Innovation and Design Processes in Small Established Companies

Licentiate thesis by

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Stockholm, Sweden 2009
A thesis submitted in partial fulfillment of the requirements for the Licentiate degree, to be presented with due permission for public presentation in room 443 of Lindstedtstvägen 30 at the Royal Institute of Technology on the 20th of November 2009 at 10:00.

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Abstract
This thesis examines innovation and design processes in small established companies. There is a great interest in this area yet paradoxically the area is under-researched, since most innovation research is done on large companies. The research questions are: How do small established companies carry out their innovation and design processes? and How does the context and novelty of the process and product affect the same processes? The thesis is built on three research papers that used the research method of multiple case studies of different small established companies.

The innovation and design processes found were highly context dependent and were facilitated by committed resources, a creative climate, vision, low family involvement, delegated power and authority, and linkages to external actors such as customers and users. Both experimental cyclical and linear structured design processes were found. The choice of structure is explained by the relative product and process novelty experienced by those developing the product innovation. Linear design processes worked within a low relative novelty situation and cyclical design processes worked no matter the relative novelty. The innovation and design processes found were informal, with a low usage of formal systematic design methods, except in the case of design processes for software. The use of formal systematic methods in small companies seems not always to be efficient, because many of the problems the methods are designed to solve are not present. Customers and users were found to play a large and important role in the innovation and design processes found and gave continuous feedback during the design processes. Innovation processes were found to be intertwined, yielding synergy effects, but it was common that resources were taken from the innovation processes for acute problems that threatened the cash flow. In sum, small established companies have the natural prerequisites to take advantage of lead-user inventions and cyclical design processes. Scarce resources were found to be the main factor hindering innovation, but the examined companies practiced several approaches to increase their resources or use existing scarce resources more efficiently in their innovation and design processes. Examples of these approaches include adopting lead-user inventions and reducing formality in the innovation and design processes.

Keywords: Innovation process, Design process, Small companies, Novelty, Context
Acknowledgements
In this section I would like to thank those who have been important and contributed to the creation of this thesis. Thanks first and foremost to those small companies that gave me the opportunity to study their processes and my main supervisor Professor Lars Bengtsson for invaluable support and supervision. Thanks to Sparbanksstiftelsen Söderhamn for funding. Thanks to my second supervisor Dr Jenny Janhager Stier. Thanks to all at the Division of Industrial Engineering and Management at University of Gävle, CFL Söderhamn, and especially the folks at FoU Söderhamn. Thanks to all the people in the research program Product Innovation Engineering Program (PIEp) and especially Dr Sofia Ritzén for valuable feedback. Thanks to Ivar Renngård for reflections on research methods. Thanks to my fantastic family Karin, Calle, and Emma who have mostly but not always accepted my work (and working hours).

Possible readers and target group of this thesis are small company managers, small company employees involved in innovation and design, policy makers involved in support programs targeting small companies, large company managers dealing with innovation and design processes in collaboration with small companies, and of course my fellow scholars.

I hope all of you reading this thesis will enjoy it and learn something new that you can put into practice.

Gävle, October 2009

Lars Löfqvist
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Appended Papers

Paper A: The Use of Methodology for Product and Service Development in SMEs: An Exploratory Study of 18 Small Companies

Paper B: Prerequisites for Innovation in Small Companies: A Multiple Case Study

Paper C: Design Processes and Novelty in Small Companies: A Multiple Case Study
1 Introduction

Research, small companies, and innovation are topics that are mentioned together increasingly frequently by governments (Swedish Government, 2008), policy makers (Jones & Tilley, 2003; European Union, 2008) and researchers (Bessant & Tidd, 2007; PIEp, 2006). When large companies are down-sizing to meet increased competition in a globalized world, the idea to notice, support, and research small companies is popular. Innovation is believed to be a key to success in these small companies because of its purported link to future welfare, job creation, and economic growth (European Union, 2005). Innovation and renewal policy initiatives aiming at small companies have become a common approach to stimulate economic development (Jones & Tilley, 2003). For example, the largest part (46 percent) of growth programs financed by the government in Sweden aims at small company innovation (Nutek, 2009).

Small companies are numerous. 99 percent of all companies in the European Union are small (fewer than 50 employees) and together employ about 50 percent of the employees in the non-governmental sector; these figures are approximately the same for Sweden (Eurostat, 2009).

Despite the large numbers of small companies and the great interest in small company innovation, the area is paradoxically under-researched. Most research on innovation is done on larger companies (Larsson, 2001; Moultrie et al., 2007; O’Shea & McBain, 1999). Hörte et al. (2008) conclude that innovation research in small companies is immature, heterogeneous, and lacking in cumulative knowledge creation. For example, no studies have been found that follow the process of developing product innovations in small companies. Small companies have different characteristics and contexts than large companies, which makes it doubtful whether results from innovation studies of larger companies can be directly applied to small companies (Audretsch, 2001; Rothwell & Dodgson, 1994).

There is great potential in knowledge about innovation in small companies especially concerning the question of how small established companies can be more innovative. This thesis examines the innovation and design processes in these small established companies. The word established is used to point out the focus on small companies that have been established in their markets for several years. These small established companies often do not have obvious potential for growth and are seldom researched. Non-established small
companies are researched in the field of entrepreneurship and studies the creation and growth of companies, the creation of the companies’ products is on the whole neglected (Bessant & Tidd, 2007; Gibb & Ritchie, 1982). When the phrase *small companies* is used in this thesis, small established companies are meant.

### 1.1 Purpose

The overall purpose of this thesis is to deepen our knowledge of small established companies’ innovation and design processes. This purpose will be more specified in three research questions in section 2.7.
2 Theoretical Framework
In this theoretical framework innovation and the process of innovation and design will be discussed. Small established companies and their context will be described as well. The design problem to be solved and novelty aspects of the innovation and design processes will also be reviewed.

2.1 What is innovation?
There is a great muddle of definitions when it comes to innovation, new product development, and design. Marxt and Hacklin (2005) state that innovation, product development, and design are terms that have evolved and adopted similar meanings. This makes it tricky to grasp the field and make distinctions among the concepts. For the present researcher these complex concepts have changed meaning several times, which is somewhat reflected in the appended papers in this thesis. But when we consider process, we must distinguish among the innovation process, the new product development process and the design process. In this thesis the term new product development is not used but is seen as included in the term innovation process. Innovation is defined as the process of turning opportunity into new ideas and of putting these into widely used practice (Tidd & Bessant, 2009). The design process is seen as a subprocess of the innovation process when the actual development work and creation of the product is carried out.

There are several ways to classify different kinds of innovations, and innovations can be developed in many different contexts. This thesis deals with innovations that are developed in the organizational structure of companies.

Tidd and Bessant (2009) present four types of innovations:
- Product innovation –Changes in the things (product/services) which an organization offers;
- Process innovation –Changes in the ways things (product/services) are created and delivered;
- Position innovation –Changes in the context in which the products/services are introduced; and
- Paradigm innovation –Changes in the underlying mental models which frame what the organization does.
This thesis focuses on product innovations, but it is likely that the four types of innovation are interconnected in an organisation and if one type of innovation is achieved the other types of innovations are affected (Tidd & Bessant, 2009).

An innovation can very briefly be described as something new that is brought into practice. This raises questions about what is meant by new? A common classification is to put the degree of newness, or novelty, on a scale from incremental to radical innovations (European Union, 2005; O’Shea & McBain, 1999; Tidd et al., 2005). Incremental innovations are minor improvements to existing products with a lower level of newness, while radical innovations are totally new products with higher levels of novelty (Bessant & Tidd, 2007). A typical incremental innovation is an improved product targeting an existing market that uses already existing technology (Reid & de Brentani, 2004). Incremental innovations are more common than radical innovations (Tidd et al., 2005; Veryzer, 1998). Incremental innovations are sometimes called evolutionary or continuous innovations; radical innovations are sometimes called disruptive, breakthrough, revolutionary, or really new innovations (Veryzer, 1998).

When discussing newness and novelty one question is: new to whom? From which perspective is this novelty perceived? Three different concepts for this are: new to the company, new to the market, and new to the world (European Union, 2005). New to the company is the lowest level, when the particular innovation is perceived as new for a particular company but not necessarily new for other companies, markets, or the world. New to the market is when a company first introduces a certain innovation to a specific market. New to the world is when a certain company is the first to introduce a certain innovation to all markets and industries. This thesis, in accordance with European Union (2005), uses the lowest level of novelty, new to the company, as the unit that perceives the newness and novelty for a certain innovation. This is further elaborated below in terms of relative novelty.

2.2 Innovation processes
One approach in innovation research is to compare the state before and after an innovation process takes place. The actual process and its activities are neglected and only the input and output are compared and examined (Edwards et al., 2005). This thesis deals mainly with the process between input and output in innovation, the innovation process, and less with the input and output to the process. Academic theory often refers to “the” innovation process as if there were only one description of innovation processes, but it is
likely that there are different kind of innovation processes due to different prerequisites and contexts (Clarkson & Eckert, 2005; Karlson, 1994). A common approach to make innovation process models simpler and more general is to make them abstract and generic, but this approach also makes the models less practical to use in real-life situations (Clarkson & Eckert, 2005; Singley & Andersson, 1989).

Before presenting some different innovation process models and choosing a model for frame of reference, concepts such as incremental and radical innovation processes, design problems, and relative novelty will be discussed.

2.2.1 Incremental and radical innovation processes
There is no single best way to manage and organize innovation processes due to the way different industries differ in sources of innovation, technological and market opportunities, and organization (Tidd & Bodley, 2002). Two opposites among innovation processes are incremental and radical innovation processes (O’Shea & McBain, 1999; European Union, 2005; Tidd et al., 2005). Engwall (2004) makes a similar division between innovation processes with low and high uncertainty. Lawson (1997) sees these different processes as different philosophies about how to solve problems, where incremental innovation processes represent a problem-oriented approach and radical innovation processes represent a solution-oriented approach. Radical innovation processes can, but do not need to, end up with a radical product. Conversely, incremental innovation processes can result in radical products.

Incremental innovation processes have a more linear structure and are more problem oriented, aiming to first analyze the problem before trying to solve it. A radical innovation process has a more cyclical structure and is solution oriented, where a solution is initially created and then tested to gain new knowledge allowing the creation of a new solution to test, and so on. Incremental innovation processes build upon existing knowledge and experience and may therefore represent less novelty, risk, uncertainty, and ambiguity. The product to be created in incremental innovation processes often has known characteristics and properties that make it suitable for more linear innovation processes that can be planned better in advance and be carried out in project form. The resulting product’s characteristics and properties are better known in advance because the product is similar to something already existing (Engwall, 2004; Lynn & Akgün, 1998; Lynn et al., 1996; O’Shea & McBain, 1999).
Radical innovation processes are more novel, with higher risks and higher levels of uncertainty and ambiguity, and they must usually be based on experiments and learning (Peters, 2006). What is to be done, the goal, the new product, are all fuzzier in radical innovation processes than in incremental innovation processes. Radical innovation processes are usually not linear but have a more cyclic character, due to experimental loops of probing and learning (Engwall, 2004; Lynn & Akgün, 1998; Lynn et al., 1996; O’Shea & McBain, 1999). There is less time spent on analyzing but more on synthesizing learning experiments (Engwall, 2004; Lynn & Akgün, 1998; Lynn et al., 1996). Early versions of the product are tested against customers, users, or other actors to gain feedback and new knowledge about the product, its usage, its market, customers, and users (Veryzer, 1998). This new knowledge yields somewhat reduced uncertainty and ambiguity and is then used in new refined experiments with the same approach of probing and learning (Engwall, 2004; Lynn & Akgün, 1998; Lynn et al., 1996). The experiments also give direction to the developing efforts (Engwall, 2004). These successive approximations strive to gain as much knowledge and reduction in uncertainty as possible and create the final solution manifested in the new product.

