrates thoughts presented by Zahra and George (2002), where they separate a company's potential in terms of acquired and assimilated knowledge from the company's realized potential in terms of the

transformation and exploitation of knowledge. Similarly, companies build a potential in terms of knowledge and ideas in the exploration process but only realize a part of that potential in the exploitation process.

The definitions and clarifications above position this thesis in relation to previous research in the field and are important to keep in mind for the reminder of the thesis. From this point on this chapter will present a short introduction to R&D management with a particular emphasis on how the management of both exploration and exploitation becomes evident in that field. This is followed by an exposition into what actually entails exploration and exploitation respectively, describing more specifically those subsets most relevant to this study. After that, the literature addressing the combination of exploration and exploitation is presented. This literature is divided into three groups; those considering the combination inevitably leading to a trade-off, those considering the combination of the two areas to be possible, and those with a contingency approach. Finally, the theoretical exposition is concluded with the research questions.

2.2 The R&D mission

The task of R&D includes continuously generating innovations in terms of product and service specifications based on the assimilation and exploitation of information. It, however, also includes the continuous learning and improvement of the capability to use and create new knowledge for future innovation purposes. (Cohen, et al., 1989). To manage this, R&D organizations must engage in both exploratory activities such as experimentation, innovation, and discovery, as well as exploitatory activities such as refinement, implementation and efficiency-seeking activities (March, 1991). The structure of exploitation needs to be interrupted and altered regularly by ideas of new ways of working which help the company maintain its viability (Burgelman, 1983). Exploration and exploitation both have positive effects on the output of an R&D unit which requires delivering new customer offerings at a price the market is prepared to meet and in time to meet the market's expectations (Figure 3). And although both aspects are required, the combined handling of the two can bear

great effects on the competitiveness of the customer offerings that the R&D organization produces and consequently also the company profit (Figure 3).

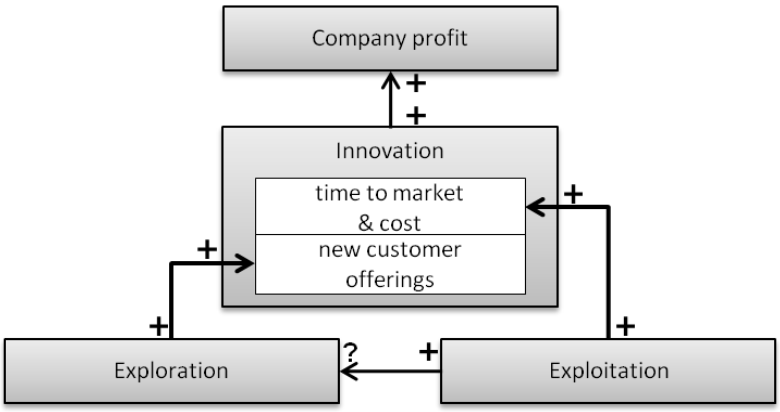

Figure 3. The concepts of exploration and exploitation each have positive impact on different aspects of innovation. The relationship between exploration and exploitation is, however, not fully understood.

Many organizations suffer great problems when trying to manage both exploration and exploitation. Reasons for this lies in that feedback from exploitative activities is so much more direct than that from exploratory activities (March, 1991) and while exploration can bring large benefits in the long run it often also comes with large risks (Burgelman, 1983). Yet, voices are raised that organizations will have to manage both in order to survive (Boer, et al., 2003; Burgelman, 1983; Stacey, 1992). To better understand what such a combination would entail, a more thorough presentation of the two fields of exploration and exploitation are presented below.

2.3 Exploring to build potential for the future

Building a potential for future exploitation by building new knowledge and coming up with creative ideas is associated with certain characteristics in organizations and individuals. These characteristics include, for example, taking risks, experimenting, and being prepared to cannibalize on the own business in times of changes in the market (Tushman & O'Reilly, 1993). It also often includes questioning the present way things are done and to challenge the status quo (Zhou & George, 2003). This chapter, as well as this thesis will focus on a subset of exploratory elements.

Such elements include for example creativity, creative climate, and knowledge creation.

2.3.1 Individual exploration expressed as creativity

Creativity is an essential part of the search and experimentation activities so important to exploration. In this thesis creativity is defined as *"the production of novel and useful ideas in any domain"* (Amabile, et al., 1996). Creativity is also an important part of a company's ability to innovate, as innovations build on creative ideas to create competitive products and services (Amabile, et al., 1996). However, as mentioned in the introduction, this thesis does not study innovation *per se* but rather its antecedents, of which creativity is one.

R&D organizations are particularly interesting to study from a creativity perspective, since the result from a creative process lies very much in line with the very mission of R&D units (Bain et al., 2001). Scholars have approached the concept of creativity from different perspectives, e.g. knowledge creation (Nonaka, 1994), the manager's role for employee creativity (Zhou, et al., 2003), creativity methods (Smith, 1998) and ideation (Björk et al., 2010). Other scholars have approached creativity by studying its antecedents such as creative climate (Amabile, et al., 1996; Ekvall, 1996) or mechanisms important for creativity, e.g. motivation (Amabile, 1997). This thesis follows a similar approach. And although the actual idea creation, when an idea is shaped inside someone's mind, is something highly individual it often happens in interaction with others (Nonaka, 1994). This motivates the research of creativity and process management at the level of the individual and the team.

2.3.2 Creative climate as an antecedent of innovation

The generation, development and sharing of creative ideas are highly influenced by the context in which the ideas are conceived. Contextual factors such as the work climate, challenges and supervisory encouragement can all have a significant impact on creativity (Amabile, et al., 1996). Other examples of factors are resources such as time to explore ideas, or level of autonomy (Ekvall, 1996). These aspects are studied as a concept of *creative climate* in the field of social psychology of creativity (Amabile,

1996). The research in that field is particularly interesting since it focuses on aspects which can be rather readily changed, in contrast to e.g. developing the own creative ability or cognitive skills (Amabile, 1996). Several attempts have also been made at measuring the creative climate (Amabile, et al., 1996; Anderson & West, 1998; Ekvall, 1996). In the research on which this thesis is based the measurement instrument CCQ (Creative Climate Questionnaire) has been used (Ekvall, 1996).

One central concept of creative climate, which is also central to this thesis, is Autonomy. A relatively high level of perceived autonomy is an important prerequisite for creativity (Amabile, et al., 1996; West, 2002). Research has, for example, shown, when individuals perceive themselves to have a choice in how to carry out given tasks, they produce more creative results (Amabile & Gitomer, 1984). Other scholars talk about autonomy in terms of freedom, and conclude that a high independence in behaviour in an organization is more conducive to creative results than an organization which is rule-bound (Ekvall, 1996).

These aspects are all important for a company's exploratory activities as they increase the chances of developing innovative products and finding new business opportunities beyond those already identified. This exploratory ability must however, at least in highly competitive markets, be combined with a well-developed exploitatory ability in order to profit from the potential built up in the exploratory process.

2.4 Exploiting built up potential

Companies which have a tendency towards exploration at the cost of exploitation will eventually reach costs that are too high for experimenting without gaining the necessary yield (March, 1991). Exploitation entails aspects such as refinement, selection, implementation, and execution. It often results in readily available returns in terms of cost savings or improved ways of working (March, 1991). In that way exploitation is an important means for companies to turn their innovative potential into profitable products and R&D organizations would not survive without it. In the 1990's it was identified that the push for even more efficient exploitation processes has increased steadily over time (Clark &

Fujimoto, 1991) and there is no reason to doubt that such push has continued to increase since then. The efficiency of an R&D unit is, however, difficult to measure. Numbers like R&D expenditure as a percentage of company turnover are blunt measures of actual productivity. Intra-industry, however, you can compare the productivity of different companies, and thereby determine relative productivity levels. Research has, for example, shown that Japanese auto-makers complete their product development projects approximately twelve months faster than their European and U.S. counterparts, even after controlling for differences between projects (Clark, et al., 1989). These examples of R&D productivity has spurred a large interest in the way Japanese auto-makers, in particular Toyota, manage their processes. Other approaches to R&D productivity are for example the works on stage-gate processes (Cooper, 1994; Cooper, et al., 2008) and product portfolio management (Cooper et al., 1999).

2.4.1 Process management approaches

Process management entails both mapping processes and improving processes, as well as adhering to the improved processes (Benner, et al., 2003). In this thesis additional emphasis is put on underlying ingredients of process management, such as management approaches and the role of the employees and other stakeholders in the system. Over the years, several different paradigms of process management approaches have emerged. A few of those which have gained most ground in industry include total quality management (TQM) (Hackman, et al., 1995), six sigma (Harry & Schroeder, 2006), and lean (Womack & Jones, 2003). This chapter will briefly present some of the characteristics of these process management approaches. The process management approach which have served as the most influential role model for the process management approaches adopted in the case company is lean.

Total quality management

The continuous improvement of customer satisfaction and quality are key elements of the TQM philosophy (Mohrman et al., 1995). The TQM movement takes a starting point in that the purpose of an organization is to promote the stability of a community and

provide a setting for satisfaction of the organization's member, and this is one of the reasons why organizations should strive to stay in business (Hackman, et al., 1995). TQM makes use of a range of organizational processes and systematic tools, complemented with the establishment of quality improvement teams as means to reach these ends (Mohrman, et al., 1995).

TQM builds on four assumptions (Hackman, et al., 1995):

1. The first assumption is that high quality products are less costly than poor quality products in the long run.
2. The second assumption is that people naturally strive for improved quality and perfection as long as they are unrestrained by economical or bureaucratic systems forcing them in another direction.
3. The third assumption is that organizations are highly interdependent systems where cross-functional challenges must be addressed collectively.
4. The final assumption of TQM concerns that role of senior management as advocates of quality and that their commitment affects the commitment of the employees.

With these assumptions in place, TQM addresses quality by means of four principles; focus on work processes, analysis of variability, management by fact, and continuous improvement (Hackman, et al., 1995).

Six sigma

Six sigma originates from the quality movement brought to Japan by Deeming and Juran where the TQM ideas were developed and refined (Tennant, 2001). Motorola is often pointed out as the company which studied the Japanese companies' success in producing high-quality products and, based on what they learned, developed what came to be known as Six sigma (Henderson & Evans, 2000). Six sigma alters the logic of quality from fixing or separating defective products to correcting the process so that defective products are nearly eliminated from the process to begin with (Kane, 1998). The production of high quality products is the core purpose of the six sigma process, but like its other process

management counterparts, six sigma takes on a holistic approach to the extent to where it should be considered a philosophy or a methodology rather than just a quality level aspiration (Tennant, 2001).

Simplified, Six sigma takes on a five-step approach to problem solving. These steps consist of defining the customers and their priorities, measuring the defects in the current process, analyzing what are the most important reasons for defects, identifying and implementing improvements, and finally controlling the new process to maintain the improved quality levels (Henderson, et al., 2000). Many similarities can be found between six sigma and the continuous improvement efforts found in lean and TQM. What does separate Six Sigma is that is strives towards a tangible and measurable goal whereas lean and TQM has a more general pursuit of perfection as the motivation for their continuous improvement efforts.

