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LICENTIATE THESIS

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Product Innovation Processes

Conceptual and Methodological Considerations

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Conceptual and Methodological Considerations

This is NOT an innovation?

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ABSTRACT
This thesis addresses the social dimension of individuals engaging in the product innovation process in order to develop and choose techniques for knowledge creation about the social evolvement of a product innovation. The social dimensions of product innovation processes are particular interesting, since many firms today organize their processes by combining individuals from different functions and knowledge areas. The main argument is that decreasing the product's time to market saves costs through divergent perspectives of the product innovation early in the product innovation process; thus, understanding the social dimension may contribute to improving a firm's product innovation process. This is addressed by (1) developing a conceptual model of the product innovation process in respect to the dynamic interplay between individuals in terms of social and cognitive dimensions; (2) formulating a research plan for a significant test of the model; (3) empirically testing a significant part of the research plan on one individual participating in a product innovation process; and (4) developing a research plan based on this test. In this study, development of the conceptual model is based on a literature review. The significant test and the formulation of a research plan are based on the repertory grid technique, social network analysis, and alter-ego network analysis in order to understand if these techniques could be applied to the central concepts, which are, frame of reference, thought, action, interaction, and structures. The significant test indicated a complex relationship between the central concepts, which implies a need for researchers to combine techniques and to participate within the process.

ACKNOWLEDGEMENTS
The physical result of a licentiate thesis may be argued to be a product innovation, perhaps not in the format of a book but in terms of its unique content, which is based on a recombination of knowledge areas and thus an innovation by definition. This would logically imply that the process of writing (an action) and thinking about the content of the thesis would be a result of the product innovation process. As in many product innovation processes, I have interacted with other individuals whom I perceive as significant in order to expand my understanding (frame of reference) within this field of knowledge.

Among all significant individuals with whom I have interacted, I would like to give my appreciation to those who have had the deepest impact on my actions and way of thinking. First of all, I would like to thank my supervisors, PhD. Anders Nilsson and Professor Einar Häckner, for their valuable comments, support, and patience. Another person who largely contributed in the early stages of this thesis is PhD. Mats Westerberg, who inspires me through his genuine interest and enthusiasm. There are also several individuals who have contributed to my work in different ways, commenting in conferences, seminars, and during coffee breaks. Even the smallest comment could alter my perspective of what is fundamental, so thanks to all of you.

Like life in general, writing a thesis has its ups and downs. To balance, I find strength in my interests, my friends, and especially my family. Without my constant friendly battles with my father, the encouragement of my mother, and the laughs with my indecisive sister, I do not think that I would have found the strength to think, write, rethink, and rewrite. I would also like to mention my uncle, whose calmness helps to balance the pace of life. Thanks to all of you!

I would like to conclude with words of wisdom from Matthew Arnold (1822 - 1888), who insightfully stated:

The freethinking of one age is the common sense of the next.

I hope that this brick of knowledge will make a small contribution to the common sense of future practitioners in product innovation processes. I hope to increase their knowledge about the social dimensions of product innovation processes and be reflected in action when practicing the art of innovation.

Luleå

Sven Andersson

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1 INTRODUCTION

Innovations are not created by themselves. It is through hard work of thought and action made within a product innovation process. In this chapter, I will introduce the topic of individuals engaging in a product innovation process and define the purpose of this thesis.

Today, many firms are competing in a turbulent dynamic environment characterized by constant and rapid changes in products offered on the market. A firm's capability of renewal is considered important for both survival and future prosperity; as such, firms rely on their product innovation ability. In most cases, companies perform incremental product innovations that focus on minor improvements or simple adjustments. Over time, companies acting in turbulent environments will encounter great leaps in, for instance, technology. Examples in modern times include the first mobile phone, pocket calculator, or jet engine. In this sense, a firm's product innovation process cannot solely focus on incremental innovation; thus, these radical product innovations may be perceived as a key source of a firm's long-term competitive advantage (e.g. Greve & Taylor, 2000). Combining this with a tendency for shorter product life cycles, which increases the number of both incremental and radical innovation processes, leads to a greater need to understand a firm's product innovation processes.

Studies have identified different factors in incremental and radical innovation processes. One important factor in both cases is the use of cross-functional teams[1] (Ernst, 2002; Brown & Eisenhardt, 1995) or cross-professional[2]. An assumption in the use of cross-functional or cross-professional teams is that individuals need other perspectives during the innovation process. On the contrary, there is an implicit assumption in use of teams where individuals represent the same function or profession that they are unable to defy the perspectives of others. In relation to innovation, this forms a paradox, since innovation by definition is represented by a new thought or/and action. How can something new be made when everyone sees it in the same way? One possible explanation is to view the product innovation process as consisting of individuals who are exposed to social processes, which reshape their thoughts[3], actions,[4] and interactions[5] within this process. However, there is a fundamental question concerning firm's product innovation process to be addressed: if innovation is a social process, then how do individuals perform their specific tasks within the context of innovation? As a social process, product innovation results from the interaction of individuals, but the action may also be divided in tasks to be solved. Participating individuals must agree on some level; in this way, they are interdependent even though individuals independently may perform thought and action. It seems as if action toward product innovation results from a dynamic

[1] Cross-functional teams refer to individuals who represent different organizational skills with a high degree of interdependence (Holland et al., 2000).
[2] Cross-professional teams refer to individuals who represent different areas of expertise.
[3] Thought is defined as an individual's conscious representation toward their frames of reference (Mandler, 2004).
[4] Action is defined as a purposeful act by an agent within a situation to achieve an anticipated consequence (Argyris et al., 1985; Giddens, 1979).
[5] Interaction represents the interplay of individuals with significant others, for example, through communication.

interplay between social and cognitive dimensions of individuals participating in the product innovation process.

1.1 THE SOCIAL PROCESS OF PRODUCT INNOVATION

Some argue that innovation is easy; it is just a question of hard work. Others argue that there is more to achieving innovation. One notable innovator is Thomas Edison. Although he received all of the credit for the innovations that he made, Edison was surrounded by several competent individuals. Carlson and Gorman (1990) analyze Edison's innovation in motion pictures (the kinetoscope) as a cognitive process. I will use their illustration, in my words, in order to illustrate the social process undergoing a product innovation process.

The innovation process started from an analogy of the phonograph. Edison wanted to create an innovation that "does for the Eye what the phonograph does for the Ear" (Carlson and Gorman, 1990). This vision was based on a discussion with Eadward Muybridge, who showed Edison how a sequence of pictures could create the illusion of motion. Based on Edison's initial frame of reference,[6] *he proposed a model based on a technical solution similar to what was used in the phonograph. He replaced the sound grooves of the record cylinder with a continuous spiral of photographs both making it possible to take photographs and display them. As such, the revolutionary idea evolved from familiar mechanical representations. Edison selected experimenter William Kennedy Laurie Dickson and a few assistants to help with the development. Edison worked on the motion due to his electrical and mechanical knowledge from previous projects, while Dickson worked on the photographic and optical representations due to knowledge in the area of photography.*

In time and space, Dickson experimented with different solutions of microphotographs and after several negative unintended consequences, he was ready to give up the idea of coating a cylinder based on the phonograph representation. Meanwhile, Edison used his frame of reference on electromechanical operation in order to solve the rotary and intermittent motions expected to be used. Based on a meeting with Etienne J. Marey, describing the technique used in a camera, which could take exposures in 1/1000th of a second and produce sixty frames per second, Edison changed his view of using a spiral of images wrapped around a cylinder in favor of a straight photographic strip. While Edison hade an embryo of what was to become a kinetoscope his experimenter decided to work on a mental model based on the tachyscope, about which he had read. As such, Dickson's and Edison's frames of reference did not share full representations about the features of a kinetoscope, leading to deviant actions.