Higher uncertainty in radical innovation processes also means an increased need for flexibility to cope with unforeseen difficulties (Tidd & Bodley, 2002). This leads to difficulties in applying structured development processes. Engwall (2004), Herstatt and Verworn (2001) and Lynn et al. (1996) state that a linear and formalized innovation process might be counterproductive and unsuitable if high uncertainty is present, as is most often the case in radical innovation processes.

2.2.2 The design problem in innovation
Innovation processes can be seen as problem-solving processes centering on the design problem to be solved. The solution to the design problem is the finished product at the end of the innovation process. The character of the design problem affects the innovation process. Cross (2008) and Ullman (2002) state that all design problems are ill-defined, which means that information needed for solving the problem is initially missing and must be filled in to understand the problem. Many different solutions to the design problem exist and the challenge is to find the most optimal solution. A design problem can be vague, messy, fuzzy, incomplete, inconsistent, and even imaginary (Cross, 2008; Jonassen, 2000) and must be explored and defined more clearly before it can be solved.
Jonassen (2000) states that problems vary in terms of their structuredness, complexity, and abstractness. Design problems are among the most ill-structured and complex kinds of problem experienced in practice (ibid.). Some characteristics of ill-structured problems are that they possess many unknown elements, are vaguely defined, and permit many different solutions. Because different design problems vary in structuredness, different design models are needed involving different problem-solving skills. Differences in a problem’s structuredness are also related to how incremental or radical the innovation process is. If the design problem is highly ill-structured, it probably needs a radical innovation process to be solved. Well-structured design problems suit incremental innovation processes better. Problem complexity is about the number of issues, functions, or variables involved in the problem and the degree of connectivity between these properties and the stability of these connections over time. Highly complex problems are more difficult to solve due to both the high number of different sub-problems and the limitation in cognitive operation in the working memory of the human brain. Abstractness is about how much the problem is embedded in a special context or domain. There are some general differences between different kinds of product categories when it comes to the design problem. If design problems in physical artifacts and in software are compared, software has better structured and less ill-defined design problems due to the constraints of language and systems (ibid.). Design problems in software development are also relatively free from issues relating to purchasing, production, materials, logistics, and distribution, all of which are normally much more important in the design processes of physical artifacts.

Many formal systematic methods exist to solve problems in innovation and design processes (Jones, 1992); these methods are commonly known as design methods (Cross, 2008). These methods are usually said to be heuristic and domain independent, able to be used in many different situations. Examples of these systematic methods are those that organize and structure the complex innovation and design process, methods that facilitate creativity or support the collection of needs and demands from customers and users, as well as methods that create and evaluate concepts. Research by Singley and Andersson (1989) shows that problem solvers who use domain-independent heuristic approaches generally do not perform better than those who do not use them. One underlying message is that domain independence achieves through abstraction, which has a negative influence on the practical use. Singley & Andersson (1989) also concludes that those who use less abstract domain-specific approaches are better problem solvers. Jonassen (2000) concludes that problem-solving activities are domain- and context-
dependent and that especially the more common ill-structured problems need domain-specific methods. Well-structured types of problems, as in software design, suit general domain-independence abstract methods better (Jonassen, 2000).

2.2.3 The relative novelty
The design problem to be solved in an innovation process is connected to the degree of newness of the product to be developed; this novelty is perceived differently by different actors (Tidd & Bodley, 2002). In accordance with European Union (2005) this study uses “new to the company” as the lowest unit perceiving the newness in an innovation. The novelty of the innovation should be determined in relation to the company developing the innovation, i.e. the ones working in the company developing the new product. This is in line with Tidd and Bodley (2002) when they introduce the concept of *relative novelty*, which is the novelty of the product to develop in the innovation process experienced by the designers and others involved in developing the product. Tidd and Bodley (2002) found that companies had different innovation processes within the same company, and used different methods and tools depending on the relative novelty of the development project for the company. Increased experience designing a certain product will decrease the relative novelty for that kind of product, and what can be highly novel for one company can be routine for another company due to more experience and knowledge (ibid.).

If the relative novelty of the product to develop is high it becomes hard to rationally plan the developing process due to the uncertainty and lack of experience of similar developing processes and the lack of knowledge about the product’s final characteristics and properties (Herstatt & Verworn, 2001; Karlson, 1994; Lynn & Akgün, 1998; O’Shea & McBain, 1999).

High relative novelty demands high interaction with customers, users, and other external actors to get input and feedback on the development process (Tidd & Bodley, 2002). Olson et al. (1995) found that the higher relative novelty the more a non-bureaucratic organizational form was needed. The newer the project was for the company and less experience, the more difficulties were found in the process. In addition, the more difficulties found, the more interdependence was seen between different functional areas and the more information flowed across the different functional departments. As more information flowed between the functional boundaries, the need for informal, non-bureaucratic ways of handling things arose. The need for an informal and non-
bureaucratic organization in developing processes with a high relative novelty was also found by Veryzer (1998).

Innovation processes where it is likely that the product being developed has low relative novelty are incremental ones. Examples of these processes are redesign projects, extensions of existing product families, small improvements to a product, addition of simpler functionality to existing products, product customization, or a combination of these. If the product to develop is similar to one the company previously developed, the process becomes less novel, because the company already has much of the needed experience and knowledge in house. A large part of the design problem for the particular product has previously been solved and the process does not need to be started from scratch every time (Karlson, 1994). Ullman (2002) refers to this as development work that has become routine when the domain for the particular product is well understood.

Innovation processes are risky, highly complex, and difficult (Tidd & Bodley, 2002), and for a new and inexperienced designer they can be hard to manage and execute. Developing a product with a high relative novelty and an abstract, ill-defined, and complex design problem also will presumably increase the relative novelty for the design process of the same product. In other words, there is a kind of relative novelty for design processes also. There is a similar conception done by Engwall (2004) that uses product and process uncertainty instead of relative novelty of the product to develop and relative novelty to design processes. It is reasonable to expect the relative novelty of design processes to decrease with increased knowledge and experience of design processes.

2.2.4 Innovation and design process models

There are many different innovation and design process models in the literature. Rothwell (1994) looked into the development of innovation process models and drew some conclusions about their evolution. The first innovation process models were technology push linear models with different stages. In the next kind of innovation process models the demand side, or market needs, was gaining more attention and was incorporated in need pull linear models. These technology push and need pull process models were later merged into the same model and the first iterative loops appeared, which meant that the process was not always linear. Different perspectives on the innovation process, for example management, project factors, and key individuals were also gaining increased attention. Concurrent models with parallel activities and integrated disciplines were then
introduced that mainly had a time compressing logic to be able to speed up the innovation process.

Innovation process models are usually divided into activities or stages (Clarkson & Eckert, 2005). Tidd and Bodley (2002) conclude that most current innovation process models are linear and often fail to catch the common iterative feedback loops present in innovation. The models can be abstract, describing the innovation process on a generic level. The models can also be less abstract, procedural, and prescriptive, and more suitable for use in practical situations (Clarkson & Eckert, 2005).

Most innovation process models target physical artifacts, but there are also innovation process models especially aiming at service innovation, see for example Edvardsson (2000). There are many similarities between developing services and goods. On a generic level the innovation process is the same (Bessant & Tidd, 2007), but on a more practical level the more specific characteristics of services must be taken into consideration. Examples of these specific characteristics are the higher level of abstraction, heterogeneity, as well as the fact that services are harder to store and often consumed at the same time they are produced (Edvardsson, 2000). Many products consist of both goods and services.

Most innovation process models fit incremental innovation work best; there is a great lack of innovation process models for radical innovation processes. The only exception found is a model by Veryzer (1998) that is unexpectedly linear and has prototyping as a main activity. In general, radical innovation processes seem to be hard to capture in a single framework (Kahn et al., 2006).

It is common that innovation process models leave out the innovation process context and only look at the activities performed, even though the innovation process is affected by its context (Clarkson & Eckert, 2005; Karlson, 1994). Examples of innovation process models that take the context into consideration include those by Bessant and Tidd (2007) and Goffin and Mitchell (2005). The innovation process model by Bessant and Tidd (2007) is depicted in Figure 1 below.
The model consists of three generic phases: generating, selecting, and implementing inputs for change. The context is divided into three different interacting factors. The first contextual factor, Strategic leadership, direction, and deployment, is about balancing risk in a strategic way with a clear direction, leadership, and committed resources. The second contextual factor, Innovative organization, describes the structure and climate appropriate for innovation, which should enable and facilitate creativity and communication. The third contextual factor, Proactive linkages, concerns the links to external and internal actors that are part of the innovation process, such as customers, users, suppliers, and sources of finance within or outside an organization.

To map findings in this thesis I selected the innovation process model by Bessant and Tidd (2007) as an abstract model of reference. There are several reasons for this choice of model: it is easy to understand, has a generic and abstract nature that will enhance the probability that it will suit different innovation processes, it includes context, and it clearly distinguishes between different phases, especially the idea phase and the implementing phase.

Bessant and Tidd’s (2007) innovation process model can be criticized in some areas. The output of the process, the product, is not present in the model, although the product to
develop affects the innovation process (Clarkson & Eckert, 2005; Karlson, 1994; Tidd & Bodley, 2002). Only three contextual factors are present in the model, even though the wider context probably influences the innovation process. Examples on this wider context are the innovating organization’s market and social context. This wider context is, for example, different for large and small companies. The model is abstract and captures activities in the innovation process on a high level. Especially in the implementing phase of the model, the model is seen as too simple for mapping findings. A more detailed implementing phase is needed.

The design process occurs inside the implementing phase of Bessant and Tidd’s (2007) model. This way of seeing the whole process from initial generation of ideas to market introduction as the innovation process and the implementation phase of actual development work as the design process is supported by Marxt and Hacklin (2005). This study sees the design process as the process when such activities as exploration of the design problem, generation of possible solutions, evaluation of the solutions, and communication of the result are performed. This is in accordance with Cross’s (2008) description of the design process. There exist several different models of design processes (Cross, 2008; Hubka & Eder, 1996; Otto & Wood, 2001; Pahl et al., 2007; Pugh, 1990; Roozenburg & Eekels, 1996; Ullman, 2002; Ulrich & Eppinger, 1995). All these models and theories have in common the basic activities of investigating the design problem, generating solutions to the design problem, evaluating the solutions, and communicating the solution further in the development process. It is further likely that these basic activities are the core of the design process and must in some way or other be present in all completed design processes. One design process model that suits this line of reasoning is the four-stage design process model by Cross (2008), depicted in Figure 2 below.
Figure 2. A four-stage model of the design process (Cross 2008)

Note the iteration feedback loop between the evaluation and generation stages. Cross’s (2008) design process model provides the more detailed implementing phase needed in Bessant and Tidd’s (2007) innovation process model.

2.3 Characteristics of small established companies

The focus in this study is on small established companies. They are established in their markets, develop their own products, and do most innovation and design work in house without extensive risk-funding. Most are family-owned and family-controlled small companies with an owner who is also the manager (Hadjimanolis, 2000), hence the term “owner-manager” is used when discussing the managers of these small companies.

In this thesis, a company is defined as small if it has fewer than 50 employees. This figure of 50 employees was chosen not only because it agrees with other definitions of small companies, for example by the European Union (2005), but also because it is an approximate limit at which the owner-manager of a company must delegate much power and control of the company, and doing this usually demands a different leadership and management (Larsson, 2001; Storey, 1994). When a company grows to over 50 employees, it becomes hard for only one person to manage and control most activities and processes in the company and there is an increasing need to formalize the structures of different processes.