Lean thinking

Lean was inspired by other Japanese auto-makers and suppliers, and it introduced us to concepts like *Kaizen*, *Kanban* cards, and *Just in time* (Womack et al., 1991). Lean should be studied beyond its tools and methods, as a philosophy where human dimensions like empowerment, motivation and respect for people are key elements (Hines et al., 2004). Many attempts have been made at capturing the essence of lean thinking (e.g. Liker & Morgan, 2006; Morgan & Liker, 2006; Spear & Bowen, 1999). Some common elements re-occur, such as the five principles outlined by Womack et. al. (1996): identify value, identify the value stream, ensure flow, pull, and pursuit of perfection (

One of the cornerstones of the lean philosophy is its differentiation from the so common resource-optimization, by instead focusing on flow-optimization (Modig & Åhlström, 2011; Reinertsen, 2009). Ensuring flow and keeping queues down requires the value-producing system to be populated with a certain amount of over-capacity (Reinertsen, 2009). Lean thinking pairs flow orientation with a *pull* from the customer thus creating high delivery precision, i.e. delivering *just in time* (Ohno, 1982).

Table 2).

One of the cornerstones of the lean philosophy is its differentiation from the so common resource-optimization, by instead focusing on flow-optimization (Modig & Åhlström, 2011; Reinertsen, 2009). Ensuring flow and keeping queues down requires the value-producing system to be populated with a certain amount of over-capacity (Reinertsen, 2009). Lean thinking pairs flow orientation with a *pull* from the customer thus creating high delivery precision, i.e. delivering *just in time* (Ohno, 1982).

Table 2. The five principles of lean thinking (Womack, et al., 1996)

Principle	Explanation
Identify value	Precisely define what entails value in the specific process
Identify the value stream	Map all actions required to take a product from concept to customer. This visualizes the value adding and non-value adding activities.
Ensure flow	Make sure the process flows by removing waste. Prioritize flow optimization before resource optimization.
Pull	Only produce what is needed and asked for by the customer. If the value stream is properly designed, end-customer pull will translate into system-customer pull in each step of the process.
Pursuit of perfection	Refine the first four steps continuously in a way that strives for perfection.

2.4.2 Central concepts in process management approaches

The process management approaches described above all share certain characteristics. Firstly, they seek to streamline operations by focusing on a flow uninterrupted by bottle-necks or other types of waste. Secondly, they build on the mapping and improvement of processes, either in manufacturing, service, or elsewhere, in order to search for a best known way of doing things. This routinization of processes is central to reach high efficiency and to avoid re-learning and re-inventing processes which can be optimized. Thirdly, they all contain an element of continuous improvement in order to strive for the best known routinization. These three common elements are further described below and all have a central role in the studies analyzed in the appended papers.

Process orientation and flow

Central to the process management approaches described here is the process orientation and the elimination of obstacles in that process to ensure that value is created in an efficient manner at a high quality. One efficient way to ensure flow is to ensure that the handovers in the process proceeds as planned, i.e. that there is delivery precision. In highly interconnected processes, a deviation in delivery in one end of the process can generate extensive delays in other parts of the process. In lean, such interruptions in the process are considered waste and should be eliminated.

Furthermore, resources in terms of employees and machinery are one of the main costs of many companies, R&D organizations included. Therefore many organizations focus on optimizing the utilization of their employees and expensive machinery. The process orientation of process management approaches go against such optimization and instead promotes flow optimization (Modig, et al., 2011; Reinertsen, 2005). Flow optimization in turn requires a certain slack in resources and it is a common mistake to view those slack resources as waste. With a focus on optimizing that which creates value for the customer the resource utilization levels in effect become irrelevant. The resources in an organization do not have a purpose in their own, but are merely means to produce value (Ohno, 1982). As resources are one of the main costs of many organizations there is often an excessive focus on utilizing those resources fully. But full utilization of resources leads to queues (Reinertsen, 2005) and consequent delays for the customer in receiving the value that could be made available for the customer much sooner if there would have been a certain level of slack in the system.

Routinization

In repetitive processes there is much to gain in terms of efficiency from documenting work procedures to identify a "best known" way of doing things (Burns & Stalker, 1961). Such processes have, however also been found to lack in flexibility which may have negative effects on exploratory outcomes (Burns, et al., 1961) and research claims that some processes, e.g. service processes with high levels of individualization should not be routinized (Hall &

Johnson, 2009). Many different terms have been used to describe the documentation of processes. To avoid confusion, the term *routinization* will be used in this thesis to span concepts like formalization (Damanpour, 1991), bureaucracy (Adler & Borys, 1996), and standardization (Morgan, et al., 2006).

In the majority of literature the formalized or mechanistic approach is considered to lead to efficiency effects but possibly also to a decrease in innovation. However, some scholars have tried to resolve this dilemma by separating routinization into different types. One of the best known examples is the separation between coercive bureaucracy and enabling bureaucracy (Adler, et al., 1996). Whereas coercive bureaucracy forces employees to adhere to processes they do not necessarily believe in or see the use of, enabling bureaucracy can yield both efficiency gains and innovation by using routines to change routines (Adler, et al., 1996). The enabling bureaucracy of Adler & Borys (1996) draw lessons from continuous improvement as used in lean manufacturing (Adler, 1993a).

Continuous improvement

The third common component of many process management approaches is that there is an element of change and continuous improvements built into the process. This leads to that processes in such systems are never static, but rather continuously evolving as the organization learns more or in cases where conditions change. Continuous improvement makes use of small, incremental improvements which over time add up to large improvements (Imai, 2007). Continuous improvement efforts also foster a process-orientation, i.e. the ability to focus on process improvements in order to achieve results instead of focusing directly on the results (Imai, 2007) which has positive effects on both flow and routinization.

2.4.3 Process management beyond manufacturing

Process management is transferable beyond the shop-floor and has the potential of increasing productivity and quality in many other operations, if the differences in structure, logic and, most importantly, value creation are taken into account (Reinertsen &

Shaeffer, 2005). R&D has over the years gained a large interest as a possible area for implementation of process management approaches to increase productivity. But the transfer of process management approaches from manufacturing to R&D comes with a number of challenges. These challenges include, for example, the view of variability and risk-taking as unwanted activities in manufacturing while in R&D value cannot be created without a certain level of variability and risk-taking (Reinertsen, et al., 2005). Furthermore, since the mission of R&D includes both developing innovations and learning for future innovation (Cohen, et al., 1989), searching for new knowledge must be seen as an inherent part of R&D activities. To create an organization conducive to learning one must acknowledge and attend to the processes important to learning, such as experimentation. And in applying a process management thinking to experimentation as a means of learning, we also need to take a fresh perspective on failure, embracing it as a natural part of R&D operations (Reinertsen, et al., 2005).

The above mentioned aspects need to be taken into account when taking the process management approach to R&D. In general, when transferring process management thinking beyond manufacturing, it is useful to take on the approach of studying the principles rather than the methods and carefully analyze how the purpose of the principles is best achieved given the new context. Focusing solely on tools and techniques when implementing process management while neglecting the strategic perspective has been argued to be one of the main reasons of failure when implementing process management approaches (Hines et al., 2006). There are many examples of companies which have tried but failed to successfully implement process management approaches in organizations such as R&D. This is likely due to the relatively abstract production of information which contrasts R&D from the more concrete production of goods we find in manufacturing (Reinertsen, et al., 2005). But there are also likely to be other reasons, such as the demand of R&D to manage both exploration and exploration. The effects of process management on exploitation are easy to understand, whereas we know far less about its effects on exploration in R&D. The following chapter

describes some of the research that has been done to analyze the effects of combining exploration and exploitation, in R&D and elsewhere.

2.5 Combining exploration and exploitation

Many scholars have highlighted that there seems to be a conflict in the combination of exploration and exploitation. Different perspectives of this conflict has been described in concepts like the productivity dilemma (Abernathy & Townsend, 1975), and the regulatory paradox (Abernathy, 1980). Ultimately it comes down to the need for companies, and in particular R&D organizations, to be able to both explore future opportunities and exploit current ones.

Companies can have either high or low levels of exploration and exploitation respectively. This gives us a number of possible combinations in how organizations can approach this challenge, as illustrated in Figure 4 (Boer, et al., 2003).

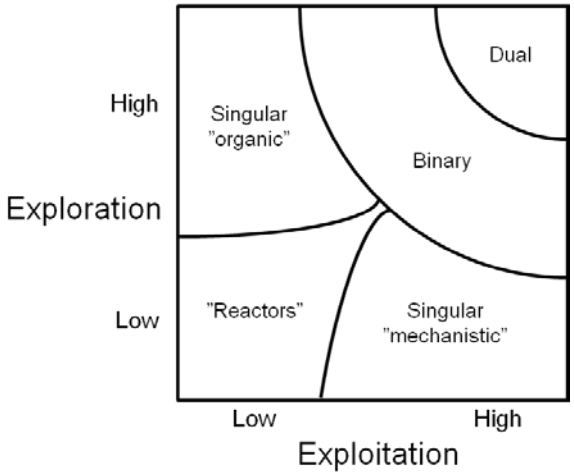

Figure 4. Outlining of the dual and binary organizations as organizations which in some way manage both exploration and exploitation. Figure adapted from (Boer, et al., 2003)

In the left part of the model (Figure 4) we find organizations which do not attempt to combine high levels of both exploration and exploitation, e.g. the reactor organization (Miles et al., 1978) and the mechanistic and organic organizations (Burns, et al., 1961). This thesis, however, focuses on the organizations in the upper right part of the model which attempts to combine high levels of both exploration and exploitation. The goal of binary and dual

organizations is to reach a state of continuous innovation, where it successfully manages to combine "operations, incremental improvement, learning, and radical innovation" (Boer, et al., 2003). When attempting to combine both exploration and exploitation, the aims of these two will inevitably affect each other. Although the majority of scholars say that a focus on exploitation will bear negative effects in a company's ability to explore (Boer, et al., 2003) there are other scholars which claim that it can be done successfully (see e.g.Tushman, et al., 1993). In the next part of the thesis a brief overview of the literature in the field of combing exploration and exploitation is presented separated into three perspectives. The three perspectives include those who view the combination as a trade-off, those who say it is possible to reach continuous innovation and a dual state, and those scholars who problematizes the picture further and uses a contingency approach.

2.5.1 Trade-off approach

Those scholars listed here as having a trade-off approach claim that when aiming high in exploitation the organization will inevitably cause a decrease in exploration, and vice versa (Table 3). This has been the prevailing view in organizational theory research (Boer, et al., 2003).

Table 3. A list of work which claim the combination of high levels of exploration and exploitation to be impossible.

Authors (Year)	Key arguments
Abernathy & Townsend (1975)	Striving for a "systemic state" increases productivity but at the cost of flexibility and innovation capability.
Benner & Tushman (2002)	An increased use of process management shifts the balance of exploration and exploitation in favour of exploitation.
Amabile (1998)	Work environments established with productivity in mind may undermine creativity.
March (1991)	Adaptive processes are potentially harmful since they may favour an inferior activity that the company knows well, over a superior activity which is new to the organization.
Garvin (1993)	To gain speed you have to avoid projects which require extensive learning. Creating knowledge is also difficult if you feel hurried or rushed.

Abernathy and Townsend (1975) highlights that the strive for increased productivity in processes, and the efforts invested in achieving that, may cause a reluctance to disruptive changes in processes so large that it inhibits product innovation. In organizations with expensive production processes and large investments in production processes this relationship is likely strengthened. March (1991) follows a similar logic in that he claims that since exploitation has much faster and clearer feedback loops than exploration, exploitative development will be favoured even if exploratory development would be more beneficial. Many mechanisms in development, e.g. learning, encourages those activities which create benefits we can see in close proximity or soon in time, leading to a short-sightedness in the development of products and services (Levinthal, et al., 1993).