Dickson demonstrated that motion pictures could be projected and synchronized with sound, but Edison was not impressed, ordering him to drop this line of work. A simple explanation for this is that Dickson's model did not fit to Edison's mental representation of a kinetoscope in terms of construction and marketing assumptions. This resulted in Dickson

[6] A frame of reference represents a mental template, schema, or cognitive structure, giving guidance to thought, action, and interaction (Walch, 1995). The concept of frame of reference is further elaborated in Section 3.2.

turning to Edison's view of a strip. However, the projection affected Edison's frame of reference, since they decided to build separate machines for recording and displaying motion pictures. The action of gluing the ends of celluloid film into narrow strips and cutting a series of notches along one edge, which engaged an intermittently driven gearwheel, resulted in a working model that, over time, gave the unintended consequence of rapidly chewing up the film. Based on this, Dickson drew upon his frame of reference, guiding him towards a mechanical representation in an old telegraph instrument using punched paper tape. After new tests and reviewed consequences of the one row of perforations, Dickson discovered that the wider films required perforations on both edges in order to advance the film smoothly. This resulted in a working model with horizontally-fed film, moving from enclosed reels on either side of the lens. Later versions were modified to vertically feed film and synchronize sound, which fulfilled Edison's initial frame of reference (vision).

Turning to the question again, how do individuals perform their specific tasks within the context of innovation? In the case of Edison and Dickson, it seems likely that their frame of reference guided them towards certain mental representations (thoughts) and actions to accomplish the innovation; at the same time, however, it restricted their perspectives. The innovation process seemed to be a social process where engaged individuals exchanged representations. However, at several times their representations were altered due to alternative perspectives of others or unintended consequences of action. This could imply a reproduction of mental representations in Edison's and Dickson's frames of reference (homogeneity) leading to unified action, anticipated consequences, and altered perspectives through input of others (heterogeneity) and unintended consequences of action and interaction.

1.2 THOUGHT, ACTION, AND INTERACTION IN PRODUCT INNOVATION PROCESSES

From an institutional perspective, individuals engaging an innovation process in time and space both forms and are formed by structures[7]. Giddens (1984) suggests that structures are produced and reproduced throughout the innovation process, guiding individuals towards innovation. These formed structures should support the individuals in their process of creating an innovation. According to Burns and Scapens (2000), these structures impose form and social coherence on individuals' activities "through the production and reproduction of settled habits of thought and action." Over time, these guiding structures of thought, action and interaction for innovation will take the form of rules and routines. In this way, formally recognized rules guide how "things should be done" as well as coordinate and give coherence to group action. Routines,[8] on the other hand, constitute how "things are actually done" through a rule-based programmatic behavior. In this sense, the realms of thought and action will form structures through a dynamic and iterative process of interplay. Brunsson (2002) illustrates these realms of thought and action:

[7] A structure represents structural properties as in the arrangement of and relations between something complex in action and interaction (Giddens, 1979). Thus, it is not related to the shape or construction of features within a product innovation process.

[8] The concept of routines will be further explored in Section 7.2

> *"Ideas can range widely in time and space; ideas may be about the past, the future, or things that are far away; action happens in the here and now. Ideas about the future in particular need not be confused or constrained by action. Thought is not subject to the same powerful restrictions as action; we can easily think or talk about actions which we cannot actually perform. Against this freedom of thought we have the constraints and limitations of action."*

Although freedom of thought exists, it is restricted by participating individuals' frames of reference. During the thought process, individuals draw on their frames of reference, which constitute an overall framework for possible thoughts. Due to their frames of reference selective filtering of perceptions, their frames of reference will guide their thoughts in the direction of their knowledge representation (frame of reference). Hypothetically, this implies that for an individual who does not have anything in their frame of reference to which they relate, innovative thought will literally be unthinkable. In this sense, participating individuals present frames of reference will selectively filter their thoughts and actions in other directions. Thus, it will be impossible to take action or to form guiding structures for innovation. In a similar way, Brunsson (2002) describes how participating individuals may have a standardizing effect on thought, which leads to what Janis (1972) calls "groupthink." In groupthink, participating individuals show homogeneity in their frames of reference, which makes thoughts and actions outside of the present structure unthinkable. In contrast, Van de Ven (1986) describes how a single innovative idea expressed to others evolves into multiple ideas through participants diverse frames of reference that filter their perceptions. This may be described as a state of heterogeneity in frames of reference among individuals participating in the innovation process; however, heterogeneity may be seen as a risk if individual's frames of reference are too divergent, resulting in lack of understanding and an inability to form adequate structures to guide action toward innovations.

Derived from the discussions above it is likely that individuals engaging in a well-functioning innovation process must balance the need for structures to coordinate thought for unified action with the need of lack in structures for unrestrained thought and thus heterogenic frames of reference that proliferate into new thoughts. Providing a more profound understanding of how frame of reference, thought, action, and interaction evolves within an innovation process may assist future project managers in forming structures to facilitate innovation. From a research point of view, there seems to be a lack of innovation literature in terms of cognitive perspectives and their relation to the product innovation process.

1.3 RESEARCH PURPOSE

Let us return to the question at hand: how do individuals perform innovations? The discussion above has shed some light on the need to balance frames of reference, thoughts, and actions in order to create a structure that enables individuals to create an

innovation. Nevertheless, this is an unexplored area and therefore a great task to deal with in the scope of this thesis. A first step, however, is to conceptually address how individuals' frames of reference evolves during the innovation process. To address this empirically, I will face difficulties in linking theory and practice; therefore, a second step is needed to test and evaluate techniques to study how these frames of reference evolves within an innovation process. However, a full test and evaluation of the research plan is restricted due to time limitations.

Since thought, action, and interaction may be studied by well-documented methods, the significant area of interest in this thesis is to determine if individuals' frames of reference about the innovation process may be captured. This test will be performed in relation to one member of a product innovation process. If the technique is tested on one individual, it will most likely work out well on other individuals participating in the innovation process. The technique to be tested has already been used to capture several individuals' frames of reference but not, to my knowledge, in the context of a product innovation process. Nevertheless, if the technique work out well on one individual it will likely work out well on other participating individuals.

An important distinction related to thoughts and actions affect on structure is whether individuals' frames of reference about the innovation or the innovation process within the context of the innovation are of interest. As previously mentioned, structures in individuals' frames of reference affecting thought, action, and interaction might both facilitate and obstruct the development of innovations. It is possible that common or different frames of reference in certain steps within the process as well as common or different frames of reference about the product both might facilitate and obstruct development of the innovation. Therefore, the main interest in this thesis is the development of frames of reference within and about the innovation process, where the product could be one parameter affecting the development within the process.

Derived from this discussion, the overall purpose of this thesis is to develop and choose techniques in order to create a greater understanding of how the social process of a product innovation process evolves in terms of individual frames of reference, thoughts, actions, and interactions. More specifically, the research purposes are to (1) develop a conceptual model of the product innovation process in respect to the dynamic interplay between social and cognitive dimensions; (2) formulate a research plan for a significant test of the model; (3) empirically test a significant part of the research plan on one individual participating in a product innovation process; and based on the empirical test (4) develop a research plan.

1.4 Outline of this thesis

This thesis consists of seven chapters (Figure 1). This chapter introduces the theoretical problem; the next chapter accounts for the scientific positioning characterizing and guiding this thesis and thus issues related to ontological and epistemological considerations. Chapter 3 deals with the theoretical framework related to product

innovation processes and its relation to individuals' frames of reference, thoughts, actions, and interactions. In Chapter 4, techniques to address the theoretical concepts are presented, with a thorough introduction to the repertory grid technique. A significant test is performed in Chapter 5 analyzed in Chapter 6, and its implications are discussed as the foundation for the research plan in Chapter 7.