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1 In Paper A, one examined company actually had 70 employees. Since the study in Paper A was done this company has downsized to only 5 employees and then increased again to 50 employees.
Small companies have broadly similar characteristics across sectors (Bessant & Tidd, 2007). If a comparison is done between small companies and large companies, there are generally great differences in several areas. Small companies have mainly behavioral advantages, but not the material advantages that larger companies have (Rothwell & Dodgson, 1994). This means that small companies generally have scarce resources (Ghobadian & Gallear, 1996; Rothwell, 1989; Rothwell & Dodgson, 1994; Welsh & White, 1981; Zontanos & Anderson, 2004) but are more flexible, with a low level of bureaucracy and rapid internal communication and decision making (Adams, 1982; Cannon, 1985; Vossen, 1998). Large companies have greater resources but are generally stiffer and more bureaucratic (Rothwell & Dodgson, 1994). Pilemalm (2002) concludes that employees’ roles are fuzzy in small companies. Separate departments are often missing and employees have multifunctional roles, working in many different situations (Bodin, 2000; Pilemalm, 2002). Informality is a central theme in small companies and most processes are informal (Pilemalm, 2002; Tidd & Bessant, 2009). Small companies’ organizational strength, ease of communication, speed of decision making, degree of employee commitment, and receptiveness to new situations obviate the need for the formal strategies that are used in large companies to ensure communication and coordination (Tidd et al., 2005). Integration of different functions is of less central importance in small companies, because functions are less specialized and less likely to be separated by physical and organizational distance (ibid.). Freel (2000) concludes that small companies lack expertise in several areas and perform certain tasks with less expertise. Scott et al. (1996) found that small companies often are tied in to existing levels of technology.

The owner of a small company is often the manager with responsibility both for the company and the employees (Guimarães et al., 1996; Larsson, 2001). Small company owner-managers are often forced to be generalists to be able to handle a lot of different managerial tasks and are involved in almost all processes in the company (Verhees, 2005; Welsh & White, 1981). Hyvärinen (1995) and Verhees (2005) state that there is a close relationship between the goals and strategies of the small company and the personal values and goals of the owner-manager. Owners-managers of small companies usually do not like to delegate authority and responsibility, because they like to control most things regarding the company (Adams, 1982; Cannon, 1985).

Small companies are working in a turbulent organization (Moultrie et al., 2007), within a highly uncertain and turbulent environment (Ratcliffe-Martin & Sackett, 2001; Welsh &
White, 1981) and have little control over this environment (Carson, 1995). One reason for this high external uncertainty is lack of power in the marketplace and the fact that it is common that small companies are dependent on a large customer (Westhead & Storey, 1996). This high external uncertainty and lack of control and power in the marketplace makes the time horizon shorter in small companies, which in turn makes long-term strategies less useful and short-term returns more favourable than long-term returns (ibid.). Dalley and Hamilton (2000) state that dealing with problems as they arise is a common approach in small companies. Carson (1990) found that small companies have a constant time pressure due to day-to-day problems that need to be solved and scarcity of available time. Small companies are usually very sensitive to any disturbance in the cash flow through the company; a constant cash flow is necessary for the company’s existence (Welsh & White, 1981).

Small companies are usually close to their customers and users (Rothwell & Dodgson, 1994). This means shorter lines of communication and easier contact between the company and its customers. Carson (1995) states that it is common that small company managers know their customers personally and the close relationship and interaction leads to benefits including customer loyalty and higher levels of customer satisfaction. Small companies are flexible in responding to customer inquiries, which further increases customer satisfaction (ibid.). Small companies have easy access to accurate and inexpensive market information due to their closeness to customers, users, and markets and thus can make better informed marketing decisions (Dallago, 2000). The main marketing technique is relationship marketing with current customers (Zontanos & Anderson, 2004). Relationship marketing suits small companies because it is cheap, has low risks, allows direct contact with the targeted market, and is highly flexible, which suits small companies and their turbulent environments (ibid.). Formal marketing knowledge in small companies is scarce (Adams, 1982; Cannon, 1985; Moultrie et al., 2007).

Table 1 provides a summary of the above-mentioned characteristics.
Table 1. Characteristics of Small Established Companies

**Limited resources**
- Scarce resources (Ghobadian & Gallear, 1996; Welsh & White, 1981; Zontanos & Anderson, 2004; Rothwell, 1989; Rothwell & Dodgson, 1994)
- Sensitive to disturbance in cash flow (Welsh & White, 1981)
- Constant time pressure (Carson, 1990)
- Limited opportunities to develop new technology by themselves (Scott et al., 1996)

**Short-term strategies**
- No formal strategies (Tidd et al., 2005)
- Family owned and controlled (Hadjimanolis, 2000)
- Short time horizon; long-term strategies are less useful (Westhead & Storey, 1996)
- Close relationship between the goals and strategies of the small company and the personal values and goals of the owner-manager (Hyvärinen, 1995; Verhees, 2005)

**Flexible organization and management**
- Flexible organization (Adams, 1982; Cannon, 1985; Vossen, 1998)
- Informal processes (Pilemalm, 2002; Tidd & Bessant, 2009)
- Owners-managers reluctant to delegate (Adams, 1982; Cannon, 1985)
- Loose and flat organization (Bodin, 2000; Pilemalm, 2002)
- Low levels of bureaucracy (Adams, 1982; Cannon, 1985; Rothwell & Dodgson, 1994; Vossen, 1998)
- Rapid decision making (Adams, 1982; Cannon, 1985; Vossen, 1998)
- Rapid internal communication (Adams, 1982; Cannon, 1985; Vossen, 1998)

**General rather than specific knowledge and skills**
- Fuzzy and multifunctional roles of employees (Bodin, 2000; Pilemalm, 2002)
- Many generalists but lack of expertise (Freel, 2000)

**Close to customers and market**
- Closeness to customers (Rothwell & Dodgson, 1994)
- Relationship marketing with high reliance on current customers (Zontanos & Anderson, 2004)

**Uncertain context**
- Lack of power in the marketplace (Westhead & Storey, 1996)
2.4 Innovation characteristics of small companies

Innovation in small established companies has different characteristics in comparison to that in larger companies, due to different technological and economical environments (Audretsch, 2001). Small companies’ beneficial characteristics in innovation are flexibility, agility in reacting and responding to changed market conditions, and rapid communication and decision making within the organization (Adams, 1982; Cannon, 1985; Vossen, 1998). Limited access to finance (Freel, 2000; Zontanos & Anderson, 2004) and scarce resources (Ghobadian & Gallear, 1996; Rothwell, 1989; Welsh & White, 1981; Zontanos & Anderson, 2004) are among the predominant characteristics that hinder innovation (Rothwell & Dodgson, 1994). This often leads to viable ideas being shelved (Adams, 1982). Small companies have scale-related disadvantages and often need to find extra resources externally for innovation (ibid.).

Adams & Walbank (1983) conclude that most small company innovations are incremental variants of already existing products. New-to-the-world, radical product innovations are rare. Dallago (2000) and Mosey (2005) conclude that small companies innovate with less novel technology or use known technology in new novel ways. There is an inability to spread risks within small companies’ innovation activities with techniques such as portfolio management (Moultrie et al., 2006; Pilemalm, 2002). Innovation seems to be most successful if existing customers are targeted (Adams & Walbank, 1983). Schmidt-Kretschmer et al. (2007) conclude that most innovation in small companies is driven by market or customers, and that small companies have good contact with their customers’ needs.

Most small companies are family owned and controlled; it is important to note, however, that more innovative small companies tend to have lower family involvement in the business (Hadjimanolis, 2000). A supportive manager is important for innovation to occur (Cannon, 1985), and a small company with an owner-manager who delegates power and knowledge among the employees is considered more innovative (ibid.). A highly centralizing, autocratic management style with all decisions and information flows involving the owner-manager, which is common in small companies, does not create a creative environment within the company, ultimately decreasing innovation (Adams, 1982; Cannon, 1985). Larsson (2001) states that information in innovation activities will naturally spread in the small company without the use of methods and tools, due to the employees working in close proximity.
Bodin (2000) and Pilemalm (2002) describe how it is hard to separate innovation activities from other daily activities in small companies, because the employees involved have multifunctional roles and are also responsible for day-to-day activities. Innovation processes must work and be executed at the same time as ordinary activities in the company such as sales, manufacturing, production, marketing, logistics, etc., and usually by the same people. In an environment of time pressures and uncertainty, innovation competes for resources. Woodcock et al. (2000) found deprioritized innovation activities when small companies were faced with short time pressure.

Small companies frequently involve some form of external linkages with external actors in innovation and are embedded in local networks (Bessant & Tidd, 2007). Both customers and competitors are perceived as important sources for ideas suitable for innovation (Hartman et al., 1994). Lots of contact with the market enhances innovation within small companies and innovative small companies are more proactive in engaging with the external environment and much more efficient in utilizing external relationships and knowledge to develop new products (Adams, 1982). Low et al. (2007) found that some small companies only innovate at customer request. Adams (1982) concludes that the most innovative small companies have a strong market orientation. Cannon (1985) states that support from existing customers is a success factor in small company innovation. Without this customer support, innovation often fails. Small companies seem to have better opportunities for market pull innovations, since they are close to their customers (Rothwell & Dodgson, 1994; Schmidt-Kretschmer et al., 2007).

Table 2 summarizes some of the characteristics of innovation in small companies.

**Table 2. Some Characteristics of Innovation in Small Companies**

<table>
<thead>
<tr>
<th>Characteristics of small company innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>- New variants of existing products are the most common product innovation. New-to-the-world product innovations are rare (Adams &amp; Walbank, 1983)</td>
</tr>
<tr>
<td>- Customers and competitors are important sources for ideas suitable for innovation (Hartman et al., 1994)</td>
</tr>
<tr>
<td>- Innovation with less novel technology or using existing technology in new ways (Dallago, 2000; Mosey, 2005)</td>
</tr>
<tr>
<td>- Inability to separate innovation activities from day-to-day activities (Bodin, 2000; Pilemalm, 2002)</td>
</tr>
</tbody>
</table>
Factors supporting innovation processes in small companies

- Flexibility, agility in reacting and responding to changed market conditions, rapid internal communication, coordination, and decision-making (Adams, 1982; Cannon, 1985; Vossen, 1998)
- Customer support (Adams & Walbank, 1983; Cannon, 1985)
- A supportive manager (Cannon, 1985)
- Delegation of power and knowledge among employees (Cannon, 1985)
- Low involvement of family issues in the business (Hadjimanolis, 2000)
- External linkages (Bessant & Tidd, 2007)
- Proactive behavior to the environment (Adams, 1982)

Factors hindering innovation in small companies

- Scarce resources (Adams, 1982; Rothwell & Dodgson, 1994)
- Inability to spread risks in innovation (Moultrie et al., 2006; Pilemalm, 2002)

2.5 Small companies’ innovation and design processes

No studies found followed innovation and design as a process over time within small companies. Instead, they have examined the innovation and design processes in small companies as snapshots, using interviews or surveys. O’Shea and McBain (1999) conclude that there is a lack of theory and models of small companies’ innovation processes. Larsson (2001) studied four small companies and found the innovation processes in these small companies to be a learning process when motivation and craftsmanship lie in the hands of one or a few key persons and the owner-manager is involved. Much of the innovation work involves these key persons gaining an understanding of the company’s competence and matching it with needs and problems within the company’s market to develop new products with the use of external relations (ibid.).