In many organizations the journey of bringing a product to the market is likely composed of a larger part of exploitatory activities than exploratory activities. This further underlines the challenge of identifying when the logic of exploration, and the temporal disruption in efficiency this may entail, is the right choice. A possible resolution to this is to separate exploratory and exploitatory units, so that the exploratory units can shape their process and culture in a way which favours exploratory activities, thus creating less instances where the organization has to shift between the exploratory and exploitatory approaches (O Reilly, et al., 2004).

In the literature which focuses on creativity we find claims that, although creativity and productivity might not be antithetical in nature, creativity is accidentally undermined by actions taken in the aim for productivity (Amabile, 1998). Another perspective presented by Garvin (1993), focusing on speed of projects, claim that it is impossible to gain speed if you conduct projects which require extensive learning. He also claims that creating new knowledge, which is an important part of creativity and ideation (Nonaka, 1994), becomes more difficult if you feel rushed. In this context it is interesting to highlight that employees in manufacturing units deploying process management approaches rarely feel very rushed although they are under tight time constraints. A likely explanation to this is that while rushing people

can give a sense of efficiency, rushed employees are likely to commit more mistakes in the manufacturing process and this leads to quality issues and consequently increased costs. Therefore the time available to perform an activity is planned to give just enough time to do it in a calm and controlled way. However, in R&D the feedback loop between a rushed employee and a poor performance is much more detached in time and therefore hard to discover. It is likely that R&D organizations are more prone to rushing their employees since the problem that it causes are not immediately visible and this needs to be taken into account when transferring the ideas of efficiency and productivity from manufacturing to R&D.

2.5.2 Co-existence approach

As a contrast to the literature claiming that high levels of exploration and exploitation cannot be combined there are a number of scholars who claim that it is possible (Table 4).

Table 4. A list of work which argue for the possibility of combining high levels of exploration and exploitation.

Authors (Year)	Key arguments
O Reilly & Tushman (2004)	Some firms manage both exploration and exploitation and these "ambidextrous" firms share certain characteristics.
MacDuffie (in (Adler, et al., 2009))	Explore and exploit are merely two different outcomes of the same problem-solving process. What will be the outcome is determined by the problem and gap definition, not the process.
Reinertsen & Schaeffer (2005)	Many concepts of process management can benefit R&D if applied properly and in a way that takes the difference between production and R&D in terms of e.g. value creation into account.
Brunner et al. (2008)	Organizations can maintain dynamic efficiency by means of deliberately disrupting the current processes to invoke learning.
Osono & Takeuchi (in (Adler, et al., 2009))	Toyota manages the productivity paradox by embracing contradictions and paradoxes. By using forces of expansion and integration in parallel, Toyota ensures continuous exploration, yet efficiency.

The scholars listed above address this question in different ways. Some have studied common characteristics in firms with a proven track record of continuously innovating (O Reilly, et al., 2004). They found that these firms typically separate their exploratory

organizational units from the exploitatory ones, although maintaining tight links between the units on a senior executive level. In the development of highly complex products it is, however, close to impossible to handle all the creativity in one organizational unit and to hand the development over to another unit which will continue the development with solely exploitatory means. The need for creative problem solving is evident throughout the process although the intensity decreases (Zhou, et al., 2003). Therefore, separating R&D into exploitatory and exploratory units may create an organization which is poorly equipped to handle the exploratory activities when the need for them arises (Lawrence & Lorsch, 1967).

Furthermore, other scholars claim that organizations can manage both exploration and exploitation by sacrificing short term efficiency by deliberately disrupting processes, thereby forcing the organization to come up with new ways of working (Brunner, et al., 2008). This way the organization stays flexible and gains an ability of dynamic efficiency. The advantages of such dynamic efficiency by far exceeds the temporary decrease in static efficiency (Adler, et al., 2009). Yet others take on the approach that many of the ideas in process management can benefit R&D, but that it is the un-reflected application of logic based on the nature of manufacturing that may harm exploration in R&D (Reinertsen, et al., 2005). They claim that if only the differences between R&D and manufacturing are being taken into account, there are many benefits to be gained from a process management approach also in R&D. This, however, demands a highly analytical approach to process management that is rarely encountered. Few R&D organizations, for example, measure and control based on their queues, which is one of the methods that Reinertsen promotes (Reinertsen, 2000).

2.5.3 Contingency approach

In addition to the above listed publications on the topic, there are some scholars that claim that by breaking down the concepts of exploration and exploitation we can resolve the apparent paradox or trade-off and thereby manage both (Janssens & Steyaert, 1999; Poole & Van de Ven, 1989). These views claim the effects of

combining exploration and exploitation depend on what aspects of the two concepts respectively that we study.

Table 5. A listing of publications which claims that the effects of combining exploration and exploitation depends on how we view the concepts that we study.

Authors (Year)	Key arguments
Adler & Borys (1996)	A coercive type of bureaucracy will create overly rigid routines, but an enabling bureaucracy will help improvement and finding new ways of working by using routines for changing routines.
Benner & Tushman (2003)	Process management activities could be beneficial for incremental innovation but inconsistent with more radical types of change.

As presented in chapter 2.4.1, Adler and Borys (1996) argued for a separation of routinization (bureaucracy) into two different types; enabling and coercive. They claim that negative effects attributed to routinization in general should rather be attributed only to coercive bureaucracy. Enabling bureaucracy on the other hand, enables and stimulates new ways of working since the routinization in place aids the development of new routines. This is an interesting way of viewing things which is highly relevant to R&D, since routinization in R&D must tolerate a large variety of outcomes. These organizations mush allow and incorporate new initiatives and entrepreneurial activities into the existing routines (Burgelman, 1983). An open solution space as an outcome of R&D routines is necessary since, in contrast to manufacturing, value in R&D cannot be created without variability (Reinertsen, et al., 2005).

Other scholars argue that we must put a finer classification on what we include in innovation before we can determine the effects of process management activities (Benner, et al., 2003). They claim that process management may be beneficial for incremental innovation but that it will have a negative effect on radical innovation. It should be acknowledged that, depending on how one interprets exploration and exploitation, the classification above can be debated. For example, some scholars would consider the standpoint of Benner and Tushman (2003) to belong to the trade-off approach, arguing that incremental innovation is part of exploitation rather than exploration. However, the definition of

exploration in this thesis, i.e. activities building a potential in terms of knowledge and ideas, includes incremental innovation as a part of exploration. Thereby the views described in Table 5 should be seen as positive to the combination certain aspects of exploration and exploitation.

2.6 Research focus

The theoretical exposition shows that, although heavily debated, the central question in the field is still relevant. Is it possible to combine exploration and exploitation successfully as a dual firm with the capability of continuous innovation? And if so, how should this be done? While some scholars claim that it is possible, the empirical evidence is still scarce (Boer, et al., 2003). There is a need to study this question, particularly in R&D where the issue is deeply embedded in the very mission of the organization. In this thesis, a subset of this question is approached by looking at the effects that process management initiatives may have on creativity in a large mature R&D organization. This thesis focuses on the three common characteristics shared by many process management approaches; flow orientation and its need for delivery precision, routinization, and continuous improvement. There is a need to better understand how these principles of process management plays out in an R&D context and how they affect the exploratory activities in the R&D unit. In order to study this, the individual and the R&D team has been chosen as units of analysis. These teams are directly affected by process management initiatives and it is also there that the ideas are conceived and thereafter developed in the specific creative climate formed by the team. This level of analysis is interesting to study since a deeper understanding of how the combination of exploration and exploitation plays out at this level can help us create actionable knowledge to facilitate that combination in the future.

2.6.1 Research question

The overall purpose of this thesis is to explore the relationship between process management activities and exploratory R&D performance outputs. As a first step in the exploration of this relationship the following research question has been defined and it is this research question that this thesis seeks to answer:

- *Which interrelations exist between the use of process management methods and creativity in R&D?*

The process management methods chosen for the exploratory approach coincides with the three principles outlined in the theoretical exposition; Focus on flow by means of delivery precision, routinization of work procedures, and continuous improvement efforts. These principles of process management and their connections to creativity have been addressed in the three appended papers and the following chapter describes the methodology used in the research study.

3 Research approach

Throughout this research I have studied the case company, Scania, from the inside as an employee. I have not personally been involved in product development projects, but I have worked side-by-side with colleagues who experience the every-day challenges of R&D. Colleagues who work right in the middle of the context I am trying to study. This has been a great asset to my research, but has also further complicated and underlined the important challenge of staying objective and scientific in my approach. I have been aided in this quest by the fact that the collection and analysis of quantitative data is difficult to bias. As far as possible I have tried to stay unbiased also in my analysis of the results. I have used my colleagues for validation and increased understanding of the practical implications of my results.

This chapter aims at, firstly, giving a picture of the case company which has served as the single case in the study on which all appended papers are based. Secondly, a review of the data collection method and analysis method is presented. Lastly, the methodological assumptions and choices are discussed, focusing on validity, reliability and generalizability.

3.1 Case company

The case company in this study is Scania, a developer and manufacturer of heavy trucks, buses and engines operating on an international market. In the development of trucks, Scania focuses solely on heavy trucks, separated into three segments; long-haulage, construction, and distribution. The company has more than 35,000 employees in approximately 100 countries (Scania, 2011). The single largest site is Södertälje, Sweden, where the company has its headquarters and R&D unit, as well as the purchasing unit and parts of the production. At present, over 3,000 people work in the R&D unit (Scania, 2011).

Scania has managed to pair a good customer offering with efficient manufacturing and distribution, showing profit every year since 1935. The company has been awarded Truck of the year four times, in 1989, 1996, 2005, and 2010 (Webpage, 2012). In 2011

Scania was also named one of the Top 100 Global Innovators by Thompson Reuters (2011).

The company continuously runs product development projects, often involving hundreds of people in one single project. The product development process is divided into three separate processes: yellow arrow (research, advanced engineering, and concept development), green arrow (industrialization process), and red arrow (field quality-induced development projects and product updates throughout its lifecycle). Many employees share their time between pre-development and the industrialization process, unlike many other companies where the two processes often are separated into different organizations. All R&D employees are geographically located at the R&D office in Södertälje, with the exception of small teams working close to each production unit. The proximity between product developers from different units, and also between product developers and other parts of the company influence the company culture and ways of working.

3.1.1 Scania's history of process management

Scania's journey of introducing process management philosophies in production and R&D has evolved over a long period of time. In the 1990's company-wide efforts were made to increase, among other things, the delivery precision, quality, and cost efficiency. But even before that many initiatives had been taken to improve the operations, and in these initiatives we find many elements that we would attribute to, e.g. lean thinking and other process management philosophies. The journey towards the process management approach that the company holds today has gradually been adapted and added to and was not introduced as a "package solution". The initiative in the 1990's was followed up by further initiatives to complement and build on the changes that had taken place. During this time period the influences by Japanese auto-makers gave impact in that the new ways of working were illustrated as building-blocks in a house, much like the house in which Toyota's production system is often visualized. In 1999 the first Scania Production System (SPS) model, also visualized as a house, was published internally. Scania's core values; Customer first, Respect for the individual, and Elimination of waste serve as

the foundation of the house. The core values are complemented with principles such as continuous improvement, tact, and visualization. The company has, unlike many other companies, kept the use of Japanese words to a minimum, and instead used Swedish translations.