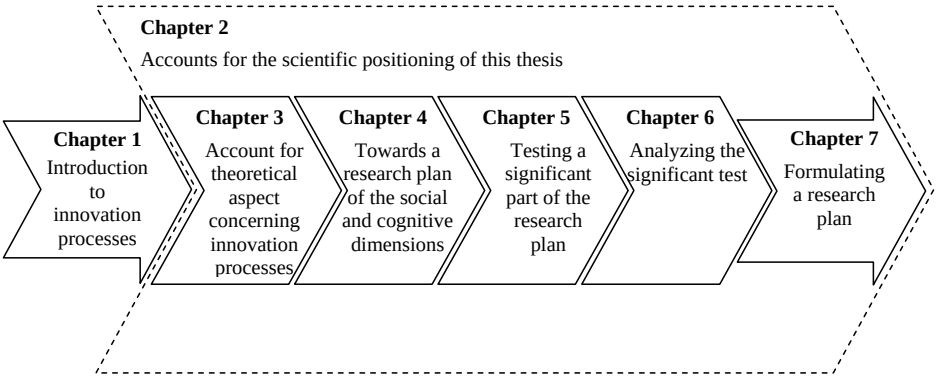

FIGURE 1 Disposition of forthcoming chapters

2 SCIENTIFIC POSITIONING AND THESIS REALIZATION

This chapter will address methodology, describing the scientific positioning of the ontological, epistemological, and methodological approaches in this thesis. Furthermore, the research design and realization of this study will be discussed. Practical aspects concerning these methods are explored in Chapter 4.

2.1 ONTOLOGICAL POSITIONING

The researcher's ontological and epistemological standpoint is in its essence fundamental assumptions about the construction of reality and knowledge. One way of describing ontological assumptions is with an objectively given reality as opposed to a subjective, actor-dependent point of view (Arbnor & Bjerke, 1994). A researcher taking an objective position bases their work on the assumption of a given reality, which may be described as independent of observing actors. A typical way of researching the innovation process based on an objective viewpoint is attempting to explain the activities involved in a best practice innovation process (e.g. Song & Montoya-Weiss, 1998; Cooper & Kleinschmidt, 1987). A researcher taking a subjective position, on the other hand, proceeds from the assumption that existing reality is based on multiple mental constructions that sometimes overlap among individuals. In this way, there will be multiple true realities; some are more well-developed and sophisticated than others. An example of research based on this assumption would be to create understanding of member's perspectives and viewpoints within an innovation process.

In accordance with Campbell (1988) and Bryman (2002), I do not see these as two solitary extremes but rather as dualistic, with the possibility to combine the two perspectives. In this sense, this thesis shares the ontological view that reality consists of both physical objects that may be described and explained in a fairly objective manner

but in the same time influenced and consisting of a highly subjective and individualistic phenomena. To further illustrate this ontological perspective, product innovations are viewed as physical objects possible to describe in a fairly objective manner. A handheld may be described as consisting of a screen, buttons and a certain material etc. In this way, each actor may give a subjective construction of the innovation that corresponds to other actors view in an objective manner and hence, the innovation may be described as an object that objectively consists of a structure and is affected by causal laws. On the other hand, the innovation may be seen as a highly subjective construction where different actors will give different descriptions about what the innovation may be used for and furthermore, these descriptions will vary in time and space. This subjective nature gives a richer description of ideas, beliefs, and knowledge, thus increasing the objective knowledge obtained through our senses. It is possible to give a fairly objective description based on a collective subjective understanding even though it is originally influenced and consisting of a highly

subjective construction. This view dissociates from naive positivism and the purest form of constructivism, even though having traits of both. In this sense, the ontological view in this thesis resembles critical realism (e.g. Campbell, 1988; Patomäki & Wight, 2000; Archer et al., 1998).

2.2 EPISTEMOLOGICAL CONSIDERATIONS OF INNOVATION

The ontology assumptions about the nature of reality affect the view of how to create knowledge and the knowledge in relation to the researcher. From a positivist ontological view, the researcher explains objective states or constitutes the fact of reality; in this way, knowledge is created by detecting statistical regularities that may explain relationships and facts of reality. In the constructivist view, reality is far too complex to understand; therefore, knowledge is achieved through increased understanding and interpretations of reality. The ontological view of critical realism characterizing this study combines these two perspectives to form an objective measurable reality and a subjective describable reality. Drawing from Kelly (1955/1991), physical objects and subjective thought are equally real, although they do not always correspond to each other in time and space. Weick (1979) illustrates this, asking "how can I know what I think until I see what I say?" The view of this thesis is that both a subjective and an objective reality exist, but they can be only imperfectly depicted. As such, knowledge may be created through a triangulation effort, combining subjective levels and objects with different ways of inquiring descriptions and data about reality (e.g. Campbell, 1988, Arbnor & Bjerke, 1994; Yin, 2003).

Implicit in the question of how knowledge is created is what defines true knowlege. What is true knowledge? Is it true if it corresponds with reality, describes the inner meaning of something, or is coherent with what is used in reality? In this thesis, the view of true knowledge is related to the correspondence between subjective statements and objective reality which partly may be explained and described but only imperfectly depicted since the subjective dimension cannot be perfectly explained and understood. On the other hand, the subjective meaning may be partly described through expressions but without a complete objective explanation. True knowledge may also be seen through its use; true knowledge arises when subjective frames of reference correspond to repeated similar holistic understandings (e.g. Alvesson & Sköldberg, 1994). However, the view of true knowledge is more closely related to the view of truth as participating individuals' subjective meaning in the sense of describing an individual's frame of reference and its corresponding meaning to a logical wholeness. This is due to differences in individual descriptions of the same objective innovation or innovation process to which they should correspond.

In research, there are two common ways of searching and argumenting for knowledge. One proceeds from the specific to the general (induction); the other, from the general to the specific (deduction). Since this thesis has its point of departure from an ontological standpoint of both objects possible to explain and understanding of

constructions, this implies a process of knowledge creation related to both induction and deduction. This alternate observation and theoretically driven knowledge creation is called abduction. However, the argumentation may be similar to deductive reasoning. In the context of this thesis, this implies a process in which knowledge of individual frames of reference in product innovation processes is created through a triangulation of methods with an alternately refined theoretical understanding.

2.3 METHODOLOGICAL CONSIDERATIONS CHARACTERIZING THIS THESIS

Methodology concerns "how to know" or attempts to investigate and thus gain knowledge about reality (Denzin & Lincoln, 1994; Burrell & Morgan, 1985). The way in which knowledge is gained is closely related to the researcher's ontological and epistemological view of reality. With a positivist ontology, a researcher attempts to create knowledge by explaining objective facts; in this situation, the human is seen as an instrument that responds to stimuli and thereby possible to read and gather information about certain actions, resulting in a best practice innovation process. In contrast, constructivist ontology is related to descriptions of complex individuals in order to understand how they create and describe the essence of the innovation process. This view increases the focus on specific individuals in the methods used to obtain knowledge. In this thesis, knowledge must be gained directly from the subject in order to describe their frame of reference, providing an in-depth understanding of the innovation process prior to any attempts to explain.

To understand the evolution of an individual's frame of reference during the innovation process, various methods may be used. However, since the focus is on frames of reference and therefore intrinsic thoughts within an individual, they cannot be objectively observed. The only way to gain such knowledge is by asking the individual. It is important to differentiate between explicit and implicit thoughts. Knowledge of explicit thoughts may be studied through documents or different forms of interviews with the help of text analysis. To depict implicit thoughts that constitute an individual's frame of reference, different forms of interviews may be used with the aim to get in depth of the individuals thoughts. In this thesis, the repertory grid technique will be used to illustrate the underlying frames of reference. In order to describe explicit modes of thought, two forms of social network analysis will be used.

From a philosophical standpoint, the repertory grid technique may be seen as a form of structured interview aimed to reveal an individual's frame of reference (for a practical description, see Section 4.1). This is made when an individual relates generated elements and constructs by grading them on a nine-point Likert scale. In this sense, the method tries to measure highly subjective elements by objectifying components in the individual's frame of reference. In the same way, social network analysis (see Section 4.2) and alter-ego network analysis (see Section 4.3) uses numbers to measure explicit thoughts by counting the number of times thought about an element or explicit thoughts in the form of contacts made to discuss a element with

someone else. From a philosophical standpoint, these methods seem to have an inherent congruity toward the critical realism paradigm.