Janhager et al. (2002), as well as Pilemalm (2002), found that innovation processes in small companies are informal. There are no studies found that link product success with formal innovation processes in small companies (Ledwith & O’Dwyer, 2008). Franke et al. (2003) found that small companies lack the qualifications and resources for a methodologically systematic design process. Meyer (2002) made an extensive survey of the use of methods and found low usage of formal methods in the innovation processes in small companies, regardless of industry. Small companies seem not to be so interested in supporting techniques as systematic methods (Scozzi et al., 2005).
No specific innovation process models for small companies were found, but for medium-sized companies, Berglund (2007) created a model that is similar to the abstract innovation process model of reference by Bessant and Tidd (2007).

Innovation processes in small companies can be seen as a continuous process with unclear start or stop points and unclear phases (Bodin, 2000; Cannon, 1985). Problems within the process are predominantly found in marketing activities and in the early parts of the innovation process (Adams, 1982). O’Shea & McBain (1999) found that small companies have problems dealing with unforeseen difficulties in the innovation process due to a lack of slack that can absorb and handle these difficulties. This lack of slack is directly caused by the small company’s lack of resources.

The design process part of the innovation process in small companies is an even more poorly researched area than the innovation process because most studies done are on a managerial level and do not usually look at design activities (Larsson, 2001; Moultrie et al., 2006; Moultrie et al., 2007). Exceptions to this are studies done by Guimarães et al. (1996) and Larsson (2001). They found that the design processes in small companies were informal and used own-developed, informal design methods. Prototyping and sketching were common approaches. The owner-manager was usually involved together with other employees and was the creative engine. The use of external expertise was scarce and knowledge needed in the process was mainly gained from suppliers or other small company owner-managers. The small companies were close to their customers and external feedback from customer during the design processes was extensive. Previous experience and common sense were used in the design processes; lack of knowledge and resources necessitated improvising and creativity in how to use existing knowledge and resources in the best ways. The design processes were highly search-oriented, dynamic, and iterative with cyclical loops. Larsson (2001) alone found concurrent design activities when early attention was paid to economic, manufacturing, and marketing aspects. Commitment to design activities was often combined with marketing activities (ibid.).

The known characteristics of small established companies’ innovation and design processes are listed below in Table 3.
Table 3. Characteristics of the Innovation and Design Processes of Small Companies

- Innovation and design processes in small companies are highly search-oriented, dynamic processes with iterative cyclical loops (Guimarães et al., 1996; Larsson, 2001)
- The processes are informal, with unclear start and stop point and unclear phases (Bodin, 2000; Cannon, 1985)
- Few persons are involved, often the owner-manager (Larsson, 2001)
- Formal systematic methods are rarely used (Meyer, 2002)
- Prototyping and sketching are common approaches (Guimarães et al., 1996; Larsson, 2001)
- Feedback from customers is common and extensive during the processes (Guimarães et al., 1996; Larsson, 2001)

2.6 Theory gap summary
Detailed studies of small established companies’ innovation and design processes are lacking; no studies have been found that follow innovation and design processes over time. There is research about general characteristics of small established companies and their context, yet how these characteristics influence innovation and design processes in small companies have been examined only to a limited extent. A more holistic picture of small established companies’ innovation and design processes that take the context into consideration is missing in the academic literature. In addition, novelty aspects in innovation and design processes in small established companies have apparently not been researched. There is a great potential in this area because of the possibility to gain new knowledge on how small established companies can be more innovative.

2.7 Research questions
From the literature review three research questions (RQs) crystallized:

RQ 1: How do small established companies carry out their innovation and design processes?

RQ 2: How does the context affect innovation and design processes in small established companies? This context consists of the three contextual factors: (a) Strategic leadership, direction, and deployment, (b) Innovative organization, and (c) Proactive linkages, present in the innovation process model by Bessant & Tidd (2007).

RQ 3: How do product and process novelty affect innovation and design processes in small established companies?
2.8 Thesis outline

This thesis is built on three research papers dealing with innovation and design processes and their contexts in small established companies in different areas and on different levels. The matrix in Table 4 below shows which research paper deals with each research question.

<table>
<thead>
<tr>
<th></th>
<th>RQ 1</th>
<th>RQ 2</th>
<th>RQ 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper A</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paper B</td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Paper C</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

Research question 1 is covered in both papers A and C but from different perspectives. Somewhat simplified, Paper A examines the use of formal systematic methods in the innovation processes, while Paper C examines the informal way of working in the small companies’ implementing part, the design process, of the innovation process. Papers A and C also used a different mix of research methods. Mapping the research questions where they belong in the quite modified innovation process model of reference by Bessant and Tidd (2007) yields the picture in Figure 3 below.

*Figure 3. Illustration of the studied areas of small companies’ innovation processes.*
The product to be developed is also put into the model to illustrate that its future properties and characteristics (i.e., the relative novelty) affect the innovation process and in particular the design process that lies inside the implementing part. In the illustration in Figure 3 above we can see that the generation and selection of innovation ideas suitable for development is not a part of this study and will be the subject of future research.
3 Research Methods
This thesis reports on the findings from three research studies. This chapter aims to describe and discuss the methodology used for answering the research questions but also to discuss the specific circumstances of doing research on small established companies.

3.1 Scientific approach

3.1.1 A case study approach
A case study approach is qualitative research that is good at answering such explorative research questions as “how” and “why” (Voss et al., 2002; Yin, 2003). Case study methodology is appropriate when the units of study are not fully understood (Voss et al., 2002), complex and hard to isolate from real-life context (Yin, 2003). Case studies will show peculiarities and different characteristics. Although they intend to test theory, they usually cannot show how common a certain phenomenon is (Yin, 2003). This study has mainly exploratory research questions and examines innovation and design processes that are complex, with unclear boundaries (Cross, 2008; Tidd & Bodley, 2002) that are affected by and dependent on their contexts (Bessant & Tidd, 2007; Goffin & Mitchell, 2005; Karlson, 1994). Thus, case study methodology suits this study well.

3.1.2 Case selection and units of analysis
It is important to choose cases that will result in an optimal contribution to theory and help to solve the research questions (Yin, 2003). The unit of analysis differs in the appended papers. Paper A was a holistic multi-case study (ibid.) and the unit of analysis was 18 different small established companies’ innovation activities. Paper B was also a holistic multi-case study, of three established companies’ prerequisites for innovation. Paper C was an embedded multi-case study (ibid.) with three established companies as cases and embedded units of different design processes. Papers B and C had the same three companies as cases, but in Paper B the analysis was on the organizational level and in Paper C the analysis was on the process level.

In Paper A, small companies were recruited that had their own, or wanted to have their own, innovation processes. 29 companies were contacted mainly by e-mail to invite them to participate in the study; 18 accepted. The companies represented manufacturers of mechanical or electronic products, as well as service companies providing, for instance, software or education. 11 of the companies were manufacturers of goods and 7 were service companies. For the studies done in papers B and C, companies 1 and 2, which also
took part in the first study, were asked to participate in a deeper case study. They were chosen because they had their own products and innovation and design processes that were run in house with their own resources. Both companies claimed and were believed to have problems within their innovation and design processes and need advice. Company 1 manufactures goods, while Company 2 produces software. This was a deliberate choice because it would enable comparing and drawing conclusions about the differences in innovation and design processes that do not depend on the product to be developed. Later a third company, Company 3, was recruited to provide a contrast with the findings from the former two companies. This was a manufacturing company that was identified by the researcher to be exceptionally efficient in its innovation and design processes despite its smallness. This conclusion was mainly based on the company’s extensive public written material and website. Some characteristics of the three small companies in papers B and C are given in Table 5 below.

Table 5. Some characteristics of the three companies in the studies in papers B and C

<table>
<thead>
<tr>
<th></th>
<th>Company 1</th>
<th>Company 2</th>
<th>Company 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td>Manufacturer B2B</td>
<td>Software B2B</td>
<td>Manufacturer B2B and B2C</td>
</tr>
<tr>
<td><strong>Products</strong></td>
<td>Technical floors</td>
<td>Booking systems for the tourism industry</td>
<td>Small wood refinement machines</td>
</tr>
<tr>
<td><strong>Employees</strong></td>
<td>23</td>
<td>9</td>
<td>25</td>
</tr>
<tr>
<td><strong>Number of New or Improved Products Launched per Year</strong></td>
<td>Approximately one small improvement</td>
<td>Several improvements</td>
<td>Several new or improved products</td>
</tr>
<tr>
<td><strong>Customers</strong></td>
<td>One big, many small</td>
<td>Many small</td>
<td>Many small</td>
</tr>
<tr>
<td><strong>People Involved in the Innovation Processes at the Company</strong></td>
<td>5</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>

3.2 Research process
This section aims to give the reader an understanding of the execution of the research and the methods used to collect data.
3.2.1 Sources of data
All methods have their advantages and disadvantages and in this thesis several different methods were used to answer the research questions. In case study research it is advantageous to use many different methods and sources to collect data to be able to cross-check and validate findings that strengthen the study (Yin, 2003). Using several different methods to study the same phenomenon is called triangulation (Voss et al., 2002).

According to Yin (2003), there are six different main sources to collect data in case studies. These sources are documentation, archival records, interviews, direct observation, participant observation, and physical artifacts. Different methods suit different situations; in the research in this thesis all these sources were used in different situations. The participating companies were studied in different ways not only to cross-check and validate findings but also due to practical limitations and that the studied phenomenon proved to be hard to understand and every possible clue was needed.

All data was summarized and a first analysis was done within a 24-hour period. All data, early conclusions, questions, and ideas were documented in the field dairies during the data collection period at the companies to not forget anything and to be able to track the research process.

Table 6 summarizes the different sources of data used in the different companies.
Table 6. The different sources of data used in the different companies

<table>
<thead>
<tr>
<th>Source</th>
<th>The 18 Companies in Paper A</th>
<th>Company 1 in Papers B and C</th>
<th>Company 2 in Papers B and C</th>
<th>Company 3 in Papers B and C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Documentation</td>
<td>Not much, mainly the company websites</td>
<td>Yes, but not much, mainly the company website, brochures, and manuals</td>
<td>Yes, but not much, mainly the company website, brochures, and manuals</td>
<td>Yes, study of extensive website, articles, manuals, brochures, the company’s newspaper and Master’s theses about the company</td>
</tr>
<tr>
<td>Archival records</td>
<td>No</td>
<td>Yes, information about a former innovation process</td>
<td>Yes, information from former customer meetings</td>
<td>No</td>
</tr>
<tr>
<td>Interviews</td>
<td>Yes, semi-structured interviews with people involved in innovation, 1-2 hours per company</td>
<td>Yes, semi-structured interviews with people involved in innovation, 1-2 hours per person, 5 interviews</td>
<td>Yes, semi-structured interviews with people involved in innovation, 1-2 hours per person, 6 interviews</td>
<td>Yes, semi-structured, 2.5-hour interview with the product development manager and 15 minutes with owner-manager</td>
</tr>
<tr>
<td>Direct Observations</td>
<td>No, but visited the companies</td>
<td>Yes, 2 days a week over 5 months</td>
<td>Yes, 2 days a week over 5 months</td>
<td>No, but visited the company</td>
</tr>
<tr>
<td>Participant Observations</td>
<td>No</td>
<td>Yes, on some occasions</td>
<td>Yes, on some occasions</td>
<td>No</td>
</tr>
<tr>
<td>Physical artifacts</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
3.2.2 The studies at the companies
The research started with the study presented in Paper A, when semi-structured interviews were carried out at 18 small companies. The interviews were mainly done with the owner-manager and/or the one responsible for innovation and design at the companies. The purpose was to get a basic understanding of small companies and their innovation and design processes and problems and needs within the companies.