In 2003 the first R&D "house" was published internally under the name R&D Factory. It had many similarities, yet some differences, with the Scania Production System. The largest differences were that R&D Factory included two lists of priorities, one for the product and one for the process. In 2009 the process management model was revised to put further emphasis on creativity. In 2010 the R&D Factory was once again revised and this time increased emphasis was put on a processes-orientation rather than a product or technology focus. In 2011, the new version of the R&D Factory was paired with a booklet describing all principles, and an educational effort with the goal of teaching the new way of thinking. The educational effort was based on a *train the trainer* method where each manager trained his or her management team. Thereafter the managers in the management team went on to train their managers or employees. The educational effort also came with an increased focus from R&D management on high demands of dedication of all organizational units to develop a way of working which fits the R&D Factory core values and principles. The decentralization of the transformation effort and the autonomy of the organizational units have always been protected, leading to different ways of implementing the R&D Factory to best suit the needs of each unit.

3.2 Research setting

The research serving as a basis for this thesis is unusual in the sense that the PhD student has been employed in the company as an industrial PhD student. Scania has a long history of regularly employing industrial PhD students. That type of employment entails being paid by the company but enrolled at a university and the PhD students is expected to continue working within the company after graduation (Kihlander et al., 2011). Traditionally, at Scania, industrial PhD students perform research in a particular technology area. There are, however also examples of PhD

students studying processes or managerial aspects of the company's operations as is the case with this particular research project.

The employment as an industrial PhD student in this case came into force after seven months in the company which enabled learning the everyday operations from the perspective of a regular employee before fully engaging in studying the organization as a researcher. At present approximately 80% of the time is spent on research and the remaining 20% on facilitation of creative problem solving workshops and various business development projects. This type of employment enables access to company data and the possibility to continuously perform informal validation.

Several persons from industry and academia are formally involved in this research project. The constellation of stakeholders has changed a little over time. However, throughout the majority of the research project it has consisted of the PhD student, two academic supervisors and two industrial supervisors, the closest manager and a steering committee. The steering committee consists of four senior representatives from the company and the two academic supervisors and meet quarterly to discuss different aspects of the research project and to make major decisions. All formally involved stakeholders are invited to the steering committee meetings, which are planned by the PhD student. The steering committee meetings, together with regular meetings with the supervisors act as a support in the process of putting the research and its finding in perspective. The main part of the scientific supervision is made by the academic supervisors. Two office spaces, one at the company and one at the university, are available for the PhD student.

The PhD employment came with a free role to explore and find a suitable area for research in the field of innovation. All actors involved in the project have played a part in shaping and finding the specific research area.

3.3 Research design

The questionnaire study which serves as the data source for the appended papers was carried out to follow the progress in the organization as a new business development effort with a focus on process management was implemented (described in detail in

chapter 3.3.1). The first questionnaire round was planned in time to serve as a baseline. The two latter rounds were collected with approximately six months intervals to follow up on possible changes (for exact dates see Table 6).The data collection procedure as well as questionnaire design is further described in this chapter.

3.3.1 Survey study design

A web-based questionnaire study was carried out in parallel with a business development effort with the aim of increasing R&D productivity and quality. The business development effort was a launch of a new version of Scania's process management programme in R&D called R&D Factory (see chapter 3.1.1 for a more detailed description), first launched in 2003. This process management philosophy has a lot in common with the ideas of lean product development (Womack, et al., 1991), although altered to fit the company's operations. For an overview of the business development effort and its relationship to the questionnaire study see Figure 5.

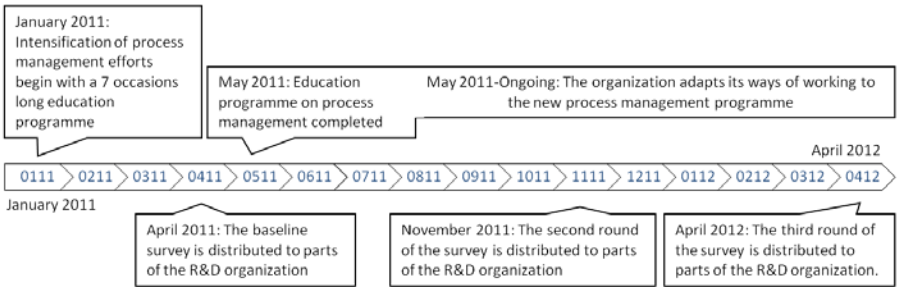

Figure 5. An overview of the questionnaire study (below timeline) and the parallel business development effort (above timeline) carried out in the company.

The intensification in the deployment of the process management programme consisted of an educational programme with the purpose of spreading knowledge of the process management principles and mindset, and to encourage the organizational units to analyze how they best could implement these ways of working. Approximately seventeen hours per employee was spent over the course of five months (January to May), where the teams met seven times. (A team at Scania consists of a group of employees, e.g. designers or test engineers and their first line manager.) The first six times were dedicated to learning more about the process

management approach. The last instance was dedicated to a scenario analysis on the implications for the own team. The baseline survey in this research was performed before the last session.

After the educational effort a continuous work implementing the suggested approach, reorganizing daily work and changing mindset was initiated. This initial effort has since been followed up with more information, evaluations and support tools. The work with the process management programme is considered a continuous effort.

Table 6. An overview of the three questionnaire rounds their respective number of participants, number of questions, dates of realization, and language. It also relates to the appended papers.

	Round 1	Round 2	Round 3
Number of respondents	558	667	647
Response rate	83% (460)	78% (519)	76% (489)
No of participating teams	46 (+1 pilot team)	58	60
Start date	1 April, 2011	15 Nov, 2011	19 April, 2012
End date	3 May, 2011	5 Dec, 2011	9 May, 2012
No. of background questions	12	12	12
No. of closed questions	75	81	83
No. of open questions	0[3]	1	1
Language	Swedish[4]	Swedish, English	Swedish, English
Data used in paper	Paper A	Paper B, paper C	

3.3.2 Questionnaire content

The questionnaire consisted of 3 parts. The first part addressed background information such as age, gender, tenure, and educational level. The second part consisted of the Creative Climate Questionnaire – CCQ (Ekvall, 1996). The third part included questions on, among other aspects, planning, learning, time spent on innovation, and project goals. Part one and three of

[3] No explicit open-ended question was asked but the respondents had the possibility to leave comments.

[4] The number of English speaking people in the organization was considered very low during the first round of the questionnaire why it was only offered in Swedish. For the next round the number of English speaking employees in the organization had increased, and the questionnaire was complemented with an English version.

the questionnaire can be found in Appendix A. The second part is not disclosed for copyright reasons.

Throughout the questionnaire rounds, the original questions were kept unchanged and a few additions were made. The only exception from that is the single open-ended question added in round two which was altered in round 3 to address other aspects.

3.3.3 Data collection and analysis

The questionnaire was web-based and a link to the questionnaire was sent to the respondents by email. An overview of the number of participating groups can be found in Table 6.

The questionnaire collected data over three occasions. However, the papers appended in this thesis only include analysis based on cross-sectional data. The data was analyzed using the statistical analysis programme IBM SPSS statistics 19 (IBM). Correlation analyzes and Ordinary Least Square (OLS) linear regression analyzes were used as methods of analysis.

3.3.4 Sampling

To create a diverse sample of the organization, a query for participation was sent to the senior managers of 13 different organizational units. All but one of these organizational units participated with all, or a sample of the design groups tied to the specific unit. In total 47 design groups chose to participate in the first round of the study. One group (n=22) was used to pilot the questionnaire to ensure that all questions could be understood and that the answers were not skewed in any direction. Two questions were altered after the pilot study. In question number 9, an option "do not belong to the C-career (applies to e.g. consultants and group managers)" was added providing an option for those to whom the question did not apply. In the question "I find it very difficult to get time to last for my work assignments", the word "very" was added since 69% of the respondents in the pilot study replied a six or seven on a 1-7 scale. The aim of this change was to include more of the variance in the available scale. The results from the pilot study have not been included in the data set for analysis.

During the course of this longitudinal questionnaire study the number of participating groups changed. Due to re-organization

some teams or parts of teams were moved to other departments and were omitted from future rounds of the study. Some teams changed names or were transferred to other parts of the organization also participating in the study. On those occasions, the teams continued to be part of the study under their new name. Some teams were added along the way, on most occasions due to an interest to learn more about their creative climate. Methodological implications due to these changes in teams are not discussed in this thesis since all appended papers make use of cross-sectional data, rather than panel data.

The response rate of the questionnaire rounds were 83%, 78%, and 76% respectively. All considered "very good", the second highest category on a five-category scale ranging from "not acceptable" to "excellent" (Mangione, 1995) (Source: Bryman & Bell, 2007, p. 244).

3.3.5 Operationalization of central concepts

This research aims at analysing the relationships between different aspects of exploration and exploitation in an R&D context. As can be seen in Chapter 2, there are a vast number of concepts associated with exploration and exploitation respectively. In this research study a subset of variables have been selected and assessed by means of a survey. An overview of the variables can be seen in Table 7 to Table 9. To formulate these questions to match the concepts they intend to measure, a mix of common-sense understanding, earlier validated questionnaires and theory was used. This approach is common in designing surveys (Bryman & Bell, 2007).

Table 7 to Table 9 includes all the questions used for analysis in the three appended papers. The questions are formulated as statements and respondents were asked to fill in how well the given statements described the own working situation. For a full list of questions see Appendix A. Questions being part of the CCQ were answered on a 0-3 interval scale to stay true to the original format of the questionnaire (Ekvall, 1996). The questions in part three of the questionnaire were answered on a 1-7 Likert scale.

Table 7. Exploratory R&D performance outputs

Variable	Question formulation
Idea time	There is time available to explore new ideas.*[5]
Time for learning	In our group we get to spend time learning new things.
Idea quantity	Many new ideas are aired here. *
Idea novelty	Unusual ideas are often aired in discussions.*
Idea implementation	We often realize the ideas that come up. *
Autonomy	People plan their work independently to a rather large extent. *

Table 8. Exploitatory R&D performance concepts

Variable	Question formulation
Existence of work routines	There are clear procedures for how my work shall be performed
Compliance with routines	I follow the work procedures that currently exist
Openness to change routines	There is scope here to change established ways of working.
Delivery flexibility	It is easy to postpone a delivery.
Continuous improvement	I continuously evaluate my work in order to find ways of working that save time and resources

Table 9. Other concepts

Variable	Question formulation
Goals for innovation	In our department explicit goals to be innovative exists.
Clear project goals	Our projects have clearly described goals.
Job satisfaction*	People here often have a feeling of job satisfaction.*
Lack of time	I find it very difficult to get time to last for my work assignments

Throughout the report the words in the variable column in Table 7 to Table 9 will be used in *Italics* with a capital first letter as a short name for the actual question. In instances where the words are not in Italics the text instead refers to the concept in a more general sense, such as e.g. lack of time.

3.4 Discussion of research approach

This chapter is dedicated to a discussion about the methodological choices and assumptions made in this study. It will, however, begin with discussing the implications of studying an organization as an employed PhD student.

[5] Statements marked with an asterisk (*) are part of the Creative Climate Questionnaire (Ekvall, 1996). The exact phrasing has been altered for copyright reasons.

3.4.1 Studying an organization from inside

There are challenges that come with insider research that needs to be taken into account when planning and executing industrial PhD projects (Kihlander, et al., 2011). In the beginning of a research project, specific attention should be given to aligning expectations and demands on the PhD student from its dual actors, as well as discussing the balance between research and industry projects. Furthermore, there should be a plan for how the research results should be anchored and disseminated in the organization (Kihlander, et al., 2011).