2.4 RESEARCH DESIGN

The overall purpose of this study is to create a greater understanting of the social process of product innovation in terms of individual frames of reference, thoughts, actions, and interactions and display how the frames of reference of participating actors evolve during an innovation process. In this sense a deep understanding of involved individuals' frames of reference, thoughts, actions, and interaction within an innovation process is sought and derived from those individuals' while similarities among individuals will be explored based on a group level of analysis, but still with the view of similarities among separate individuals. According to Yin (2003), possible methods include experiments, surveys, archival analysis, history, and case studies. Since individuals' frames of reference are constantly produced and reproduced, history or archival analysis cannot be used, since it would be difficult to interpret in terms of present frames of reference. In view of the fact that this thesis seeks in-depth understanding, a survey would not provide enough insight for interpretation, although it could be used for capturing explicit thoughts and interactions. Since this study does not need to control behavioral events, experiments are seen as too extensive compared to the aim of this study. Instead, it may be useful to reflect actors' frames of reference, thoughts, actions and interactions within the natural environment of individuals in the product innovation process. In favore for a case study approach is the intention to describe all participating actors' frames of reference in an innovation process and the richness in aspects of an actor's frame of reference, thoughts, actions and interactions. The nature of understanding characterized by the research question, combined with the focus on the contemporary innovation process, makes a case study design most appropriate. A single case study will be conducted due to the critical need to make a significant test in order to both develop elements and test the possibility to use these elements in several techniques to depict frames of reference, thoughts, actions, and interactions (e.g. Yin, 2003).

2.5 LITERATURE REVIEW

The literature review was conducted from the EBSCO, (Academic Search Elite, Business Source Elite) Emerald, Science Direct, and Blackwell Synergy databases. To conduct a search, key words were identified (see Table 1) based on early scattered searches, suggestions from co-workers and supervisors. Single-, double-, triple-, and all word-searches were performed so that all possible combinations were considered. The selection among the hits where made based on perceived importance in title and abstract in relation to the purpose of this study. By reviewing references in the selected literature and suggestions from co-workers and supervisors, additional works were identified.

TABLE 1 Search words, their combinations, and number of hits

SINGLE SEARCH	Total hits
1) Innovation OR "Product development"	>10 000
2) Cognitive OR Scripts OR Schemas OR "Frame of reference"	>10 000
3) Team OR Project OR Collaboration	>10 000
4) Institution OR Structure OR Action	>10 000

DOUBLE SEARCH	Total hits
5) **1.** AND **2.**	431
6) **1.** AND **3.**	>10 000
7) **1.** AND **4.**	7447
8) **2.** AND **3.**	1882
9) **2.** AND **4.**	7569
10) **3.** AND **4.**	>10 000

TRIPLE SEARCH	Total hits
11) **1.** AND **2.** AND **3.**	60
12) **1.** AND **2.** AND **4.**	89
13) **1.** AND **3.** AND **4.**	797
14) **2.** AND **3.** AND **4.**	309
ALL WORDS-SEARCH	**Total hits**
15) **1.** AND **2.** AND **3.** AND **4.**	11

After selecting and reviewing the literature and discussions on seminars with valuable insights from colleagues, supervisors and other researchers, additional searches where conducted using the words "innovation process" and "structuration," in combination with the synonymous words for frame of reference used in the first search (Se nr 2 in Table 1). These additional searches were conducted in order to obtain knowledge about areas that were not included in the early searches. This rendered a small number of hits with few relevant articles. Some of these articles were also identified in the first search and thus not included as relevant.

After the significant test had been performed and analyzed, it implied a need to search based on identity, routines, and fuzzy front-end. Identity was selected later as a theoretical area to increase understanding of the relationship between frame of reference, thought, action, and interaction in the product innovation process. Searches on identity and routines were made in a selective manner in order to receive highly relevant articles; as such, the Science and Social Science Citation Index was used for these searches. The results were sorted based on the number of citations. In this way, articles where found which other have seen as relevant and if highly cited it also increases the possibility to find articles being influential within its area. Selection among these highly cited articles were based on a review of their abstract. Selected articles were used in additional searches for related records based on the criteria of using the same references. This resulted in handful relevant articles, which could be used for additional understanding about product innovation processes. In the late phase of this thesis, a third search was performed to further limit the area of product innovation processes into the early phase. This was a result of the experience collected during the significant test, which gave the search word, fuzzy front end. This gave a few relevant hits, even if the search was performed in all databases listed above.

3 CONCEPTUALIZING THE PRODUCT INNOVATION PROCESS

Frames of reference may be seen as a fundamental feature that both enables and constrains an individual's thoughts, actions, and interactions. This chapter will address the theoretical frame of reference in order to understand thought, action, and interaction in the product innovation process.

3.1 THE PRODUCT INNOVATION PROCESS

An early author to indirect describe innovation is Schumpeter (1994)[9] in his definition of production as new products or a new combination or use of resources. Contemporary authors, such as Dewar & Dutton (1986), define innovation "as an idea, practice, or material artifact perceived to be new by the relevant unit of adoption." Included indirectly in each of these definitions is a view of innovation as an outcome. However, this view of innovation does not differentiate the degree of perceived newness about the content embodied in the innovation. Dewar & Dutton (1986) evolve the definition to this fact and separate into radical and incremental innovations. In their view, similar to the definition by McDermott & O'Connor (2002), incremental innovations are characterized by minor improvements or simple adjustments in current products or processes, while radical innovations involve fundamental and revolutionary changes that represent a substantial departure from the existing practice (Dewar & Dutton, 1986; Chandy & Tellis 2000; cf. McDermott & O'Connor, 2002). In order to classify the degree of radical innovation different methods have been used. Dewar & Dutton (1986) describes a perspective based on the level of new knowledge embedded in the innovation. Based on this level, it is difficult to distinguish a point of transition on the continuum between incremental and radical innovation; in contrast, an alternate classification is based on the perceived level of risk (radical innovations are associated with higher levels). All of these definitions view innovation as a subjective phenomenon. Similarly, Van de Ven (1986) describes innovation as relative to a subjective perceived degree of newness about an innovation, even though others may perceive it as an imitation of something that exists elsewhere. This subjective feature is similar to a perspective of innovation described as a process of collective creation, which leads to the outcome of the innovation.

This thesis focuses on innovation without distinguishing between incremental and radical. Specifically, I will focus on the subjective innovation process regardless of whether the innovation afterwards is perceived or measured as incremental or radical. This choice is related to the focus on processes, which implies reliance on subjective appreciations and apprehensions, whether the innovation will end up as incremental or radical. Although some studies indicate differences between the activities performed in incremental and radical innovation processes (e.g. Koberg, Detienne, & Heppard, 2003), focusing on a cognitive, institutional, and structuration perspective reveals the

[9] I have used a book, which reprint collections of chapters from different books written by Schumpeter. This chapter was originally published in 1934.

thoughts, actions, interactions, and routines that lead to intended or unintended consequences and thus produce or reproduce the structures that govern the social setting. For example, Royston (1989) describes how innovation may depend on serendipity to a large degree. If it is luck, then a process with different degrees of unintended consequences is likely whether the innovation is incremental or radical. Nevertheless, it is likely that an innovation process that is characterized as more radical may face greater unintended consequences concerning the fundamental features of the product. However, this may not be the case when it comes to the actions being performed within the process, which may be performed as planed. Based on this discussion, I define the product innovation process as a social setting resulting in a product and emerging from participating individuals' frames of reference guiding their thoughts, actions, and interactions.

3.2 COGNITION IN THE PRODUCT INNOVATION PROCESS

In the introduction of this thesis, it is argued that an individual's ability to innovate may be based on differences or similarities in frames of reference guiding their thoughts and actions. This individual level is extracted to a group analysis that provides an understanding of the effects that these frames of reference may have on a group's ability to produce innovation. However, the theoretical area is complex in terms of abstraction, assumptions, and language use.