After this initial study, companies 1 and 2 were studied. The way of working in companies 1 and 2 was hectic. The employees usually had multifunctional roles and many different working tasks and different processes were combined. At both companies there were a turbulent working environment with a continuous stream of urgent issues that arose, meaning plans had to be changed on a daily basis. Examples of this turbulence are changed customer requirements, urgent problems with the products at customers’ locations that had to be fixed, and problems in production and sales. There was always more to do than there were resources and there were usually no extra buffers to deal with these unexpected urgent issues. There was always creativity about how to use existing scarce resources in the most efficient way and it was always important to sell and keep up the cash flow. When things arose that threatened the cash flow, most other activities were put aside to get resources to fix it. People were constantly in a hurry and it was common that planned interviews with employees had to be postponed not once but several times due to urgent issues that required handling right away. It was easy to deprioritize the needs of a researcher, but this must be seen as natural because of the importance of keeping the cash flow up. The researcher dealt with this in different ways; either observed the emergent issues that arose or waited and did other tasks until people were available. It also happened that people had less to do through changing circumstances and the researcher could quickly take advantage of these moments, for example to do interviews.

In companies 1 and 2 it was not possible to isolate innovation and design processes from other operational processes, so it was not possible to find and study the innovation and design processes at one special place or at a special time or time span. Bits of these processes could be found in different locations, situations, and times. Pauses in the processes were common, due to other more acute things that arose. To be able to identify, study, and catch these scattered parts required 5 months of direct observation, participant observation, semi-structured interviews, informal talk with people, studies of documents, archival records and physical artifacts.
The semi-structured interview was chosen as one method, since it may provide high-quality and detailed data about the respondents’ thoughts, values, and attitudes towards various ideas and concepts – all in a relatively short interview situation (Silverman, 2006). It also caught historical events that would have been hard to catch with other methods. In Company 1, interviews were done with the general manager, the product development manager, salespeople and others involved in the innovation and design processes. In Company 2, interviews were done with the owner-manager, the strategic manager, a marketing person, a support person and others involved in innovation and design. A set of basic questions about innovation and design were used, but the interviews turned out in different ways depending on the interviewee. Examples of questions asked are:

- What do innovation and design mean to you?
- Describe the way new products are realized in the company.
- What is your knowledge and experience of innovation and design?
- How are the innovation and design processes affected by the fact that the company is small and family-owned?
- Who is involved in the processes and when?
- What are the special difficulties and problems that used to occur in the processes?
- What are the common sources for ideas suitable for innovation?
- Is there a strategy behind the innovation activities?
- What characteristics do your customers and users have?

Knowledge gained and particular interesting areas that arose in interviews were incorporated in later interviews. Questions that were missed in early interviews were asked later. In addition to these more formal semi-structured interviews, many innovation and design subjects were discussed informally with the persons interviewed and others at the companies or in the companies’ contexts.

The participant observations were done mainly at the place where innovation and design activities occurred answering questions and giving advice. Direct observation was done mainly through following different people as they went about their working activities. Participation in different meetings was also done mainly as observant at companies 1 and 2. It is difficult to distinguish between direct and participating observation, but in the direct observations the interference was lower. It was generally hard not to interfere with what was studied in the small companies. It was not possible to hide and the researcher
had to interact and participate to be accepted and get access. Most of this interaction consisted of informal discussions: answering questions, asking questions and giving advice in different situations. Occasionally it was hard to balance interference with neutrality to what was studied, but the researcher was always aware of this issue.

Observation made it possible to study innovation and design processes when they naturally occurred in the natural environment. In this way *tacit knowledge* (Polanyi, 1967), knowledge that persons are not aware they possess, could be captured. This knowledge could not be articulated at the interviews done but could be observed in real working situations. Examples of tacit knowledge captured are synergy effects when innovation and other processes are mixed, and the way unfinished design processes were executed. During the observation time it was possible to cross-check findings with different sources. There was not always conformity between what was said in interviews and the observations. The people interviewed were not conscious of this but had certain beliefs expressed in the interviews that were not in accordance with the observations. An example of this was the belief that certain processes were not present or were highly inefficient.

To observe two different small companies with different products and innovation processes was shown to be advantageous. It was possible to compare the companies in many areas and see similarities and differences that probably would not have been noticed if only one company had been observed. An example of this was the differences in abstract thinking in the design processes between the companies. Company 2 had a more abstract product, software, which demanded a higher level of abstract thinking in the design processes.

The companies’ products were studied because they are the results of innovation and design processes done and gave clues about these processes. All findings were later compiled and checked with the companies in special seminars to validate that the researcher had understood the findings right.

After the studies at companies 1 and 2, the researcher had two good and extensive cases but felt that one more case of a small established company with recognized efficient innovation and design processes that produces novel products was needed to contrast the findings from the two cases. An extensive search for this kind of small company began and one company that fulfils these characteristics was found. The company, Company 3,
launched several new products and products improvements per year and had extensive written material about the company and its innovation and design processes. This was unexpected, because secondary data from small companies is often rare or unavailable (Davis et al., 1985) which was the case with companies 1 and 2. It was not possible in practice for the researcher to study Company 3 in the same way as companies 1 and 2. The company was contacted and a visit made to the company’s premises. A 2.5-hour semi-structured interview with the product development manager and a 15-minute informal talk with the founder/owner were done with a guide round the premises. The fact that companies 1 and 2 were studied before Company 3, and important new knowledge was gained through these cases, made it possible to fine-tune questions and focus them on the most relevant parts of small company innovation and design. The fact that the company also had extensive written material about itself and its innovation and design processes also allowed for a pre-understanding that facilitated the interview. After the interview, some additional questions arose that were asked and answered by e-mail by the product development manager. The findings were also checked for accurateness by e-mail and phone with the product development manager.

Analysis of the data took place concurrently with the observation time at companies 1 and 2. After the interviews at Company 3, all findings from the three case studies were cross-case-analyzed with each other, compiled, coded and abstracted, and related to existing literature in the subject.

3.3 Research quality
According to Yin (2003) there are four conditions related to quality in case study research: construct validity, internal validity, external validity, and reliability. These are discussed below.

3.3.1 Validity
Construct validity is about establishing the correct operational measures for the studied phenomenon (Yin, 2003). Three ways to increase the construct validity are to use multiple sources of evidence, to establish a chain of evidence, and to have key informants review findings and conclusions (ibid.). Multiple sources of evidence and key informants reviewing findings were used in this research to increase the construct validity. Much of the studied phenomenon’s context has also been studied, which will decrease the probability that parts of the studied phenomenon have been missed.
Internal validity is about establishing the casual relationships between certain events that lead to other events (Yin, 2003). This kind of validity is mainly an issue in explanatory case studies. Some explanatory claims are made in this thesis, mainly causal relationships between the kind of design processes found and the context, but the strength of these relationships must be judged by the readers.

External validity deals with the question of whether findings and conclusions from the study are generalizable beyond the actual case study (ibid.). A case study is generalizable to theoretical propositions and to broader theory, but not to other populations, and the goal is to expand and generalize theories, not to show how common certain phenomena are in a statistical view (ibid.). Case studies allow analytical generalization; external validity is increased if the findings and conclusions can be used in other contexts or situations in other studies with the same results. The use of multiple cases in this research strengthens external validity more than single case studies would. Also, findings have been related to existing theory in the field (ibid.).

As a way for readers to do their own estimation about the validity of the studies done, the research process is extensively presented in section 3.2. Firestone (1993) talks about validation and generalization and how a richly detailed description of the case and the case context help the reader.

Small companies have broadly similar characteristics across sectors (Bessant & Tidd, 2007); one underlying assumption is that small companies are exposed to approximately the same external and internal difficulties in their innovation and design efforts, independent of industry and country. This assumption can affect the validity but may also enable comparisons with studies in different contexts, for example different industries and/or countries.

3.3.2 Reliability
Reliability is about how it is possible to do the same study again and reach the same findings and conclusions (Yin, 2003). Although exactly the same study cannot be done again, because it is impossible to find the same research objects again and the objects are affected by the research done, still reliability is increased in this study by the use of field diaries that document the studies.
3.4 Methodology reflections
The research done and described in this thesis was not executed in a straightforward way. The research questions have evolved over time and were at one occasion completely reformulated. This section aims at discussing the special circumstances and difficulties in doing research on small companies.

3.4.1 The initial research question
Paper A’s purpose was to give the researcher a basic understanding of small companies, their innovation and design processes, and problems and needs within them. The researcher had at this point little prior knowledge of small companies and their innovation and design processes and expected similarities with larger companies but somehow on a smaller scale. What was not known then is that most processes in small companies are informal, so the questions asked in the interviews did not catch this informal way of working. Many questions aimed at the use of formal working procedures as formal systematic methods and tools. What could be concluded was that the small companies seldom used formal approaches in their innovation and design processes and that innovation and design processes were problematic mainly due to scarce resources and lack of knowledge in different areas. After the initial study, I believed that theory, methods, and tools from academia derived from research on larger companies would also be suitable for small companies. I saw the formal systematic methods as the answer and the solution to the problems the small established companies had in innovation and design.

The study that resulted in papers B and C was initially planned as an action research study in several steps, with active participation by the researcher. The idea was to test different formal systematic methods and tools in real innovation projects in small companies. Companies 1 and 2 were contacted for participation because they had shown interest and believed they had problems with their innovation and design processes. First the companies’ current innovation and design processes had to be mapped. From this current situation each company was to determine a new goal for their innovation and design processes. To accomplish this new goal, innovation projects were to start, where different systematic methods could be introduced and tested. In these innovation projects I was to participate as the expert in these systematic methods. The projects were then to be evaluated and followed up. The initial research question was: How can efficient systematic methods suitable for innovation and design be implemented in small established companies?
When the initial research approach was started, the researcher thought that current ways of working in the innovation and design processes in companies 1 and 2 would be easy to map and understand, but this was not the case. What was supposed to take about 3-4 weeks took 5 months.

Within this period of 5 months I discovered that the studied small companies did not suffer from the problems that many existing formal methods aim to solve. These problems are more common in larger organizations, for example communication, coordination, and customer interaction problems. In addition, the constant need for cash flow at the small companies and their hectic and turbulent working environment prevented the small companies from starting a common innovation project with the researcher. It was also perceived as a great risk of harm to the companies if the researcher did major interference through action research with the current processes in the companies. The innovation and design processes found were also considered to be fairly appropriate and efficient with respect to the small companies’ contexts. The problems that the small companies had in innovation and design were mainly due to scarce resources and a turbulent environment, factors that probably cannot be changed but must be dealt with. The probability that the first research approach would work was estimated as low. With this in mind the research questions were completely revised. The implementing idea of formal systematic methods was abandoned and never carried out. The research questions was redefined and become more exploratory of small established companies’ innovation and design processes.

3.4.2 Small companies’ identity
Before this research, I mainly knew about large companies and their innovation and design processes and used large companies as a reference in innovation and design. The innovation and design processes were initially very hard to grasp and understand in companies 1 and 2. To be able to understand these processes, I read a lot of academic literature in the field, but could not confine myself to studies of the innovation and design processes in small companies because so little has been written on the topic. The strategy was to look at the context of innovation and design in small companies to get knowledge and clues that would help to understand the studied phenomenon. These literature studies were done in parallel and after the observations at companies 1 and 2. General small company literature told me what a small established company is and its general characteristics and properties and what context they are working in. More specialized study of the innovation and design processes in small companies revealed them to be highly context dependent. With the extensive literature study done it was easier to grasp
and understand the studied small companies and their processes, organization, and culture.