The question of bias becomes evident when discussing insider research. Some argue that native researchers are too connected to the researched situation, and thereby not able to maintain the distance and objectivity needed (Anderson et al., 2007). On the contrary, others argue that, with the use of reflexivity, insider researchers provide important knowledge of what organizations are really like (Brannick & Coghlan, 2007).

In the first year of the research project it was decided that the initial study would take on a quantitative approach the main reason being the ability to follow a large business development effort over time on a large scale. In addition, starting the research with a quantitative study also fits the insider researcher role. The interaction with the employees and the risk of bias in data collection and analysis is smaller than with qualitative research. With that said the true advantages of access to people and data, and a thorough understanding of the organization come into play mainly in qualitative studies. Qualitative studies are also a natural next step of research in this project.

3.4.2 Discussion of methodology

The studies described in the appended papers rely solely on quantitative data collected by means of a web-based questionnaire of a subjective self-assessment type. Data of this type has its limitations due to the subjectivity of the responses. To increase quality in the analyzes it should be complemented with objective data in related areas.

Some of the main challenges of quantitative survey type research are concerned with construct validity, causality and generalization. Construct validity, the extent to which the chosen questions actually do measure the concepts they claim to measure, is a relevant concern also in this research. For example, all appended papers are based on single-item variables. There are potential problems with using a single item, such as the question being too general or that it assesses only a part of the concept it aims to measure (Bryman, et al., 2007). This is a risk in the research in this study and should be taken into account in future studies. The issue have been addressed in some cases in the appended papers, e.g. variables measured using two separate single-items, such as using both *Idea quantity* and *Idea implementation* to assess innovation in Paper B. For some variables, such as job satisfaction, a single item can be considered reliable (Wanous et al., 1997).

Furthermore, as variables are indirect measures of actual behaviour there is always a filter of interpretation. In this study the questions in the questionnaire address attitudes and perceptions of behaviour, rather than actual behaviour. For example, there is a risk of interpreting the perception of that there are many ideas aired in the organization as a measure of actual number of ideas. In the current research this issue has been addressed mainly through transparency. All questions analyzed have been disclosed (or a versions of the question in cases where the exact wording is protected by copyright) so that readers can judge construct validity themselves.

Regarding causality, the present research study, as described in chapter 3.3 is, given its longitudinal approach, enough to use as a basis for causality conclusions. The appended papers, however, all rely on cross-sectional data which makes causality difficult to determine. Consequently, causality conclusions are limited and instead replaced by a discussion on relationships between variables. In some instances causality is supported by theory, e.g. autonomy leading to innovation (Paper B), and in some cases it is obvious, e.g. that increased demands on delivery precision has an effect on idea novelty and not vice versa (Paper C).

The generalization of the results described in this thesis is limited since it relies on a single case. However, the sampling together with the high response rates should at least be considered robust enough to be valid for the whole R&D organization in the case company. The size of the case organization and the diversity in the teams' profiles, including e.g. designing, testing, and pre-development increases the chances of generalizability. In Paper C an attempt was made to increase generalizability by selecting only respondents who fulfilled a set of criteria. This increases the chances that the results are generalizable to another population fulfilling identical criteria.

The replicability of this study is limited due to two reasons. Firstly, the insider setting under which the research has been performed, which is hard to replicate, have effects on data access, response rates and questionnaire design. Secondly, the business development effort carried out in the company in parallel with the questionnaire study provides a unique situation. In other words, the method used is replicability, whereas the challenges in that respect lie in finding a similar research setting.

Data analysis

The collected data in this research is mainly of a categorical type. The analysis used, OLS linear regression analysis, is developed for interval data. Hence, the use of categorical data violates some basic assumptions needed for OLS regression analysis. However, simulations have shown, that for categorical data (unless exponential in nature), OLS linear regression is robust enough to give indications of relationships, although not the magnitude (slope) of that relationship (Larrabee, 2011). Given this, some assumptions of how strong the connections between variables are, may have been drawn too far in the appended papers. The claim of relationship is, however, sound.

The data analyzes in the appended papers are mainly of linear type. In some of the analyzed areas, curvilinear relationships are common (e.g. slack (Nohria & Gulati, 1997)). With the data analysis methods used, there are limitations to how well curvilinear relationships can be revealed and it is a natural continuation of this research to further investigate such possible relationships. In

general, more advanced modelling, also using statistical analysis better suited for categorical data, is needed.

Study design

Surveying attitudes, climate and other aspects of exploration and exploitation over the course of a business development effort is an unusual opportunity which strengthens the relevance of this research. The appended papers in this thesis, however, only perform analysis on single instances of the questionnaire study. The subjective nature of the questions, paired with prevailing attitudes in the organization related to the questions addressed may induce validity and reliability issues. For example, the assessment of whether demands of delivery precision are high may reflect only attitudes and not actual delivery precision. There could also be effects of change reflected in the second and third instance. It is, for example, possible that changes in operations introduced after the first round will show up in the replies in the second round but decrease again in the third round. This decrease could be due to, not that the efforts wore off, but rather because the difference from the previous round is smaller.

A strength of this study is that it studies the central concepts on a team and individual level rather on firm level. The research on firm level far exceeds that on the team and individual level (Richtnér, 2004). Process management for efficiency has high impact on the individual level, and it is also there that change has to begin if a company wants to reach higher efficiency.

Creativity, although individual in its conception, often has a social element to the process (Nonaka, 1994). From those reasons the chosen units of analysis, focusing on the individual and the team, should be seen as a strength in this study.

3.4.3 Methodological assumptions

A number of methodological assumptions are necessary in order to justify the study of organizations by means of quantitative survey research. Firstly, one needs to assume that people who reply to the questionnaire understand the question and interpret them in a similar manner (Bryman, et al., 2007). Secondly, the assumption that we can treat, and thus study, the abstract social contexts of

organizations as a real thing is necessary (Bryman, et al., 2007). The results from this study should be considered a first vague picture of a reality, whose complexity surpasses that which we can study by means of questionnaires. The questionnaire studies, however, do reveal patterns not easily detectable by qualitative studies, thus motivating the choice of method. With that said, the results described in the appended papers should be viewed as indications rather than conclusions and serve as the basis for future research which should rely more heavily on combining quantitative and qualitative data.

4 Summary of appended papers

Each appended paper in this thesis has provided me with an opportunity to analyze my data from a new perspective. Pairing different concepts of exploratory and exploitatory nature and analyzing their relation with the help of statistical tools have increased my understanding of how these two intertwined areas of R&D affect each other. This thesis is the first attempt to try and comprehensively summarize what these findings mean when we look at them as a whole.

In this chapter a summary of each of the three appended papers can be found. An overview of the papers can be found in Table 10 which outlines the titles, methods of analysis, units of analysis and the exploratory and exploitatory concepts of each paper.

Table 10. An overview of the appended papers.

Paper	**Paper A**	**Paper B**	**Paper C**
Title	Slack – a driver of innovation in R&D?	The delicate co-existence of standardized work routines and innovation	Creativity just in time? The effects of delivery precision in product development
Exploratory concept	Idea time	Idea quantity	Idea quantity Idea novelty
Process management concept	Work routinization	Work routinization Continuous improvement	Delivery precision
Method of analysis	OLS regression analyzes and correlation	OLS regression analyzes and correlation	OLS regression analyzes and correlation
Unit of analysis	Individual. All respondents.	Individual. All respondents.	Individual. R&D employees in industrialization process.

4.1 Paper A

Lund, K., Magnusson, M. (2011). Slack – a driver of innovation in R&D? *Proceedings of the 12th International CINet conference*, September 12-13, Aarhus, Denmark.

The purpose of this paper was to analyze, whether the existence of clear work routines can free up time which can be used for exploratory activities. It also addressed whether having explicit goals for innovation would affect how much time is spent on idea exploration.

The results show that *Lack of time* has a strong negative link to the perception of available *Idea time*. Merely focusing on cutting waste from the organization without closely monitoring the flow of ideas may decrease exploratory activities. More interestingly is, however, that availability of time in general, and in turn *Idea time*, is positively linked to the *Existence of work routines*. The results also show that *Goals for innovation* is positively related to *Idea time*. It can thereby be concluded that managers have the possibility to positively affect the allocation of time for exploratory activities by communicating strategic goals of innovation and by encouraging the employees to find work routines which help them become more efficient.

The harder it gets to manage ones work tasks, the less time is spent exploring new ideas. Time can, however, be freed up by using work methods to reach higher efficiency levels. This paper also points out the importance of guarding explorative time as the cost-cutting and competition gets tougher. One way of doing so is by setting goals for innovation. Furthermore, Paper A positions this research together with the group of scholars who view value flow, and not waste-cutting, as the most important ingredient in process management philosophies.

4.2 Paper B

Lund, K., Magnusson, M. (2012). The delicate coexistence of standardized work routines and innovation, *Proceedings of the 19th International Product Development Management Conference IPDMC*, June 18-19, Manchester, U.K.

The purpose of this paper was to analyze two aspects of work routines and creativity. The first is to analyze the relationship between autonomy and work routinization. The second is the possible effect that routines will free up time, which in turn can be used as time to come up with, and implement, new ideas. These two relationships were explored quantitatively using linear OLS regression modelling.

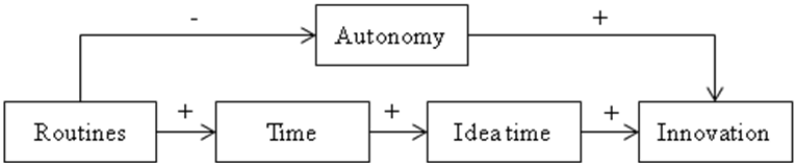

Figure 6. A model of how the analyzed concepts are interlinked.

The results in this study showed that the *Existence of work routines* does free up time for ideation, which in turn is positively related to aspects of innovation. The *Existence of work routines* also has a direct positive link with both *Idea quantity* and *Idea implementation*. Furthermore, the *Existence of work routines* was positively correlated to *Job satisfaction*, which indicates that striving towards clear work routines will not generate the desired performance outcomes at the cost of people's job satisfaction.

The study also showed that people do not experience a decrease in *Autonomy* although they experience high levels of *Existence of work routines*. The Openness to change work routines is positively related with *Idea quantity* and *Idea implementation*, indicating that experiencing that routines are cut in stone has a negative relationship with those aspects of exploration.

The results from this study indicate that the question of work routines and innovation is more complex than just whether they can co-exist. One must take a nuanced look on type of routine, the purpose of routines, dynamism of routines and, last but not least,

who has the ownership and power to change routines. The right kind of routines may very well co-exist with innovation and will, under the right conditions, improve not only efficiency but also innovation.

The previous publication (Paper A), indicated that by having work routines, you can free up time which, in turn, can be used for idea exploration. Paper B, not only confirmed the finding from Paper A, but also showed that the *Existence of work routines* has a direct positive relationship with both *Idea quantity* and *Idea implementation*.

4.3 Paper C

Lund, K. (2012). Creativity just in time? The effects of delivery precision in product development. *Proceedings of the 13th International CINet conference*, September 17-18, Rome, Italy.