The first step is to understand the concept of frame of reference and its relationship to thought and action. Several terms are used to refer to frames of reference in the literature, such as cognitive structures, knowledge structures, schemas, and scripts, all referring to a similar concept (e.g. Walsh, 1995). According to Fiske and Taylor (1991), schemas concern individuals' "cognitive structures that represent knowledge about a concept or type of stimulus including, its attributes and the relations among the attributes." This definition focuses on the content of the frame of reference; other definitions also include individual use of frames of reference. Westenholz (1993) defines frame of reference as describing individuals' strategies in order to make sense out of situations in the form of representations, which Weick (1995) argues are formed through retrospective experiences when individuals try to make sense out of the situations that they encounter. Similarly, Walsh (1995) refers to a mental template that individuals impose on an information environment to give it form and meaning. In this way, individual knowledge structures order the information environment, enabling subsequent interpretation (thought) and action.

Thus, a frame of reference is related to a cognitive phenomenon representing a complex network of knowledge about an information setting. As individuals engage in a social setting, they use their frames of reference to make sense of that particular setting. These frames of reference guide the interpretation of the environment as well as the thoughts, actions, and interactions made within that environment. Harris (1994) emphasizes frame of reference as dynamic knowledge structures regarding specific concepts, entities, and events used by individuals to efficiently encode and represent

incoming information. These are typically conceptualized as subjective theories derived from one's experiences about how the world operates, which guides perception, memory, and inferences. The important extension in this definition is the explicit view of individuals' frames of reference as dynamic in nature (and thus continuously produced and reproduced in an information environment. This constant modification, however, results not only directly from experience but also indirectly through stories, myths, etc. As a result, self-induced reflection may result in a modified frame of reference (e.g. Walsh & Charalambides, 1990). Based on the discussion above, frames of reference are defined in this thesis as continuously altered mental templates that filter and order an information environment, subsequently guiding thought, action, and interaction.

This definition proceeds from the assumption that individuals are always filtering and interpreting information in the product innovation process based on their present frames of reference. However, it is likely that an individual's present frame of reference is meaningless in some encountered context, which entails the individual's response of action as guided by the context itself rather than as a frame of reference based on experience. Turning to one's frame of reference implies the use of a present frame of reference to understand a new or altering context (Nilsson, 1998), which cannot be fully understood through past and perhaps irrelevant experience. In both cases, this results in a modified frame of reference, which may later assist in guiding future thoughts and actions for use in that particular situation or in other contexts (Walsh, 1995). This reasoning resembles what Louis and Sutton (1991) call shifts in automatic and conscious modes of cognition. In the automatic mode, individuals use "habits of mind" to guide thoughts and actions; thus, present frames of reference are efficient to guide perception, interpretation, and responses in a familiar situation. However, Louis and Sutton argue that situations that both are new and perceived as new (and thus lack a present frame of reference) will cause the individual to switch to a conscious mode of cognition.

In the product innovation process, the automatic mode of cognition is represented when thought and action represent habitual patterns in the way of doing things. Walsh (1995) suggests that individuals approach the product innovation process based on their present frame of reference which guidies their thoughts and actions; thus affecting their ability "to attend to, encode, and make inferences about new information." In this sense, individuals use of automatic mode of cognition will, according to Walsh (1995), lead to increased problem solving ability, or in my terms, increased ability for coordinated action. However, Walsh also discusses several negative effects of individuals' use of present frames of reference that may affect the product innovation process. An individual's use of present knowledge structures may encourage stereotypic thinking, resulting in a lack in ability of new thoughts and actions towards innovation. In addition, individuals may fill gaps in their data with typical but perhaps inaccurate information, prompting one to ignore discrepant and possibly important information, discourage disconfirmation of the existing frame of reference, and inhibit creative problem-solving.

When applying the notion of individuals' frames of reference in the context of a product innovation process, all individuals procede from a frame of reference before forming a new idea and developing an innovation. Drawing on the arguments of Dougherty (1992), individual frames of reference reflect the style individuals organize their thinking and action about an innovation while function as barriers in terms of shared assumptions about reality, identifying relevant issues and helping people to make sense of those issues. Harris (1994) argues that individual frames of reference serves as mental maps that enable individuals to traverse and orient themselves within their experiential terrain as well as guide interpretations of the past, present, and future. Individual frames of reference become similar due to shared experiences and shared exposure to social cues regarding others' constructions of reality. Since frames of reference are summaries of experiential knowledge, sharing experiential space and time as well as the challenge posed by communicating, interacting, and solving common problems facilitate and encourage the development of similar frames of reference.

By extracting the effects of individual frames of reference through group level of analysis, it seems reasonable that individuals sharing the same experience develop homogeneity in their frames of reference, which both enables and inhibits thought and action toward a product innovation. Boland and Tenkasi (1995) emphasize that effective innovation necessitates both perspective making and perspective taking. As such, a group of individuals engaging in a product innovation process must develop their frames of reference in order to strengthen their knowledge domain and practices and recieve (and understand) the perspective of others in order to modify their present frame of reference. When the group comes together, some aspects of individual frames of reference will overlap, and some will not. A shared frame of reference emerges from shared experience and a social process characterized by negotiation and argumentation as well as by a host of unarticulated internal and external triggers for change (Langfield-Smith, 1992). Over time, when the group has formed an enough overlapping or shared frames of reference, it is possible for the group to take unified action (Fiol, 1994). Based on this, it seems reasonable that homogeneity in terms of overlapping or shared frames of reference will increase the group's ability to take action toward an innovation. However, group homogeneity in frames of reference may inhibit new ideas and creative problem-solving (Walsh, 1995). This resembles what Janis (1972) call groupthink. Similarly, Stubbart and Ramaprasad (1990) stress how the strength of individual present frames of reference increases with repeated practice, which entails increased inflexibility, lack of reflection, and reduced perceptive ability within the situation.

If homogeneity in individual frames of reference inhibits new ideas and creative problem-solving, then logically this would mean that heterogeneity in individual frames of reference is a desirable state. In Van de Ven's (1986) view, individuals engaging in a social process express a single innovative idea that evolves into multiple ideas as a result of the participants' diverse frames of reference. At the individual level,

this resembles Harris's (1994) view of how present frames of reference guide perception of and inferences about the information setting encountered. Nevertheless, frames of reference that are too heterogeneous and do not overlap result in a lack of understanding and thus an incapability to form ideas or guide action toward product innovations. Thus, it seems reasonable that a group engaging in a product innovation process must balance the need for homogeneity and heterogeneity in their frames of reference.

3.3 PRODUCT INNOVATION PROCESSES AND INDIVIDUAL IDENTITY

Identity is a concept used in multiple levels of abstraction, such as individual-, group-, and, organizational identity (Whetten, 2006), conceptualized with diverging definitions. In addition, authors use different distinctions on the same concept as well as similar definitions of different concepts, which make identity a complex idea to comprehend (Jussim, Ashmore & Wilder, 2001). For example, it is difficult to distinguish between identity, self-identity, and social identity. One aspect of identity must address the question of "who am I", since identity through action and interaction with significant others is incorporated into the self-concept (Scott, 1997). As such, the image, and expectations of associated behaviors become an important dimension of the self-concept (Charng, Piliavin, & Callero, 1988). An important distinction is an individual's use of several identities. Smith-Lovin (2002) describes how a connection to five alters (a wife, a son, an employer, and two co-workers) generates four identities (husband, father, employee, and co-worker) in which each relationship occupies a social position and an associated role (Scott, 1997). In the context of a product innovation team, this implies that individuals ascribe and play certain identities such as project manager and technical developer.