It is particularly interesting to note that not only the researcher had large companies as an ideal and reference, but also the people at the studied small companies saw large companies and their characteristics as the ideal, model company. As a consequence of this the people at the small companies believed themselves and the company to be less great in different areas and some even felt guilt that they do not do as large companies do. This picture was proven later not to be valid, because they benchmarked themselves against large companies and not against other small companies with which they had much more in common. A general, common and healthy picture of small companies’ and their characteristics seems to be missing, not only in academia but also at the small companies themselves. Small companies have broadly similar characteristics across sectors (Bessant & Tidd, 2007), so explaining this phenomenon from the delusion that small companies are so different from each other is not possible. Why this is the case can only be speculated on. But let us speculate. A possible explanation from an academic view is the fact, that most research on established companies is done on large companies (Edwards et al., 2005; Tidd et al., 2005) and as a consequence most knowledge in this field has originates with large companies, something that is not always realized. As a natural consequence this knowledge is also what mainly is communicated externally and taught in courses in this field at universities. It is odd that small companies are neglected, when 99 percent of all companies are small and employ 50 percent of those employed in the non-governmental sector (Eurostat, 2009).

Most research actually done on small established companies consists of quantitative surveys or interviews. It almost looks like researchers feel that they must cover many small companies in the same research to compensate for the companies’ small size. More focused research approaches, such as observations of innovation and design processes over longer times in small established companies are not found in the academic literature despite the great need for them (Edwards et al., 2005). In this way the research in this thesis is unique.

I believe that this phenomenon of having large companies as the reference and ideal and regarding the way large companies solve different processes and working tasks as the best method can do harm if it is practiced in small companies. Ways of working in larger companies are necessitated by the fact that the company is large, whereas working in the
same way in a small company is not a guarantee of making the small company larger or more professional but can actually make the small company less efficient, solving problems that do not exist.

### 3.4.3 Differences between research and small companies’ practices

Another issue that affected the research relates to the differences between academia and small established companies. There is a mismatch between the short-term near-market focus of small companies and the long-term basic research interests of universities (Almeida et al., 2003; Freel, 2003; Lee et al., 2001). Benefits, from the small companies’ perspective, of collaborations between academia and small companies have not been shown (Freel, 2003; Stridh & Swärdh, 2008). This mismatch was present during the observation time at companies 1 and 2. Table 7 lists some differences between my experiences as a researcher and the experiences of those who work in a small company.

### Table 7. The differences experienced between doing research and working in a small company

<table>
<thead>
<tr>
<th>Doing research</th>
<th>Working in a small company</th>
</tr>
</thead>
<tbody>
<tr>
<td>New knowledge as goal</td>
<td>Profit as goal, make the business run</td>
</tr>
<tr>
<td>Theoretical</td>
<td>Practical, hands on</td>
</tr>
<tr>
<td>Long time horizon</td>
<td>Short time horizon</td>
</tr>
<tr>
<td>Formalization and systematization</td>
<td>Informality and flexibility</td>
</tr>
<tr>
<td>Why does it work and how?</td>
<td>It works! Don’t touch it!</td>
</tr>
<tr>
<td>Results demand accuracy and take time</td>
<td>Fast results at the expense of accuracy</td>
</tr>
<tr>
<td>Practical usage of new knowledge is not always important</td>
<td>Practical usage of new knowledge is paramount</td>
</tr>
<tr>
<td>Uncertain results, no guarantees</td>
<td>Clear and confident results are preferred</td>
</tr>
</tbody>
</table>

With the above in mind, I am glad to report that actual benefits, from the small companies’ perspective, to collaboration with academia were shown in this research approach. Companies 1 and 2 principally benefited from having the researcher in the companies for direct and participating observation. For companies 1 and 2 the most appreciated parts were the interaction with the researcher on site and on the companies’ conditions. It was a knowledge exchange between the companies and the researcher in real working situations inside the companies, and this suited the small companies. The larger part of the knowledge transfer occurred during the period of collecting data at the companies and not from the academic papers that were written later on. The research did not trespass or interfere with daily activities but the employees felt that they got support, a
new perspective, and ideas from the researcher during his time there. The researcher gave alternative views of certain processes or tips that sped up some problematic processes. Since the companies did not have much to offer me for free, it was very important that this exchange occurred during my visits to the companies. Company 2 said that they invested little resources in the research and doubted that academic research could offer them anything useful, yet they got much back that they had practical use for. We found the approach to be a good way to transfer knowledge from academia to small companies and vice versa. Walker et al. (2007) found that small companies are interested in skill training as long as it is directly applicable to the current situation in the company; the approach used in the study of companies 1 and 2 achieved this. These actual benefits for the small companies were unexpected but very welcome. For the researcher, the inside perspective gained through the long observation time yielded a lot of new knowledge.
4 Summary of Appended Papers
A short summary of the three research papers and their results and conclusions is presented next.

4.1 Paper A
Title: The use of methodology for product and service development in SMEs: An explorative study of 18 small companies
Author: Lars Löfqvist
Purpose: The purpose of the study was to examine the innovation processes within small companies and their use of systematic methods within these processes.
Research method: Case study methodology was used and semi-structured interviews were done in 18 small established companies, 11 of which were manufacturers of goods and 7 service companies.
Main findings and conclusions: Main conclusions from this study are that innovation was seen as a problematic area for small companies. There were many good ideas suitable for innovation within the small companies but their realization was usually prevented by scarce resources. The use of systematic methods in the innovation processes was scarce but possible, as was shown in one company.

4.2 Paper B
Title: Prerequisites for innovation in small companies: A multiple case study
Author: Lars Löfqvist
Purpose: The purpose of this study and paper was to examine the prerequisites for innovation in small companies and to describe and analyze their effects on the small companies’ innovation processes.
Research method: Case study methodology was used, with three small established companies as cases. Direct and participating observation, semi-structured interviews, studies of archival records, documents, and physical artifacts were done.
Main findings and conclusions: The study used Bessant and Tidd’s (2007) model of the innovation process as reference. The contextual factors in the model were found to be
valid. The study also confirmed existing research on prerequisites for small company innovation in several areas, including management, strategy, committed resources, creative climate, and proactive behaviour. The examined small companies were close to their customers and users; these relationships were friendly and consisted of an intertwined mix of trust, give and take, support, service, sales, and innovation that all reinforce each other. Relationship marketing was the main marketing technique, which was found to be closely connected to the innovation processes. Customer support was found to be important. Knowledge needed in the innovation processes was gained through direct informal communication with external actors. Scarce resources being a known barrier for innovation in small companies was confirmed in this study. However, the study also showed five different ways that small companies can increase and use existing resources more efficiently: receive financing for innovation work from customers, have customers and users do actual innovation work for free, adopt lead-user innovations, use external experts in the small company’s network as pro bono consultants, and outsource activities that usually steal a lot of resources from the innovation activities. It was found to be both common and easy to take resources from innovation activities and put them in more acute areas to enable sales and maintain cash flow.

4.3 Paper C

Title: Design processes and novelty in small companies: A multiple case study
Author: Lars Löfqvist
Status of publication: Published in the Proceedings of the 17th International Conference on Engineering Design ICED’09, Stanford University, Stanford, CA, USA, 24-27 August 2009.

Purpose: The purpose of the study was to expand knowledge of design processes in small companies. The explorative research questions were:
• How do small established companies execute their design processes within their innovation processes?
• How do the relative novelty of the product being developed and the relative novelty of design processes, to the designers and others involved, affect the design process?

Research method: Case study methodology was used with three small established companies as cases and different design processes as embedded units within the cases. Direct and participating observation, semi-structured interviews, studies of archival records, documents, and physical artifacts were done.

Main findings and conclusions: Eight different design processes were identified and examined. The findings show that small companies have different kinds of design
processes even within the same company. The design processes found were linear, systematic, and structured or cyclical, experimental, and knowledge-creating and there were both finished and unfinished design processes. A generic design process model of reference by Cross (2008) was found valid in the linear design processes. If an extra feedback loop was added it also managed to describe the cyclical design processes. The concept of relative novelty (Tidd & Bodley, 2002) was used to explain the two different kinds of design processes found. If the relative novelty of design processes and the product to be developed were low for those involved in the design processes, a linear design process worked. The same design process was found to be less suitable if both the relative novelty of the product to be developed and of design processes were high. A cyclical design process was found to work no matter the relative novelty. Intense interaction and communication with customer, users, and other external actors was seen to be needed in all examined design processes.
5 Findings and Discussion

5.1 Small companies’ innovation and design processes

5.1.1 The use of methods in the innovation and design processes
In Paper A, the use of formal systematic methods in the innovation processes in small companies was examined. The use of formal systematic methods was rare among the companies with the exception of one company that had a systematic, method-supported design process. Small companies often lack the qualifications and resources for a methodologically systematic design process (Franke et al., 2003). Most processes in small companies are informal, as has been stated by Tidd and Bessant (2009) and Pilemalm (2002); the study in Paper A did not record this informal way of working. In Paper A it is concluded that formal systematic methods were seldom used; in Paper C the informal way of executing the design processes was examined.

Methods are used to solve problems (Jones, 1992) and many systematic methods available in innovation and design must be regarded as tools for large companies to solve their problems in their innovation and design processes. These problems were not present in the examined small companies. For example, the examined small companies did not have the internal and external communication and coordination problem that many systematic methods, such as cross-functional teams and formalized documentation procedures, aim to solve. Easy communication and coordination are common characteristics in small companies, which has been found by Adams (1982), Cannon (1985) and Vossen (1998). Integration of different functions is furthermore of less importance in small companies, because functions are less specialized and less likely to be separated by physical and organizational distance (Tidd et al., 2005), which was also shown in the companies examined in papers B and C. Systematic methods for market, customer and user interaction, and communication, as for example focus groups and customer surveys, were also found to be less needed because of the close, natural, and intense interaction and communication found between the examined small companies and their customers and users. Proximity to customers and users in small companies were also found in studies by Carson (1995) and Rothwell and Dodgson (1994). Using systematic methods to find ideas suitable for innovation seems unnecessary because of the abundance of good ideas suitable for innovation originating in the interaction with customers and users. Finding good ideas was not a problem, obtaining resources to
develop them was. This abundance of good ideas suitable for innovation in small companies was also found in a study by Dalrymple (2007).

Systematic methods are often formal (Cross, 2008) and this property probably contributes to their unsuitability with the informal processes common in small companies. Another reason for informality in the small companies examined is that an informal relationship with customers and users was found to be a large part of their innovation and design processes. This was particularly found in companies 2 and 3.