The purpose of this paper was to explore the relationship between *Delivery flexibility* and the idea exploration performance variables *Idea quantity* and *Idea novelty*. Employees in the case company had aired concerns that an increasing demand on delivery precision would harm the comprehensive view of the product. They feared that strong incentives of delivering in time would happen at the cost of quality of the content delivered. Furthermore, characteristics of a product development phase of highly complex products contain sub-projects carried out concurrently and intense cross-project hand-over which rely heavily on delivery precision. These two factors motivate the quantitative analysis of the relationship between demands on delivery precision and ideation outcomes.

This study found that *Delivery flexibility* was negatively related to *Idea novelty*. In addition *Openness to change work routines* and the perceived *Lack of time* were factors positively connected to *Idea novelty*. No significant linkage between *Delivery flexibility* and *Idea quantity* could be found. *Idea quantity* was instead positively related to *Idea time* and an *Openness to change work routines*.

This study highlights the importance of setting aside time for exploratory tasks. It also indicates that, given that time is allocated to explorative activities, such work does not need to be harmed,

but could instead be aided, by strict deadlines and a fast-paced work environment.

This paper indicates that, to avoid constantly being side-stepped by every-day tasks, creative tasks, too, need strict deadlines. Creativity may flourish best when given no constraints in time and resources, but only given that time will, at all, be allocated. Perhaps we do creativity a disservice when we treat it overly carefully in the name of optimizing creative thinking. Deliverables with a strict date will inevitably most often be prioritized over deliverables without deadlines, disregarding of delivery content. The demands on delivery of a result which requires problem solving actions and the generation of novel ideas will likely lead to the allocation of resources to accomplish that. Without those demands there is a risk that the time for exploration will never be allocated, in the worst scenario leading to, initially unintended, carry-over of parts from the previous generation of the product. When people in the organization testify that they could have delivered a better solution, if only they had not been pressured by the strict demands on delivery, they likely compare with the situation of having plenty of time, whereas in reality there would likely in the end have been no time available at all. To survive in a world where most tasks are of exploitatory nature, the exploratory tasks of our work perhaps have to learn how to act under the rules of the exploitatory majority.

5 Analysis and discussion

The work with this thesis has required taking a more comprehensive view of the research findings than when working on individual papers. The main thing I would like to highlight from that process is the context dependent nature of the challenge of combining exploitation and exploration. In R&D organizations there is often a given set of employees, an ever-present lack of resources, conflicting demands and a continuous struggle between projects for the available competence and time. Perhaps this world of ambiguity and trade-offs is what explains the sometimes surprising results in this thesis. This chapter lends us more room to discuss this.

5.1 Highlighting interesting results

The overall purpose of this thesis aims at exploring the relationship between process management activities and creativity and to analyze whether process management has either positive or negative connections with creativity among individuals in an organization. This thesis does so by addressing the following research question:

- *Which interrelations exist between the use of process management methods and creativity in R&D?*

Previous research in the field point to that the introduction of process management approaches will bear negative effects on innovation and creativity (Abernathy, et al., 1975; Amabile, 1998) or hamper positive effects of creativity (Gilson et al., 2005). The results of the appended papers in this thesis, however, indicate that process management actually seems to have several positive effects on exploratory R&D performance output. Table 11 below presents the relationships between the different process management concepts and exploratory R&D performance outputs. These findings are then further analyzed in this chapter.

When taking a comprehensive view of the table it shows that creativity can, in many ways, benefit from process management methods. In fact, this study shows no negative relationships between any of the analyzed process management concepts and the selected R&D performance outputs. The only possible exception

to this is the case of overly rigid routinization. The variable *Openness to change routines* show strong relationships with several of the outcome variables in the studies, such as *Idea quantity*, *Idea novelty* and *Idea realization* (Paper B, Paper C). A possible explanation to this is that very formalized and rigid routines have a negative influence on several of the exploration variables. Previous research has pointed to that high routinization will make teams constrained to the extent that performance will suffer (Gilson, et al., 2005). However, most process management approaches promotes dynamic routines which can be changed by the employees to fit the organization and the context (Adler, 1993a; Adler, et al., 1996). Such routines would require an openness from the organization to change existing routines. From this reason an openness to change routines should be consider part of routinization in process management.

Table 11 overview of the findings in this thesis. Paper in parenthesis. Asterisk (*) indicate that the relationship is supported by correlation. All other relationships are supported by OLS regressions.

Exploratory performance variables	**Process management concepts**		
	Work routinization	**Delivery precision**	**Continuous improvements**
Idea time	Positively related(B), positively related via time slack (A)	No relation* (C)	Positively related. (B)
Idea quantity	Positively related[6] (B)	No relation (C)	Positively related (B)
Idea implementation	Positively related (B)		Positively related* (B)[7]
Idea novelty		Positively related (C)	
Autonomy	No relation (B)		
Time for learning		No relation* (C)	
Job satisfaction	Positively related[8] (B)		

[6] Also indirectly related by freeing up *Idea time*.
[7] Positive relationship supported by correlation analysis. OLS regression analysis indicates that *Autonomy* and/or *Compliance with routines* act as mediating variables, see paper B, Table 5.
[8] The analysis controlled for a curvilinear relationship without significant results

In general, routinization is positively related to several of the exploratory variables, such as *Idea time* and *Idea quantity* (Paper A, Paper B). What further underlines this relationship is the positive link between the *Existence of work routines* and *Job satisfaction* (Paper B). This serves as an indicator of that the effects of routinization is sustainable in the long run since it has not given R&D performance effects on the cost of the employees' job satisfaction levels.

Paper C took a closer look at delivery precision as an important element of process management approaches. In the paper the opposite of delivery precision, i.e. delivery flexibility was analyzed, and it was found that *Delivery flexibility* is negatively linked to *Idea novelty*. This indicates that high demands on delivery precision are beneficial for generating unusual and novel ideas. Paper C also indicates that *Clear project goals* can serve as a means to decrease *Delivery flexibility*. Having *Clear project goals* is also positively correlated with antecedents of creativity, such as *Idea time* and *Time for learning* (Paper C). These findings are interesting since setting goals and demands on delivery are aspects of which managers have relatively high control.

Finally, the element of continuous improvement is central to process management. This principle can be considered as situated in the area between exploration and exploitation, including elements of both, since it aims at making current work methods more efficient and effective by coming up with new ideas for better work methods. It is therefore not surprising that *Continuous improvement* is positively linked to aspects of creativity, such as *Idea time* and *Idea quantity*. It also seems to have a positive, although weaker, link with *Idea implementation* (Paper B).

5.2 Analysis of the results in relation to the R&D context

The findings from this research paints a more optimistic picture than the dystopian reality that scholars with the trade-off approach holds forward (chapter 2.5.1). What aspects could explain why the process management approaches implemented in the case company show such positive links to creativity when others claim that process management will push aside exploratory activities (Benner, et al., 2002) or that productivity goals have the risk of

killing creativity (Amabile, 1998)? In this chapter we will look closer at possible explanations to that.

5.2.1 The R&D setting and its influence when combining process management and creativity

To understand the findings in this thesis, we first need to take a closer look at the setting in which the research study took place: a typical R&D unit in a large, mature product developing and manufacturing company. Such R&D settings often constitute an environment where there is a constant lack of time, where people work on a multitude of projects concurrently, and where different projects fight for the same resources. If often also entails, as in the case company, that one person can work with exploratory activities, such as coming up with new product concepts and creative problem solving one day and with exploitatory activities, such as ordering tests, handling communications with suppliers and computer aided product modelling of concepts already decided upon the next day. This constant shift between exploration and exploitation has several implications for research.

First of all, if we take the example of lean thinking applied to R&D, we must ask ourselves what constitutes value in an R&D organization. R&D organizations produce both an exploratory and an exploitatory value (Kennedy, et al., 2008). The exploratory value in an R&D organization can be defined as building a potential in terms of new knowledge and novel ideas which can be used for future exploitation purposes. The exploitatory value created, however, is better illustrated in terms of e.g. drawings and reports of test results. The flow of these values and the way they are created differs and therefore employees in the organization need to shift logic depending on what type of activity they are working on.

In this thesis the concepts of *priority* and *challenges* are introduced as a means to clarify this challenge.

- *Priority* has the purpose of communicating an elevated importance of certain tasks and can be made by e.g. setting strict deadlines for certain activities or formulating an outspoken goal to be innovative. *Priority* affects how we share our time between the two types of activities since, in

an R&D organization, every employee has a limited amount of time and often a workload which exceeds that time. Assigning *priority* is often combined with means to monitor and follow-up if a certain amount of something was produced. It communicates that this area is of particular interest and importance to the organization.

- *Challenges* on the other hand have the effect of hindering us from taking the fastest path towards a produced outcome. On the other hand they also decide the innovation level of the activities carried out. Examples of *challenges* are ambitious product performance goals or the ambition to design the next generation of a product to a significantly lower cost than the current generation. Those examples are typical ways that *challenges* play out in exploratory activities. However, challenges can also constitute incompatible processes which require specialized solutions every time a recurring task is performed. *Challenges* thus often take on the nature of unwanted obstacles in exploitation whereas it constitutes motivators and inspirations in exploration.

Priority and *challenges* have different effects on efficiency, effectiveness, and creativity depending on if they are applied to an exploratory or an exploitatory task (Table 12). In R&D many employees constantly need to shift between exploration and exploitation in work. This also has the effect that they constantly need to shift logic, i.e. one moment while working on exploitatory tasks *challenges* constitute waste, whereas in the next moment when working on exploratory tasks *challenges* are a necessity in order to create value.

Table 12. An overview of the role of **priority** *and* **challenges** *in exploration and exploitation respectively.*

	Exploration	Exploitation
Priority	Encourages more time spent exploring but not necessarily elevated "innovation height".	More time is spent on routine work. If routines are good the work is efficient. Builds product value but not knowledge.
Challenges	Encourages more radical innovations. Creates value in terms of knowledge. Must be paired with corresponding levels of *priority*.	Poor routines or obstacles in the process forces the wheel to be re-invented and induces frustration. No added value created.

Challenges in exploitation activities forces creativity to be used to produce the information required. In exploitation re-inventing the wheel every time is considered waste and does not produce additional value. Instead, the best known practice should be utilized in the most efficient manner since the process outcome is known. In exploration however, *challenges* are what helps us push the knowledge and ideas created towards more radical levels. Depending on the desired innovation level we should simulate and pose *challenges* in our processes. To successfully apply process management methods to exploratory activities, the positive effects of *challenges* need to be acknowledged and integrated into the routinization of such work.

The view in this thesis acknowledges that the introduction of *challenges* will reduce speed-to-market, but that it will yield a higher innovation level which will be more beneficial in the long run if planned carefully. And like deliberate perturbation (Brunner et al., 2010), exploration must be prioritized and the short term efficiency losses be accepted, in order to gain in the long-term perspective. However, R&D organizations should be careful to pair the desired level of innovativeness, and thus *challenges,* with the adequate levels of *priority* in order to gain efficient knowledge creation. When failing to prioritize exploration activities, e.g. assigning enough resources, the innovation level will likely go down. On the other hand, only assigning *priority* but without the complementing *challenges* will result in resources spent on generating incremental knowledge or ideas. Efficient and effective exploration activities thus require both *challenges* and *priority* whereas exploitation activities thrive under conditions of high *priority* and a minimum of *challenges*.