According to Charng, Piliavin, and Callero (1988), variations in identity depend on the extent to which an identity internalizes as part of the self. Rousseau (1998) discusses similarly but in terms of situated identification, only persisting as the situational cues persists, and deep structure identification, which incorporates identity into the self-concept, as parts of an individual's social identity. Other authors (Meyer, Becker, & van Dick, 2006; Patriotta, Francesco, & Lanzara, 2006) state that individuals produce identities socially in discourse. Similarly, Willmott, (1996) argues that "identity dependent upon the reproduction of discourses and practices that affirm its reality … by embodied beings whose sense of identity is either confirmed or denied through processes of accountability." Thus, individual identity is a collective notion of social exchange with significant others in constant production and reproduction of a currently used identity.

Although identities evolve in social exchange through produced and reproduced action and interaction, the very nature of identity is assumed otherwise. Giddens (1991) states that the nature of individuals is "not to be found in behaviour, nor – important though this is – in the reaction of others, but in the capacity to keep a particular narrative going" (p.54). When Rousseau (1998) elaborate deep structure

identification she refers to "cognitive schema formed in work settings across roles, over time, and across situations that leads to congruence between self-work and one's broader self concept" (p. 218). Based on this, it is important to note that identity refers to a cognitive state in relation to significant others and not behavior, even though it may influence behavior in terms of action and interaction (ibid).

How individual identity affects behavior in terms of action and interaction carried out in product innovation processes is a central aspect of this thesis. Since identity forms socially with reference to membership in different social categories (Meyer, Becker, & van Dick, 2006), it is hardly astonishing when found related to in-group favoritism (Schneider & Northcraft, 1999). Meyer, Becker & van Dick (2006) also presents other important implications such as behavioral involvement, intra- and inter-group relations, and stereotyping, all of which may have implications in the product innovation process. In-group favouritism implies showing favour or partiality to the individuals participating in the product innovation team or neglect of others with equal or superior claims outside the group. By such action, valuable input of others in ongoing production and reproduction of institutional traits may be neglected without reason. In concrete terms, it could be feedback from an individual outside the group, which would have altered some aspect of the innovation process if accounted by, for example the project manager.

Stereotyping implies a fixed nature, which may be described as the opposite of innovation. Smith-Lovin (2002) gives valuable insight on the effects of stereotyping in product innovation processes. According to her, individuals participating in social production and reproduction of action and interaction draw on their frame of reference to define situations and interpret experiences. The more deeply structured identity, the more likely a situation will be defined using that identity's institutional framework and the behaviors associated with it. Thus, individuals in a product innovation process associate with a particular deep structured identity that guides their thoughts and actions in the ongoing moments of action and interaction. As such, it is highly likely that an individual who ascribe to different identities within a product innovation process will lead to differences in thoughts and actions. That is, an individual who includes project manager in his or her self-concept has certain expectations of action (for instance, greater financial responsibility) within the context of the product innovation process. Similarly, would a technical developer ascribe certain technical functions more importance than the project manager. Therefore, thought and action in product innovation processes cannot be discussed without notice taken to the identity ascribed by each individual.

3.4 Institutions and institutionalization in thought and action

A study by Dougherty (1992) concludes that different departments within an organization give different meanings to the term "market-orientation," which is considered important for innovation (Brown & Eisenhardt, 1995; Ernst, 2002). Based

on these findings, it seems reasonable that these meanings influence the product innovation process. According to Hardy, Lawrence, and Grant (2005), a group must have common constructions for effective collaboration. In this thesis, it is argued that both similarity and dissimilarity is needed for effective product innovation processes. The meanings or structures that individuals construct while participating in a product innovation process may be seen as an effect of institutionalization. Two central considerations are essential for understanding this influence on the innovation process: the fundamental features of an institution and how institutions are (re)produced. These two concepts are closely intertwined since the fundamental features of an institution are altered in the production and reproduction of institutions.

3.4.1 Fundamental features of institutions

To define the institution, various authors (Giddens, 1979; Scott, 1995; Barley & Tolbert, 1997; Burns & Scapens, 2000; Phillips, Lawrence, & Hardy, 2000) draw on definitions with similar nuances on fundamental features of institutions. Scott (1995) defines the institution as consisting "of cognitive, normative, and regulative structures and activities that provide stability and meaning to social behavior... transported by various carriers – cultures, structures, and routines." Phillips, Lawrence, and Hardy (2000) refer to institutions as taken-for-granted patterns of organizing that shape and constrain the behavior of societal members. Burns and Scapens (2000) define institutions as "a way of thought or action of some prevalence and permanence, which is embedded in the habits of a group or the customs of a people." In this aspect, Burns and Scapens stress that "institutions can be regarded as imposing form and social coherence upon human activity, through the production and reproduction of settled habits of thought and action."

Some aspects of these definitions appear to be central to understanding institutions. An institution is not related to an objective phenomenon; it has a subjective nature that is deeply rooted in the individual enclosed in the institutional context. Although the individual is central, it is not a solitary unit of institutions. Most definitions include social behavior, societal members, habits of a group, or customs of a people; however, the institution is also related to ongoing moments of interaction within an individual or among groups of individuals (Phillips, Lawrence, & Hardy, 2004). In these ongoing moments of interaction, the institution may work as a filter for individual perception and giving guidelines for social acceptance in the form of stabilized human activity. All authors mention this stabilizing feature of institutions in their definitions; or in their own words, "provide stability and meaning", "shape and constrain the behaviour", and "imposing form and social coherence" on individual's or group meanings, actions, and interactions.

According to Giddens (1979), another effect on individuals is the institution's enabling ability. While providing constraning stability, institutions also enable unified action. In the sense, institutions give meaning to the individuals enclosed in the institutional context by enabling action, even though it may seem like constrained thought and action for an outsider. In the product innovation process, participating individuals

bring their existing institutions into the process, continuously producing and reproducing these enabling and constraining structures through ongoing moments of interaction. According to Scott (1995), these structures will be embodied in the form of cognitive, normative, and regulative structures, which are all equally important.

A final fundamental feature of institutions is the condition of constant change in enabling and constraining structures. Following the thoughts of Giddens (1979), the duality in constant change of institutions concerns the fundamental features of enabling and constraining structures. Since these structures affect the individual, they will be a part of the individual's ongoing moments of interaction; thus, individuals both shape and are being shaped by institutions. In this sense, the institution is impermanent, as individualized structures both enable and constrain individualized thoughts and actions.

3.4.2 Institutionalization in thought and action

The process by which institutions are produced and reproduced is generally called institutionalization. DiMaggio and Powell (1983) ask why institutions are so similar on the macro level, but this thesis will focus on micro processes within each institution in order to understand why individuals are guided in a similar manner. Perhaps the most influential researcher in the area of institutionalization is Giddens. According to Giddens's (1979) structuration theory, the product innovation process can be seen as a system of social interaction between individuals in regularized relations of interdependence in time and space. Present product innovation processes constantly guide future processes through the structural properties that are institutionalized as codes for participating individuals' actions. These structures are also a part of human agency (see Figure 2), since the actions of individuals within the social system are based on the same structures that form the social system. Thus, social systems and human action, in other words institutionalized product innovation processes are produced and reproduced in structural properties (e.g. Macintosh, 1994).

According to Macintosh (1994), structures are the implicit codes or templates that guide individual action in social settings. These structures can change either gradually or radically. Although independent of human agency, they are available for individuals during social interaction in product innovation processes and are (re)produced by the individuals in the ongoing moments of interaction (Giddens, 1979). In social settings, individual action is not completely determined by these structures; as Barley and Tolbert (1997) point out, "institutions set bounds on rationality by restricting the opportunities and alternatives we perceive and, thereby, increase the probability of certain types of behaviour." Thus, institutions are altered by conscious or unconscious changes in an individual's behavior. However, this does not mean that all individuals are alike. It just implies that humans tend to take similar action in social settings based on structures. In this sense, individuals will never express identical thoughts within their frames of reference although their structured actions may be similar (Boland 1993, 1996; Scapens & Macintosh, 1996).