The rare usage of formal systematic methods can also be explained from the perspective and fact that small companies have scarce resources (Ghobadian & Gallear, 1996; Rothwell, 1989; Rothwell & Dodgson, 1994; Welsh & White, 1981; Zontanos & Anderson, 2004) and must use them efficiently. Although formal and systematic methods are claimed to work in many different specific situations (Cross, 2008), Jonassen (2000) states that it is more efficient to use domain-specific methods than abstract and generic domain-independent methods. This makes domain-specific ways to solve problems in innovation and design more suitable for small companies because they are always forced to be as efficient as possible. Companies 2 and 3 displayed informal design processes with their own domain-specific methods developed to suit the companies, the design processes, and the context. Examples of these domain-specific methods used are the integration of customers and users in the design work and the use of prototyping and mock-ups to gain feedback. The combination of processes to maximize resources and to coordinate the innovation and design processes with other processes in the companies is another informal domain-specific method that was practiced. Other examples are the use of overall constraints in the design work to obtain consensus on the design, running many design processes concurrently to be able to evaluate them properly, and striving for a simple design to facilitate lead-user inventions, as occurs in Company 3. Formal, abstract, systematic methods were in fact in use in Company 2 in the development of software products with low relative novelty. Examples of these systematic methods were project planning, abstraction, and different flowcharts. This exception can be explained by the fact that design problems in software development are quite well structured, making formal methods suitable (Jonassen, 2000). Problems in software design are also quite abstract which fits abstract formal design methods better. In the study in Paper A, another

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2 Lead-users are users that face needs that will be general in a marketplace earlier than other users, and they benefit greatly if a solution to these needs is obtained. Lead-users can by themselves modify existing products to satisfy their unmet needs (von Hippel, 1988).
small company, not in software development, was found to use systematic design methods. Examples of identified methods used in this company were brainstorming (Osborn, 1953), quantitative structures (Tjalve, 1979), and design for assembly (Andreasen et al., 1983). The designers in this company had all worked with the same products in a large company before, so the relative novelty of the products to develop and the process to do so were low. They had found a process that almost always worked and were also able to explain it in a generic, abstract form. This ability to explain their process and way of working on a generic and abstract level was interpreted as the usage of formal systematic design methods. It is possible that the companies studied in Paper A were not aware that the way they were working can be seen as method supported. It is important to note that even if the companies could not always describe their innovation processes, they still developed and launched successful products. Products do not develop themselves and are too complex to be realized by chance, so there must be some kind of working process by which they are developed. Perhaps many of the companies studied in Paper A had well-functioning ways of developing new products, and the interviewees simply could not describe them. This was apparently the case with Company 2, where observations showed well-functioning innovation processes with the use of systematic methods but interviewees could not describe them properly.

To summarize the reasons why small established companies seem not to be using formal systematic methods:

- The problems the methods aim to solve are not present.
- It is more resource efficient for a company to use their own domain-dependent methods than formal, domain-independent methods.
- The methods’ formality is less suitable given the informal processes common in small companies.
- The methods’ formality does not fit well with the informality in the interaction with customers and users.

In spite of Jonassen’s (2000) findings of efficiency in the use of domain-dependent methods, the above reasons why small established companies do not use formal systematic methods have not been found in other studies.

Paper A concluded that innovation is an area of concern for the examined small companies. The use of formal systematic methods in innovation processes was rare, and the above discussion shows how these methods are probably not the solution to small
companies’ problems with their innovation processes. It was also found that scarce resources were the main reason that prevented the exploration and realization of innovative ideas, and this seems to be the primary source of the problems in the examined small companies’ innovation processes. The small companies were found to have some approaches and strategies to deal with this resource scarcity in innovation and design, which will be further discussed in section 5.1.4.

5.1.2 Intertwined innovation processes
The innovation processes were found to be intertwined in other activities and processes in the examined small companies in the studies in papers B and C. Innovation apparently must be done side by side with ordinary activities and processes; the innovation processes apparently cannot be isolated in small established companies. This is due to the fact that the same employees have responsibility for both day-to-day activities and innovation activities and to the physical smallness of the companies’ premises. The companies must make the best of the situation. These intertwined innovation processes had both positive and negative effects in the studied companies. The negative effect from an innovation perspective is that resources were easily taken from innovation activities to fix acute problems in daily operations. The positive effects were the synergy effects that were achieved when innovation processes were intertwined and mixed with other processes and activities. This caused existing scarce resources to be used in a more efficient way. For example, the support function in Company 2 not only supported issues in the contact with customers and users. The support was also a channel for sales, marketing, and input and feedback on innovation activities. The small size of the companies, with easy communication and coordination, and the employees’ often broad knowledge and multiple functions at the companies enabled this way of working. Intertwined innovation processes are not a totally new phenomenon; for example, Clarkson and Eckert (2005) and Berger (1999) have also found this. The inability to isolate innovation activities in small companies was found in studies by Bodin (2000) and Pilemalm (2002). However, these researchers did not relate the intertwined innovation processes to the ability to gain synergy effects and the efficient use of resources, a finding unique to this thesis.

5.1.3 The important role of customers and users
To involve customers and users in innovation processes is not a new idea. One famous pioneer in the area is for example von Hippel (1988) with his lead-user theories. One important kind of proactive linkage found in the examined companies in papers B and C and at the same time a large part of the innovative organization in companies 2 and 3 are
the companies’ customers and users. In Company 1 the importance of customers and users was shown in the design processes that had low customer and user involvement during the process. These design processes had difficulties due to lack of customer and user feedback to the processes. The friendly and close relations to customers and users in companies 2 and 3 meant that they become a fundamental resource in the small companies’ innovation processes. The customers and users were found to finance innovation processes, provide most of the ideas suitable for innovation, participate and do innovation work for free for the companies. They also developed lead-user inventions by themselves and then gave the inventions away for free to the small companies, while continuously giving feedback and input to innovation processes as a way to steer the processes in the right direction.

For example, with the lead-user inventions done in Company 3 in Paper C, the company actively searched for a simple design for its products. Complex design and solutions presumably mean complex innovation and design processes, which can be expensive and hard to manage. The simple design of the products also meant that users could more easily modify the products on their own and make lead-user inventions, as described by von Hippel (1988). This was an efficient way to increase resources for innovation. The company not only learned of real customer and user problems, but also got the solutions to these for free, which saved a lot of effort and resources.

One exceptional thing is that intense customer and user interaction and communication took place not only in the design processes with a high relative novelty but also in the least novel design processes. This high customer and user interaction and communication in processes with low relative novelty was an unexpected finding. According to Engwall (2004) and Tidd and Bodley (2002), a high level of interaction with customers, users, and other external actors is needed in innovation processes with high uncertainty and high relative novelty, in order to get input and feedback to the development process. This indicates or is an indirect proof that the innovation processes found are affected by something external that further increases the uncertainty and the relative novelty. A qualified guess is that this external thing is the turbulent and uncertain organization and environment that the examined small companies were working in. This turbulence and uncertainty affects the whole small company, including processes such as the innovation process.
5.1.4 Efficient use of resources in the innovation processes

In section 5.1.1 we concluded that the most probable cause for problems in innovation processes in the examined small companies was scarce resources and not the lack of formal systematic methods. What was mainly found in Paper B is that the examined small companies had several approaches to increase resources or to use existing scarce resources more efficiently in their innovation processes. These approaches were receiving financing for innovation work from customers, having customers and users do innovation work for free, adopting lead-user innovations, using external experts as pro bono consultants, and outsourcing activities that steal resources from the innovation activities. In addition to those approaches, other approaches to the efficient use of resources will be discussed.

A creative and efficient use of internal and external resources has been shown to be a central theme in the examined small companies’ innovation and design processes. What has not yet been discussed is how resource efficiency can be reached through the structures of the design processes. It will also be discussed how small companies lower risk and save resources through a closeness to customers, together with a fit between the product to develop, skills and knowledge, and certain small company characteristics.

Knowledge in project management was found to be important in innovation processes with low relative novelty. Low relative novelty made it easier to plan and execute design processes as projects. The design processes with high relative novelty were not executed in the form of projects. Company 1 tried executing a high novelty design process in the form of a project but failed. In the design processes with low relative novelty in Company 2, planning time and resources meant that existing resources were used in a more efficient way. But there was also another resource-saving logic used in the cyclical innovation processes. This was made possible by the small companies’ special characteristics, including fast and informal communication, rapid decision making, and flexibility, together with the extensive and continuous feedback from customers, users and other external actors. Following a cyclical approach with continuous and extensive feedback, the company can quickly find out if they are working on the right things and in the right direction, which saves resources. It is hard to predict the optimal solutions, especially with the design processes with high relative novelty, and it is easy to put effort into the wrong activities or solutions. A cyclical approach caused as little as possible of the innovation work to be applied to the wrong solutions, because the customers and users continuously valued solutions and gave feedback and ideas during the whole innovation
The customers and users are the final judges of a product’s value, and this value can be said to be optimized since these judges are part of the process creating the value. The often friendly and honest relationships with customers, users, and other external actors made feedback honest and accurate.

Although the actual selection of ideas to develop in small companies’ innovation processes is outside the scope of this thesis, one common approach used by companies 1, 2, and 3 in the selection phase pertains to the efficient use of resources in later parts of the innovation process. Small companies are usually used to risk because of the uncertain and turbulent environment common in small companies (Ratcliffe-Martin & Sackett, 2001; Welsh & White, 1981). One approach to lower risk is to only begin serious amounts of design work if there is a customer that demands or needs the innovation. Low et al. (2007) also found that some small companies only innovate upon customer requests. This lowers the market uncertainty and risk and mainly leaves only technology risk and uncertainty to handle. With a customer to buy the innovation in the end and to pay for the development effort, the company can receive continuous feedback from the customer during the whole design process. The very fact that it is a customer asking for advice and feedback in the innovation process further lowers the risk that efforts are applied to the wrong solutions. Sometimes the customer also finances the design process, which in turn also lowers the risk and increases the resources further.

Cannon (1985) has found the importance of customers’ support during the innovation process when he states that innovation processes without customer support often fail in small companies. Technology uncertainty and risk are handled through the fact that there are special kinds of product innovations that small established companies bring into being. Dallago (2000) and Mosey (2005) found that product innovations in small companies are not accomplished due to new technology but rather with less novel technology or by using existing technology in new ways. This use of less novel technology and reusing existing technology was shown in the studied companies’ design processes. Less novel technology or existing technology increase the probability that specialists will be unnecessary in the innovation process, which suits small companies that usually have owner-managers and employees with generalist knowledge (Bodin, 2000; Pilemalm, 2002; Verhees, 2005; Welsh & White, 1981) and no employed specialists (Freel, 2000). Most likely the needed skills and knowledge to create the innovation can be found in just a few or one single person in the company, due to their generalist knowledge. This generalist knowledge is also complemented by the knowledge
possessed by customers, users and others in the company’s environment that are part of the innovation and design processes. Thus, the technological uncertainty and risk are lowered, because the technology chosen matches the knowledge and skills possessed by the actors in small companies’ innovation processes. External and expensive expertise is less needed, which saves resources. The reusing of known existing technology also saves development resources.

5.2 The prerequisites for innovation in small companies
For innovation to be possible in small companies, some prerequisites must exist. On a fundamental level there must be resources available for innovation. The study in Paper B primarily dealt with the prerequisites for innovation to occur in small companies. What could be concluded from that study is that if a small company has well-developed routines within the contextual factors of Bessant and Tidd’s (2007) innovation process model, it may have a working innovation process. If parts of the contextual factors were missing, a working innovation process is problematic to achieve. The three contextual factors will be further discussed more deeply in the sections below.

5.2.1 Strategic leadership, direction, and deployment
Some kind of uniform strategy, vision, goal, or direction within the small companies studied seems to enhance innovation, a finding that is supported by Bessant and Tidd (2007). Example of a lack of conformity in strategy, vision, and goal were shown in Company 1, whose two leaders at the helm confused the employees. The companies in the study did not have great power or control over the marketplace, and their environment was uncertain and turbulent. These characteristics of small companies, also found by Carson (1995), Ratcliffe-Martin and Sackett (2001) and Welsh and White (1981), made planning hard and long-term strategies less useful in the examined companies. This was also indirectly shown by the fact that sales almost always had priority and production troubles had to be quickly fixed to maintain cash flow. Any plans were put aside if the cash flow was threatened. Deprioritized innovation processes when faced with short time pressure were also found by Woodcock et al. (2000). The fact that small companies are sensitive to disturbance in the cash flow was also found by Welsh and White (1981). This made the time horizon short in the examined small companies; short-term returns were favoured over long-term ones. Westhead and Storey (1996) have also found this predilection for short-term returns in small companies.
Apparently it is easy to steal resources from innovation and design processes if doing so will not affect the company’s performance in the short run. Production troubles were a resource stealer from innovation. One company, Company 3, had outsourced all production primarily because it was cheaper, but an incidental effect was that fewer resources were taken from the innovation activities. It seems that long-term strategies and goals had less importance in the small companies in this study because the future seemed to be hard for them to predict. One thing that mitigates the effects of and compensates for this uncertain and turbulent environment was that the examined small companies were flexible and had the ability to rapidly respond to future situations and could handle future difficulties when they occurred. Deal with problems as they arise is a common approach in small companies, as was also found by Dalley and Hamilton (2000).