5.2.2 The effects of time allocation on creativity

Creativity is often claimed to need freedom and autonomy to excel (Amabile, et al., 1996; Ekvall, 1996) and previous research has claimed that reduced possibilities to depart from project deliverables may have a negative influence on the type of knowledge creation most important in the early phases of development projects (Richtnér & Åhlström, 2010). Due to such

findings, a common misconception is that this means that creativity can only happen if we leave both planning and execution entirely to the creative person, e.g. in R&D the designer in charge of the development of a certain product (Andrews & Farris, 1972). However, since exploitatory tasks are more tightly connected to its consequences and feedback loops (March, 1991) exploratory activities are easily pushed aside if they are not earmarked with deadlines and specific content. With the time pressure and pressure to deliver constantly present in many R&D units, tasks left unmonitored and with little follow-up, i.e. with low levels of *priority*, are at great risk of being eliminated to leave room for exploitatory tasks.

In R&D, there is a risk that the reluctance to monitor exploration will lead to such activities being down prioritized in comparison to exploitatory activities. Thereby, the risk that we get no creativity without monitoring is likely greater than the risk that we get inferior creativity because we monitor it too hard. The results from this research study, e.g. that *Delivery flexibility* is negative for idea novelty, indicates that we can put high demands on delivery and still get creative results, and actually even benefit from it. A possible explanation to this is that a delivery includes both content, e.g. desired innovation level which can serve as a *challenge* and a time limit which serve as *priority*. This can be used as a means to encourage creativity.

Furthermore, this research showed indications of that lack of time possibly has positive effects on ideation if time for exploration can be ensured (Paper B). In other words, lack of time which does not "steal" time from idea exploration or is caused by spending extensive amounts of time on idea exploration may have a positive effect on ideation. This gives indications that it is not lack of time or a fast-paced work environment *per se* that may harm innovation but rather that a lack of time often moves time from exploratory activities to exploitatory activities where the consequences of delay would be more directly evident and which thereby get higher *priority*. These indications that time pressure and creativity are positively connected are supported by previous research which claims that time pressure just above the desired levels is positive both for productivity and innovation (Andrews, et al., 1972). Their

study even show indications that people who have previously produced innovative results may be given less time constraints to further enhance innovation but which instead resulted in less innovative results. It should be pointed out that the research in this thesis does show that a lack of time causes time spent on exploration to go down (Paper A, Paper B). And while some positive connections between time pressure and ideation is indicated in this research, some researchers claim that time pressure most often is negative for creativity (Amabile et al., 2002).

5.2.3 Routinization and creativity

This thesis shows that routinization may have positive effects on idea creation, both in terms of *Idea time* and *Idea quantity*. Clear routines which are open to change, paired with working conditions where the employees have a great possibility to plan their own work, seems to be beneficial for ideation (Paper B). These connections between aspects of routinization and aspects of exploration were somewhat unexpected since previous research has claimed that standardized practices and routines will discourage employee creativity (Gilson, et al., 2005; Zhou, et al., 2003). Perhaps the discourse in this case lies in the nature of the participants in the study. Historically much of the research on creativity have been based on learning about the intellect and personality of particularly creative individuals or it has taken the standpoint of separating creative individuals from those who are less creative (Amabile, 1996). In this study, however, the participants are not selected based on creative ability, but are simply the members of the organization under study. Furthermore, much of the previous literature on creativity is based on experiments (e.g. Amabile, et al., 1984; Isen et al., 1987). It is relevant to study creativity in a more naturalistic setting since it may produce other results than an experimental setting (Paulus, 2002). The employees in the case company represent a heterogeneous mix of people, although with similar educational backgrounds. It could be that a large part of those individuals benefit more from structure and routines also in creative environments. Research in the field of psychology has for example shown that a high personal need for structure (PNS) under certain circumstances can produce more creative results than those with a

low PNS (Rietzschel et al., 2007). Could it be that people in the organization to a larger extent than typically creative people could benefit from a structured approach also in exploratory work? The research by Rietzschel et. al. (2007) has interesting implications for our collected body of knowledge about creativity since it potentially renders knowledge based on experiments with highly creative people irrelevant. Should there be a strong link between people that we generally consider highly creative and a low PNS, we may face a situation where the procedures to facilitate and encourage creativity among people with a high PNS are different from those that we have learned encourages people with high creative abilities.

Another possible explanation is that with good routines in place, fewer *challenges* disrupt the exploitatory work which then becomes more efficient. Since many R&D employees suffer from having more possible work to perform than there is time available, each freed up minute can be spent on doing something else. Therefore it is logic that some of the time freed up by having good routines in place is shifted to exploratory activities. There are however two scenarios where more efficient exploitation processes will not benefit exploration. Firstly, if the *priority* of exploitation is much higher than that of exploration, paired with an abundance of exploitatory tasks, freed up time may be entirely consumed with other exploitatory tasks. Therefore it is important to combine efficient exploitatory routines with *priority* of exploration, such as setting innovation goals. The second possible pitfall when engaging in exploratory activities is the potential risk of solely assigning *priority* to exploratory activities whereas at the same time failing to pair it with adequate *challenges*. This would shift the gained time from exploitation to exploration but not lead to a high innovation level. This way large exploration efforts are spent which only yield incremental results. Therefore *priority* in terms of e.g. goals for innovations also needs to be paired with *challenges* such as specifying an innovative content or bold product goals.

Furthermore, it seems like having clear routines is positively associated with high job satisfaction (Paper B). This is positive from many reasons. Firstly, previous research has suggested that job satisfaction is positively linked to innovation (Pierce & Delbecq, 1977; Rasulzada & Dackert, 2009). Although, the perhaps

most important reason to analyze job satisfaction is because it is an important indicator of sustainability of ways of working. Previous research has found a negative link between job satisfaction levels and routinization (the extent to which written rules govern employee activities) (Rousseau, 1978), and thus, organizations which have introduced routinization as a means to reach higher levels of efficiency may find a decrease in employee job satisfaction (Arches, 1991). Gaining positive results on aspects of exploration or exploitation in the short term may see its effects wear off amply if job satisfaction at the same time goes down. A system of continuous innovation must seek ways to work which takes into consideration employee satisfaction and motivation. Given the arguments for routinization above, it seems that a type of routinization where the employee is in charge of both changing existing routines and planning their work days have a positive impact on both aspects of creativity and job satisfaction.

In general, the results in this thesis show interesting results which in some cases contrast existing theory. This motivates further research in this field and points out a few areas which are of particular interest. These areas are outlined in a number of research questions in the next chapter.

6 Concluding remarks

A thesis of this kind has at least two stakeholders; academia and industry. Whereas the interest for academia lies in what new knowledge we can get from the results of the current research, the interest for industry lies in how they can make use of the new knowledge to improve their organizations and operations. This chapter aims at clarifying the contribution of this thesis for each of the two stakeholders.

Will the introduction of process management in R&D harm or aid the creativity among employees? The research in this study has shown indications that process management and creativity can co-exist and that process management even has positive effects on aspects of creativity and other exploratory R&D performance outputs. The research presented in this thesis is, however, far too limited to provide a conclusive answer to the question above. In this chapter future research which could help answer the above question is outlined. In addition to that, a number of managerial implications are presented.

6.1 Implications for theory and future research

This chapter aims at outlining a number of questions which need to be answered in order to move from the increased understanding of how process management methods and creativity are related that this thesis has provided, to more actionable knowledge. Future research should follow the recommendations that have previously been outlined to move the field of continuous innovation towards a more mature state (Boer, et al., 2003; Martini et al., 2012). First of all, it is important that the context of an R&D unit is taken into consideration extensively in research on continuous innovation. In line with Boer and Gertsen's thoughts (2003), I argue that future research should aim at taking an inductive and empirically grounded approach and to particularly focus on those units who manage to combine process management with increased or sustained creativity levels.

RQ1: What differences in ways of working can be found between teams who manage to combine exploration and exploitation successfully and those who do not? (Figure 7)

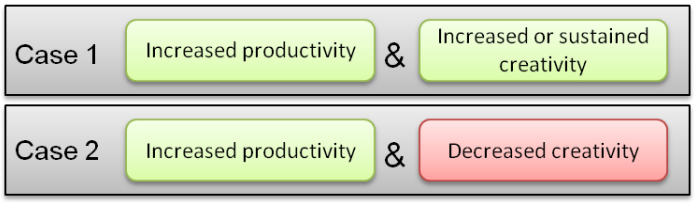

Figure 7. Future research should investigate the way of working behind the two above described scenarios: Increased productivity paired with sustained or increased creativity, and increased productivity paired with decreased creativity.

Secondly, this thesis has presented somewhat surprising results with regard to the connections between routinization and creativity. It is likely that the type of routine matters to a large extent and that we know too little of what separates *good routines* from *bad routines*. Current research, viewing routines as processes which shut down the creativity among its organizational members (Zhou, et al., 2003) perhaps need to take on a more nuances view of routines. Literature show several examples of routines that claim not to hinder creativity (Adler, et al., 1996), as well as routines which claim to systematically aid creativity (Osborn, 1953; Smith, 1998). Future research should build more heavily on the dynamic and enabling routines central to process management and carefully pay attention not to focus blindly on the coercive type of routines (Adler, et al., 1996). Future research should also take on a more fine-grained view of routines to analyze what entails a routine which enables or even inspires creativity whereas at the same time providing structure and predictability. There is a particularly strong need for such routines in R&D organizations since the successful combination of exploration and exploitation lies so close to the very mission of the R&D organization. Few oppose that the research units of R&D must find routines which enable creativity, but that is also the case for development units as unforeseen deviations which require creative problem solving may occur also during the implementation process (Zhou, et al., 2003).

RQ2: What are the characteristics of routinization processes which aid structure and creativity simultaneously?

Thirdly, the task of prioritizing between a mix of exploratory and exploitatory activities becomes key as resources in an R&D unit often are split between the two areas. Time for both idea exploration and learning is an important part in reaching high levels of creativity, but exploitatory tasks are often prioritized before exploratory tasks since they produce a more direct feedback in terms of e.g. improved processes (March, 1991).

Since the logic of exploration, i.e. creating a potential of knowledge and ideas differs from that of exploiting the built up potential, applying the right logic is key to gain the desired results. Organizations must learn how to navigate between different types of activities and to apply the right logic. The decision making process when it comes to prioritizing between exploratory and exploitatory tasks is likely highly unstructured. Learning more about how such decisions are made could teach us about how we should elevate those decisions to more well-analyzed and rationally sound decisions.

RQ3: How do employees and managers in R&D organizations prioritize between exploratory and exploitatory tasks?

Fourthly, it should be taken into consideration that exploitatory results are often more tangible than exploratory results, which include things as abstract as knowledge or ideas. This has the effect that exploitatory results are easier to measure which likely leads to heavier measurement and follow-up on such results. Measuring exploration often limits itself to tracking patent applications or ideas submitted in ideation systems. Although difficult, it would likely be beneficial for the prioritization of exploratory activities if we could find ways of measuring the results closer in time to the activity.

RQ4: In what way are exploratory results measured and monitored?

Finally, a process management approach should be sustainable in the long run. Pushing an organization into generating efficiency gains while sustaining creativity levels could likely be done rather easily, but at the cost of people's job satisfaction levels or even health. Introducing process management approaches must be sustainable both for employee well-being and creativity in the long run. There is a need for more empirically based research which

addresses the sustainability aspect of process management and creativity.

RQ5: What constitutes a design of process management which enable sustained or increased exploratory R&D performance output sustainably over time?