As shown in Figure 2, individuals receive intended and unintended consequences (through their actions and interactions) that produce and reproduce social structures, which mediate future actions and interactions through structures of signification, legitimation, and domination (Giddens 1979; Macintosh, 1994). In daily social situations in a product innovation process, the institution is reproduced through the duality of structure, both of which are manifested in habits of thought, action, and interaction. However, new structures may be formed if the individual receives unintended consequences or through a conscious choice of altered action and interaction. This is based on the fundamental assumption of structuration theory: an individual can make conscious and deliberated choices in actions and interactions. Nevertheless, these deliberate choices are affected by internal processes due to different levels of consciousness and an individual's psychological makeup (Giddens, 1979).

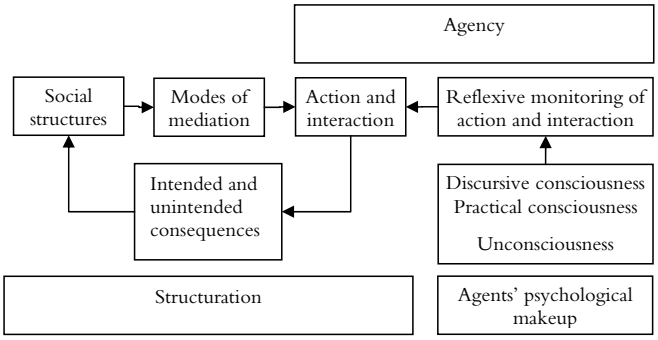

FIGURE 2 Logic within the process of structuration
Source: Macintosh, (1994)

While Giddens (1979) and Barley and Tolbert (1997) emphasize human action, Burns and Scapens (2000) also emphasize individual thought in the process of institutionalization. To refer to their definition, an institution "impos[es] form and social coherence upon human activity, through the production and reproduction of settled habits of thought and action" (ibid). These settled habits of thought and action are institutionalized through routinization of human activity. Thus, institutionalized individuals share taken-for-granted assumptions within their frames of reference that shape their actions (ibid). Giddens (1979) includes thought as part of the modalities of structures. While Giddens discusses different modalities for structural properties, Barley and Tolbert (1997) use the simplification of scripts defined as observable, recurrent activities and patterns of interaction. In the terms of Burns and Scapens, individuals draw on routines and rules as the structural modality between agency and structure.

According to Burns and Scapens (2000), the institutionalization process is a continuous flow of action and interaction between individuals that draws on rules and routines in production and reproduction of the realms of thought and action. By this, the duality between institutions and human agency becomes more implicit than as suggested by Giddens (1979) and Barley and Tolbert (1997). Another perspective on structural

properties, is to view individual action as institutionalized through discourses (Phillips, Lawrence & Hardy, 2004). A discourse "…*'rules* in' certain ways of talking about a topic, defining an acceptable and intelligible way to talk, write or conduct oneself and also 'rules out' limits and restricts other ways of talking, of constructing ourselves in relation to the topic or constructing knowledge about it. They go on to define discourse as "structured collections of meaningful texts…not just to written transcriptions but to any kind of symbolic expression requiring a physical medium and permitting of permanent storage." They argue that these discourses may take various forms such as written documents, verbal reports, pictures and symbols. Focusing on this approach, only explicit discourses will be analyzed; thus, Giddens's (1979) cognitive structural property of signification mediated by interpretive schemes will be implicit.

Giddens (1979) analyze individual participation in a social setting through the structural dimensions of signification, legitimation, and domination (see Figure 3). These dimensions are inseparable in the ongoing moments of action and interaction. The structural property of signification is related to the abstract cognitive dimension of social life through which agents communicate and understand each other. Signification involves scripts, cognitive schemes, and other abstract structures organized as a web of semantic codes guiding individual interpretations and discursive practices. In the ongoing moments of interaction, individuals draw on these signification structures through their frames of reference, which embody knowledge, skills, and rules for communication and discourse in order to make sense in social settings (Giddens, 1979; Macintosh, 1994). An individual's frame of reference is also used for interpreting action and interaction. Thus, each individual frame of reference is used for mediating an individual's own use of signification structures in social settings as well as for interpreting signification structures used by other participants.

While signification structures concern individual frames of reference when communicating in language and texts, structures of legitimation involve moral constitution while participating in a particular social setting. These legitimation structures take the form of normative rules and moral obligations, guiding thought and action in a social setting. Macintosh (1994) states that these norms "constitute the shared set of values and ideals about what is regarded as virtue, what is to count as important, and what ought to happen in social settings" as well as what is considered immoral, trivialized, and should not happen. Individuals participating in the ongoing moments of action and interaction about a product innovation will draw on these legitimation structures to follow norms; at the same time, these norms guide and reproduce the same legitimation structures. Individuals sanction their own behavior by complying to norms (ibid). However, these norms are not universal in terms of complete obedience but rather a question of compliance. This implies that individuals do not necessarily have complete commitment to norms as in diverging thoughts and complying action. According to Macintosh (1994), this moral undercarriage inculcates values into the individuals' frames of reference and thereby ensures a fit within the group. Against this view, Boland (1996) argues strongly by implying each individual's

distinctive character in terms of dissimilarities. By this, the meaning is that the collective structures in mind will never be the same as the structures within an individual. Thus, it may be argued that inculcating values over time results in an increased similarity in structures but not an exact match (cf. Macintosh, 1994).

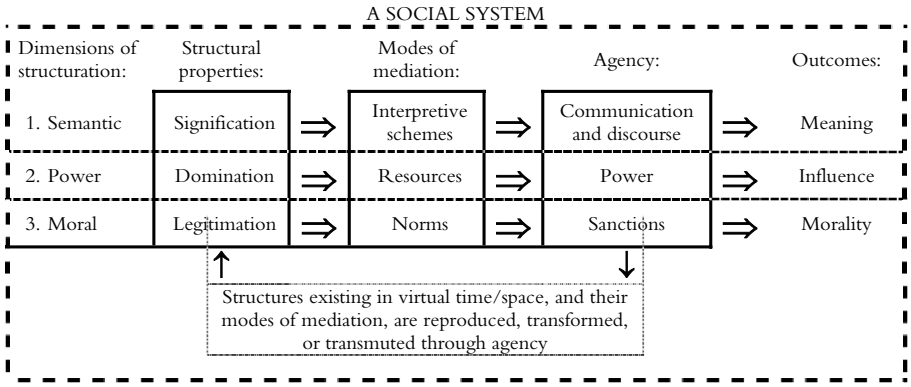

FIGURE 3 Structural properties of relationships to modalities
Source: Macintosh, (1994)

In some situations, individuals draw on structures of signification to communicate the meaning of something in order to make other individuals morally accountable (structures of legitimation) and to subsequently guide others action in a product innovation process. However, in some situations, these structures are not enough; the individual may also draw on the structures of domination, by use of power, to achieve innovation. For example, an individual acts or interacts by commanding authority within the social setting (e.g. Giddens, 1979). This power may also be implicit, making it possible to interpret based on experience (ibid). This influence may work by constraining individuals from a certain task and thus gain their cooperation in some other area of interest or by liberating individuals from moral obstacles within the product innovation process.

An important aspect in the formation of settled habits of thought and action is routinization. In a routine, individuals obtain recognizable action and interaction across time and space (Giddens, 1979). In routine situations, human action is continuously repeated day after day with no need to consciously think about or negotiate new social codes; in other words, individuals are institutionalized with commonly agreed upon social codes of conduct reproduced in action and interaction. According to Zilber (2002), institutionalized individuals "perceive, enact and further reinforce these habituated behaviours and their shared meanings." In this sense, institutionalized individuals have similar frames of reference. Thus, a change in the institution will change these frames of reference concerning ascribed meaning to the social setting.