5.2.2 Innovative organization
The need for a creative climate cannot be underestimated in the examined small companies’ innovation activities. Scarce resources made creativity necessary in at least three stages: obtaining needed resources, using these resources in the best way in the innovation and design processes, and then actually creating the new product. Communication and coordination was not a large problem in the examined small companies’ innovation processes due to their small size and relative easy access to different people they required within and outside the organization. The few communication problems found had their origin in interpersonal relations and not in organizational issues. To achieve a creative and constructive climate suitable for innovation, those companies that trusted their employees and had an owner-manager who delegated authority and power had this effect. Often small companies have an owner-manager who does not like to cede authority and responsibility rather to retain control over most aspects of the business (Adams 1982; Cannon 1985). Examples of this were seen in the study in Paper B, with the effect of decreasing creativity among employees.

5.2.3 Proactive linkages
This study shows that proactive linkages and external linkages in general were crucial and very important in the innovation processes in the studied small companies. These linkages were primary with customers, users, suppliers, other companies, and external specialists. Relationship marketing was found to be the primary marketing technique, which was also highlighted by Zontanos and Anderson (2004). Relationship marketing was found to be highly related to innovation activities. Through these relationships and links, ideas suitable for innovation and continuous and extensive feedback on the innovation and
design processes were gained. Without efficient linkages innovation processes were found to have difficulties due to lack of knowledge, information, and feedback. This was shown in an abandoned design process in Company 1. Different kind of links and communication channels seem to enhance communication and innovation in the examined small companies, because they increased the probability that different actors would find a communication channel that suited them best. Example of communication channels used were personal meetings, phone, mail, e-mail, customer support, and trade fairs. The small companies in papers B and C were all reactive to requests for innovations; the companies that also were proactive were more innovative and launched more new products. This importance of proactive behaviour in innovation is supported by Bessant and Tidd (2007).

5.3 Relative novelty and innovation processes

5.3.1 The impact of relative novelty
In the study in Paper C, eight different design processes were found and examined as to their relative novelty in two dimensions: the relative novelty of the product to develop, as described by Tidd and Bodley (2002), and the relative novelty of design processes in general for the designers and others involved. The results showed that the small companies studied had different design processes, with different degrees of relative novelty. The eight design processes found are depicted in Figure 4 below.

![Figure 4. The eight different design processes found in relation to two different kinds and grades of relative novelty](image)

Figure 4. The eight different design processes found in relation to two different kinds and grades of relative novelty

The realized small modification design process (Company 1)
The large new product design process (Company 1)
The unrealized small attempts design process (Company 1)
The lead-user design process (Company 3)
The open experimental design process within certain constraints (Company 3)
The small standard design process (Company 2)
The large standard design process (Company 2)
The customer-specific design process (Company 2)
The grey dots in Figure 4 are design processes that are usually finished and the white dots are abandoned design processes with unfinished products. Both linear and cyclical design processes were found in the examined companies; if these structures are added to the conclusive picture above the result is Figure 5, which shows the working and non-working structures of design processes within different kinds and grades of relative novelty.

![Figure 5. Working and non-working design processes in relation to different kinds and grades of relative novelty](image)

Linear structured and systematic design processes were successfully used when there were low relative novelties of both kinds. These design processes mirrored the design process model of reference by Cross (2008). In these linear design processes most of the exploration of the design problem was done prior to the generation of possible solutions. This low relative novelty meant that these design processes could be planned accurately in advance and executed in a quite systematic linear manner. During this kind of design process there was extensive feedback and communication with customers and users.

The other kind of design process found is the cyclical, experimental, and knowledge-creating design process with extensive feedback from customer, users, and other external actors. These design processes were done in cyclical loops of exploration, generation, and evaluation. Solutions are generated and tested on the design problem to gain new knowledge to use when new possible solutions are created to test, and so on. In practice these tests of solutions were done with customers, users, and other external actors to gain feedback and new knowledge. In the cyclical design processes the exploration is done in several stages within the cyclical loops. A cyclical design process is theoretically
estimated to be working if a high relative novelty is present (Engwall, 2004; Lynn et al., 1996; O’Shea & McBain, 1999), but this approach also worked with low relative novelty of the kinds examined, which was an unexpected finding. These cyclical design processes commonly used in the examined small companies did not quite fit into the design process model of reference by Cross (2008). If Cross’s (2008) design process model of reference is modified with an extra feedback loop, it manages to catch these cyclical processes too. In Figure 6 below this modified design process model with linear and cyclical design processes is shown.

![Figure 6. Modified design process model for both linear and cyclical design processes](image)

### 5.3.2 Do cyclical design processes naturally suit small companies?

Five out of eight design processes found had a cyclical structure. These kinds of design processes were also found by Guimarães et al. (1996) and Larsson (2001) in small companies. This cyclical approach was also found by Engwall (2004), Lynn and Akgün (1998) and Lynn et al. (1996) to be well-functioning approaches in innovation processes under conditions of great uncertainty, as processes with high relative novelty normally are. Lynn et al. (1996) states that experimental innovation processes of probing and learning are expensive for a company, but they are probably referring to large companies in this statement. For small companies this probably does not hold true, because of their flexibility, low bureaucracy, rapid decision making and the natural and intensive interaction and communication with their market, customers, and users. Cyclical, experimental, and knowledge-creating design processes with probe and learning
approaches were used in the small companies studied, even though the final product innovations did not always appear radical to an external viewer. Large companies must create a special organization form and environment to cope with the development of radical product innovation with high uncertainty (Engwall, 2004), but small companies do not need to create this because they already have the requisite environment and therefore have the natural ability to create both incremental and radical new products in cyclical design processes. It seems that it is not only the relative novelty of the product to develop and the relative novelty of design processes in general that determine the choice of process, but also the characteristics of the organization, its size, and its environment.
6 Conclusions and Future Research
The overall purpose of this thesis, to deepen the knowledge about small established companies’ innovation and design processes, has been achieved. Existing research was confirmed and new knowledge was found. The conclusions from the studies done are summarized below.

6.1 Small companies’ innovation and design processes
The conclusions about small established companies’ innovation and design processes are divided into different categories for a better overview below.

The use of methods in the innovation and design processes
- The use of formal systematic design methods is low in small companies.
- Formal systematic methods seem not to be efficient in small companies’ innovation processes, because many of the problems they aim to solve, for example coordination, communication, and interaction problems, are not present, while for other problems domain-specific methods are more efficient.
- Formal systematic methods fit less well with the informal processes common in small companies.
- Formal systematic methods do not match the informality in the interaction with customer and users.
- One exception found, when formal, abstract, and systematic methods do suit the tasks, is in design processes for software which has more abstract characteristics resulting in a better fit between the methods and the design problem to be solved.

Overall structures of design processes
- There are different kinds of design processes used within the same small company.
- The two main structures of design processes used are cyclical and linear design processes.
- The cyclical design processes consist of learning experiments of probing and learning in cyclical loops, with extensive feedback from customers and users.
- Linear design processes follows the steps in Cross’s (2008) design process model of exploration, generation, evaluation, and communication. This kind of process also includes extensive feedback from customers and users.

Intertwinement of the innovation and design processes
- The innovation and design processes were intertwined in other processes to gain synergy effects and to use existing scarce resources more efficiently.
• Innovation and design processes were found to be impossible to separate from daily activities in the examined small companies.
• It is common that problems in day-to-day activities steal resources from innovation and design processes.

The importance of customers and users in the innovation and design processes
• Customer and user interaction, communication, and feedback are crucial during the innovation and design processes in small companies.
• There are relative few employees involved in innovation processes inside small companies, but if external actors such as customers, users, and others are taken into consideration, the number involved increases.
• Small companies have the natural prerequisites to efficiently take advantage of and use lead-users and adopt lead-user inventions in their innovation activities.
• Customer and user feedback help to steer innovation and design processes in the right directions.

Approaches to increase and use existing scarce resources more efficiently
• Obtain financing for innovation from customers asking for or needing the product innovation.
• Include customers and users in the innovation and design processes, doing actual innovation work.
• Use external experts in the small company’s network as pro bono consultants in the innovation and design processes.
• Intertwine the innovation and design processes in other operational processes to gain synergy effects.
• Outsource activities that might otherwise steal resources from innovation and design processes.
• Reduce formality in the innovation and design processes, making the processes more efficient.
• Use the right kind of design process structure to match relative novelty aspects and small company characteristics.
• Strive to achieve a simple design to lower the complexity of both the design process and the final product, which in turn increases the probability of lead-user inventions.
• Adopt lead-user inventions.
• Match the technology used in new products with small companies’ knowledge and skills and reuse known technology and solutions.
• Only start to do serious innovation work if there is a customer asking for or needing the innovation, to be sure that the innovation efforts will be compensated.

6.2 The context’s effect on innovation and design processes
Innovation and design processes in small established companies were found to be highly context dependent and hard to understand without also understanding the context. The following conclusions about the effect of the context are categorized according to the contextual factors in Bessant and Tidd’s (2007) innovation process model.

6.2.1 Strategic leadership, direction, and deployment
• Some kind of uniform strategy, vision, or goal was found to be important for innovation processes to succeed.
• Mixed family and business issues can affect innovation processes negatively.
• Delegating power and authority among the employees increases innovation.
• Committed resources to innovation were found to be crucial for innovation to occur.

6.2.2 Innovative organization
The need for a creative environment in small companies, with trusted employees and shared power and control, cannot be underestimated. Creativity is needed to gain resources, use them in the most efficient way and actually create the product.

6.2.3 Proactive linkages
• Proactive linkages to customers, users, and other external actors are crucial in small companies’ innovation and design processes and many different communication channels with these actors increase innovation.
• The examined companies were all reactive in innovation but those that were also proactive were more innovative.

6.3 Product and process novelty
The characteristics of the design problem to be solved, small company characteristics and the concept of relative novelty for the product to develop and for design processes in general are found successful in explaining the use of different kinds of design processes in small established companies. The following conclusions may be drawn:
• Linear, systematic, and structured design processes worked when the relative novelties were low for both the product to be developed and for design processes
in general. The same type of design process was found unsuitable within a high relative novelty situation.

- Cyclical, experimental, and knowledge-creating design processes worked no matter the relative novelty.
- Small companies seem to have the natural prerequisites to practice cyclical design processes, mainly due to their flexible organization and close relationships with customers and users.

6.4 Future Research

The research done in this thesis focussed on the context and the implementing phase, the design phase, of the innovation process. The phases of generating and selecting ideas for input to innovation are very briefly described in papers B and C but not examined more deeply. If Bessant and Tidd’s (2007) innovation process model were used, additional knowledge about these issues would fill in all parts of the model and give a more complete overall picture of small established companies’ innovation processes. All parts of an innovation process and its context interact; therefore, this thesis only provides a partial description of innovation processes within small established companies.

Carrying out a quantitative test on findings from this thesis would be interesting to see if it is possible to generalize the findings statistically. Many more interesting areas for further research exist, such as a closer examination of the concept of relative novelty and its content, to see how it influences the innovation and design processes further in small companies. To further examine the intertwinements of innovation and other processes in small established companies would also be interesting for future research.
7 References