To address these five research questions a comprehensive approach is necessary. Future research need to take a holistic approach where the study of methods and organizational structures is combined with studying how people in the organization set goals, make decisions, what the social context of employees look like, as well as managerial aspects. To address the apparent paradox in the field of continuous innovation future research should take on a larger, more comprehensive perspective, it should question the assumptions behind the trade-offs, and it should seek new ways of working and managing which can help us resolve the conflict between many of the concepts which we associate with exploration and exploitation (Martini, et al., 2012). The apparent loss in efficiency in one team can, for example, lead to efficiency gains further down the value stream, in another department, or in future product development projects. A fresh perspective on routinization could be what is needed to create routines which not only helps to gain structure and efficiency but which also inspire creativity. And finally, developing new ways of setting goals for exploratory tasks could be what resolves some of the challenges that exploratory activities face in a highly exploitative environment.

The findings in this thesis point to a number of interesting areas to study further using the above described approach. Surprisingly positive relationships between aspects of exploration and exploitation was revealed and it motivates the search for a dualistic view of exploration and exploitation. The findings in this thesis also point to a number of managerial implications. The next, and final, part of the thesis elaborates further on these implications.

6.2 Managerial implications

This section of the thesis lists some managerial implications which can be drawn from the results in this research. These implications should be viewed as preliminary. Further research is needed to

validate that actions listed in this section would actually generate the desired effects.

6.2.1 The management of time and goals

The managerial implications of the results on time management revealed in this study are many. First, managers should ensure time for exploration also in times of cut-backs and efficiency programmes. Formulating and communicating clear goals for innovation may help dedicate time to idea exploration even when time is scarce. A fast-paced work environment can be beneficial for ideation, but a fast-paced work environment drained of idea time is not. Managers should ask for innovative delivery and state clear deadlines also for such delivery. Delivery dates should be held on to as they empower the prioritizing of exploratory activities which could else be put aside by more urgent short-term activities. However, delivery also includes a specific content and managers should put careful consideration to how that content is specified as it has important implications for posing the right challenges which can inspire employees to excel in their creative endeavours. Managers should also be responsive to the desired levels of time-pressure of the employees in the organization and push them enough to meet, or slightly exceed those levels (Andrews, et al., 1972).

6.2.2 The management of ways of working

When it comes to management of the development of work routines some implications are revealed by this study. Managers should encourage development of work routines and that employees should be given ownership of, and a power to change these routines as they see fit. The continuous improvement of routines should also be encouraged as this has positive effects on idea creation. Managers should not avoid questioning existing routines and ways of working and be open to let the employees redesign routines. The autonomy in execution of tasks should be guarded, but should not be seen as being in conflict with the existence of work routines. And where autonomy in execution is desired, people often desire less autonomy in setting strategic goals (Andrews, et al., 1972). Some employees may desire a higher level of structure also in the execution of goals and may benefit from

this in their creative endeavour (Slijkhuis et al., 2012). Managers should, due to this, be responsive to employees desired level of structure and seek ways to provide the necessary structure also for creative activities.

6.2.3 Avoiding illusive efficiency

The results reveal a strong linkage between the openness to change work routines and several of the exploratory R&D performance output measures. This underlines the importance of a dynamic way of viewing work routinization, and to incorporate a certain amount of flexibility. Furthermore, the results show a positive link between *Lack of time* and certain R&D performance outputs, such as *Idea novelty*. These relationships are only valid as long as *Lack of time* does not come at the cost of *Idea time,* since *Idea time* is a very important factor for ideation. The implementation of, e.g. continuous improvement efforts, where cutting waste is interpreted as cutting time to explore ideas, may harm the creative ability. A great level of insight into what constitutes value in the creative process and what is required to ensure the flow of that process is necessary to not cut out necessary elements in the name of productivity-enhancement.

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Appendix A

Questionnaire

Appendix A: Questionnaire

Appendix A discloses the questionnaire used in this research study. Questions with an asterisk (*) were added in the second round of the questionnaire. Questions with two asterisks (**) were added in the third round of the questionnaire. Part two of the questionnaire have not been disclosed from copyright reasons.

Part 1/3

Part 1 consists of a number of questions regarding your background, employment and previous work experience.

State the year you were born

State gender

- ❑ Male
- ❑ Female

State your level of education

- ❑ Secondary education
- ❑ Upper secondary school
- ❑ University 1-3 years
- ❑ University 4-5 years
- ❑ University > 5 years
- ❑ Other _____

Enter group affiliation

If your group is not in the drop-down list, please state group affiliation here:

_____

State how many years you have worked at Scania (round up to a full year). If you have worked as a consultant and employee then enter the total time.

_____

State approximately how many years total work experience you have (round up to a full year). Also include such work experience that is not directly relevant to your current position.

_____

State the year you started in your current group (e.g. 2003)

_____

State the year you started in your current position (e.g. 2003)

_____

State the competence level in the technician career to which you belong. (If you belong to different C-levels in different technical areas then state the highest)

- ❑ C1
- ❑ C2
- ❑ C3 (Senior)
- ❑ C4 (Expert)
- ❑ Technical Manager
- ❑ Senior Technical Manager
- ❑ Senior Technical Advisor
- ❑ Do not belong to the C-career (applies to e.g. consultants and group managers)
- ❑ Don't know

State whether you are an employee at Scania or consultant

- ❑ Employee
- ❑ Consultant
- ❑ Other/Don't know _____

What type of position do you currently have? (Choose the answer option that you think best corresponds with your position)

- ❑ Designer (hardware or software)
- ❑ Tester (hardware or software)
- ❑ Project manager/Object manager
- ❑ Mechanic
- ❑ Group Manager
- ❑ Other (please specify) _____

Estimate roughly how you divide your time in Silbertime between yellow, green, red, white and blue time.

Yellow _____

Green _____

Red _____

Blue _____

White _____

Del 2/3

In part two you shall consider a number of brief statements about the creative climate in your work group. (This part is omitted for copyright reasons.)

Part 3/3

Part three consists of a number of questions concerning learning and work procedures. After you have answered the questions you will have the opportunity to give any additional comments.

Innovation is the process that aims to develop new products, services or ways of working. Approximately what percentage of your working hours would you say has been devoted to innovation activities during the past six months?

- ❑ 0%
- ❑ 10%
- ❑ 20%
- ❑ 30%
- ❑ 40%
- ❑ 50%
- ❑ 60%
- ❑ 70%
- ❑ 80%
- ❑ 90%
- ❑ 100%

Innovation can be categorised in various ways, e.g. a distinction can be made between radical and incremental innovation.

Examples of radical innovation are:

***The development of completely new products or completely new technology.**

*** Major changes in ways of working that completely replace old ways of working.**

Examples of incremental innovation are:

*** Minor improvements to existing products that e.g. lead to improved quality or improved functionality.**

*** Minor changes in ways of working that lead to cost savings, for example.**

Divide the time you devote to innovation between the four categories below:

Radical product innovation _____

Radical innovation in ways of working _____

Incremental product innovation _____

Incremental innovation in ways of working _____

With regard to the development of products , I have enough time to:

	Fully disagree						Fully agree
Identifying problem areas	❑	❑	❑	❑	❑	❑	❑
Coming up with new ideas	❑	❑	❑	❑	❑	❑	❑
Implementing ideas	❑	❑	❑	❑	❑	❑	❑

With regard to the development of ways of working, I have enough time to:

	Fully disagree						Fully agree
Identifying problem areas	❑	❑	❑	❑	❑	❑	❑
Coming up with new ideas	❑	❑	❑	❑	❑	❑	❑
Implementing ideas	❑	❑	❑	❑	❑	❑	❑

Fill in how well you think the description corresponds with your work situation.

	Fully disagree						Fully agree
In our group we get to spend time learning new things.	❑	❑	❑	❑	❑	❑	❑
I make sure I document my lessons.	❑	❑	❑	❑	❑	❑	❑
I make sure I share what I learn with my colleagues.	❑	❑	❑	❑	❑	❑	❑

Fill in how well you think the description corresponds with your work situation.

	Fully disagree						Fully agree
There is scope here to change established ways of working.	❑	❑	❑	❑	❑	❑	❑
I continuously evaluate my work in order to find ways of working that save time and resources.	❑	❑	❑	❑	❑	❑	❑

Fill in how well you think the description corresponds with your work situation.

	Fully disagree						Fully agree
It is easy to postpone a delivery.	❑	❑	❑	❑	❑	❑	❑
I find it very difficult to get time to last for my work assignments.	❑	❑	❑	❑	❑	❑	❑

Fill in how well you think the description corresponds with your work situation.

	Fully disagree						Fully agree
There are clear procedures for how my work shall be performed.	❑	❑	❑	❑	❑	❑	❑
I follow the work procedures that currently exist.	❑	❑	❑	❑	❑	❑	❑
We are able develop the work procedures we work to ourselves.	❑	❑	❑	❑	❑	❑	❑

The work procedures that currently exist support me in my work with:

	Fully disagree						Fully agree
Minor improvements in the work processes	❑	❑	❑	❑	❑	❑	❑
Major changes in the work processes	❑	❑	❑	❑	❑	❑	❑
Minor improvements in the product	❑	❑	❑	❑	❑	❑	❑
Major changes in the product	❑	❑	❑	❑	❑	❑	❑

Fill in how well you think the description corresponds with your work situation:

	Fully disagree						Fully agree
There is scope for a holistic approach when developing new products.	❑	❑	❑	❑	❑	❑	❑
In our group we have being innovative as an explicit objective.	❑	❑	❑	❑	❑	❑	❑
During the past six months we have made efforts aimed at increasing the creativity in our group.	❑	❑	❑	❑	❑	❑	❑
During the past six months we have actively worked with understanding how the principles of R&D Factory relates to the work we do in my work unit.*	❑	❑	❑	❑	❑	❑	❑
During the past six months I have changed the way I work to better comply with the principles of R&D Factory.*	❑	❑	❑	❑	❑	❑	❑

Fill in how well you think the description corresponds with your work situation:

	Fully disagree						Fully agree
Our projects generally have clearly defined goals.*	❑	❑	❑	❑	❑	❑	❑
In general Scania has been successful at innovation.*	❑	❑	❑	❑	❑	❑	❑
In general my work unit has been successful at innovation.*	❑	❑	❑	❑	❑	❑	❑
We are successful in implementing new ideas to obtain results in my work unit.*	❑	❑	❑	❑	❑	❑	❑

Fill in how well you think the description corresponds with your work situation.

	Fully disagree						Fully agree
My manager encourages creativity and new ideas **	❑	❑	❑	❑	❑	❑	❑
I have great confidence in the way my manager leads the work unit **	❑	❑	❑	❑	❑	❑	❑

The final question in the three questionnaire rounds were of an open format. Those questions were formulated as below:

First round: In this text box you can add comments about the survey. If you do not wish to give any additional comments, click "Done" below.

Second round: The last question concerns what you experience as the main obstacles for innovation at Scania. Submit your comments in the text box below. In this text box you can also leave comment about the questionnaire as such or post specific questions. If you do not wish to give any additional comments, click "Done".

Third round: The last question is of open character and you submit you answer in the text box below: What makes you innovative in your work? E.g. methods, occasions, other people, challenges, etc. And what do you experience as important in terms of resources, support, encouragement or alike in order for you to be innovative? Preferably list several things. In this text box you can also leave comment about the questionnaire as such or post specific questions. If you do not wish to give any additional comments, click "Done".

TRITA – MMK 2012:20
ISSN 1400-1179
ISRN/KTH/MMK/R-12/20-SE
ISBN 978-91-7501-576-7