To summarize, individuals in a product innovation process both produce and reproduce institutions in the form of settled habits of thought, action, and interaction. At the individual level, thoughts and actions are guided by individual frames of reference, which restrict perceived alternatives thereby increasing the probability of certain types of thought and actions. In this sense, institutions only exist within frames of reference based on structural properties that guide individual action and interaction within a social setting. In actions and interactions throughout time and space, individuals produce and reproduce institutions as patterns of structures within individual frames of reference, guiding settled habits of thought, action, and interaction. In this sense, individuals in a social setting are constantly exchanging knowledge, experience, etc. by incorporating structures in terms of signification, legitimation, and domination. Through this constant exchange of action and interaction, common meanings arise that allow individuals to make sense of actions and interactions (cf. Ifvarsson, 2003). Thus, similarities within individual frames of reference will evolve.

3.5 INDIVIDUAL FRAMES OF REFERENCE IN TERMS OF CONTENT AND STRENGTH

In the sections above, individual frames of reference in relation to institutionalization have been discussed in order to account for the process in which similarities in frames of reference occur. However, to further theorize the cognitive dimensions in product innovation processes, it is important to distinguish between content and strength. According to Flynn and Chatman (2004), strong culture (interpreted as homogeneity) may limit individual creativity and direct individuals to more relevant and better ideas. This depends on the content of the institutional rules, routines, and norms affecting individual frames of reference before and during the product innovation process. If these institutional structures in terms of content correspond to innovative action, this implies positive effects if a high degree of group homogeneity exists. I will draw on content and strength in relation to individuals' frames of reference in the following sections.

3.5.1 The innovation process in terms of content

On a collective level, individual thoughts and actions are guided by institutional structures, which are constantly produced and reproduced in the ongoing moments of action and interaction in the innovation process. How this affects the ability to create product innovations depends on the content of the institutional structures and individual frames of reference guiding their thoughts and actions. Several factors (see Table 3) affecting innovativeness have been identified that may be seen as institutional content in rules, routines, norms, and values. Some studies (e.g. Takeuchi & Nonaka, 1986; Nonaka, 1991; Adler, Goldotas, & Levine, 1999) identify content in terms of broadly defined institutional structures related to innovativeness, while others (cf. Madhavan & Grover, 1998) make the connection to concrete action. A common feature of institutional content is structures promoting change in which participants expect initiative, creativity, and risk-taking (Jassawalla & Sashittal, 2002). Other

research focuses on the relationship between individuals as in tolerance for perspectives of others (Madhavan & Grovers, 1998).

The *Harvard Business Essentials* series (2003) presents paradoxical characteristics of innovative groups. The first concern innovating teams need of both experience and a beginner's mind to balance perspectives. The second concerns the need to balance discipline with freedom in order to align company strategy and how it will be achieved. The third concerns the need to balance professionalism with playfulness to provide situations (time and space) possible for innovative playfulness and the final fourth paradoxical characteristic is the need to balance planning with improvisation by flexibility in plans. This resembles the view of Brown & Eisenhardt (1998) of balancing on the edge between structure and chaos.

TABLE 3 Institutional content and action related to innovativeness

Study	Institutional content	In action	Related to
Takeuchi & Nonaka (1986)	• Built-in instability • Self-organizing project teams • Overlapping development phases • Multi-learning • Subtle control • Organizational transfer of learning	⇒	Success
Nonaka (1991)	• Broadly defined vision	⇒	Success
Madhavan & Grover (1998)	• Tolerance for perspectives of others • Maintenance of innovative structures	⇒ Appoint new teams with successful past team members ⇒ Mentor past successful teams ⇒ Do not change the entire team simultaneously	Success
Brown & Eisenhardt (1998)	• Rule-breaking culture • Loose structure • Random communication • Rule-following culture • Rigid structure • Channeled communication	⇒ Lack of discipline ⇒ Unclear responsibilities and vague priorities ⇒ Randomized communication in amount and content ⇒ Follow the rules ⇒ Detailed description of processes, procedures, and plans	Failure
Adler, Goldotas, & Levine (1999)	• Meta-routines	⇒	Success
Jassawalla & Sashittal (2002)	• Initiative, creativity, and risk-taking are expected • Trust in all participants' equal capability • All participants are involved early • Change is embraced	⇒ Involvement ⇒ High level of creative collaborative action ⇒ Willingness for feedback	Success
The Harvard Business Essentials series (2003)	Balancing: • Beginner's mind vs. Experience • Freedom vs. Discipline • Playfulness vs. Professionalism • Improvisation vs. Planning	⇒ Bring outsiders in the group ⇒ Demand alignment and give latitude ⇒ Professional conduct with time and space for play ⇒ Plan carefully but remain flexible	Success/Failure
Van der Panne, Van Beers, &	• Explicit recognition of the collective nature of innovation	⇒ Learn by doing	Success

Kleinknecht (2003)	• Prior experience • Use of multidisciplinary skills • Clearly articulated innovation strategy • Compatibility to core competences • Timing		
Ernst (2002)	• Systematic scheme for suggesting new products • Innovation-friendly climate • Risk-taking behavior • Commitment • Product champion	⇒ Active idea search ⇒ Allow free time for creative informal projects ⇒ Provide resources to informal projects ⇒ Encourage diverse experiences	Success
Eisenhardt & Tabrizy (1995)	• Multifunctional teams • Iterations • Testing • Milestones • Powerful leaders	⇒ Use experiential and improvisational tactics ⇒ Allows for multiple iterations ⇒ Features a hands-on approach	Fast development

A fundamental issue in respect to institutional content is its relation to individual frames of reference and therefore thought, action, and interaction. One way to illustrate this relation between level of content in individuals' frames of reference and individual's actions is by a funnel analogy (Figure 4). The (a) axis of the funnel describes different semantic levels of content in institutional structures. The word "semantic" refers to the meaning or signification in both explicit and implicit content of institutional structures. The level of content also refers to a broader content in terms of its degree of preciseness (b). In the upper end of the funnel (a), broadly defined content (b) in terms of visions is compressed into precise instructions at a low level of content. Takeuchi and Nonaka (1986) cite instructions of the Honda City project team as "the kind of car that the youth segment would like to drive." It is not, in this case, expressed whether the institutional structure are in the form of a rule, routine or norm but it is an explicit expression of a high level of content. A low level of content

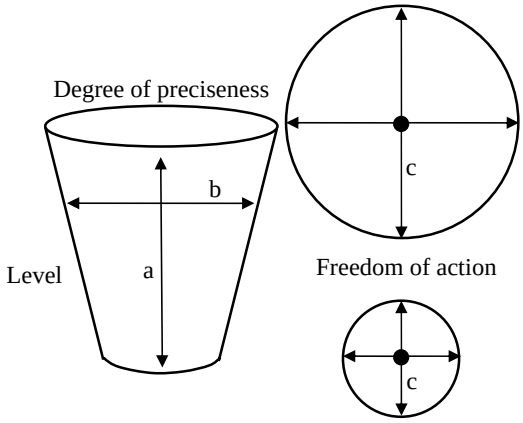

FIGURE 4 Visualizing the content effect on action

implies detailed instructions and specifications of the task, namely a specification of features that the car would have. In this way, the institutional structure sets wide boundaries, which gives the participating individuals great freedom of action (c). By setting the institutional norm at a high level of content it widens the group freedom of action, allowing them to create innovative solutions. As such, the institutional content sets broadly defined boundaries of acceptable and unacceptable ways of thought and action, which may improve the innovation climate. In the case of Thomas Edison, he gave the following description about the innovation: "I am experimenting upon an instrument which does for the Eye what the phonograph does for the Ear" (as cited in Carlson & Gorman, 1990). By giving these instructions, Edison acted on a high level of content with a broad degree of preciseness, which gave his assistant great freedom of action in fulfilling this vision of the kinetoscope. The examples correspond to a vision made by managers, but the principle is the same for any other content included in the ongoing moments of action and interaction produced or reproduced in the institution. A rule, routine, or norm with a content of tolerance for other perspectives (Madhavan & Grover, 1998) is at a high level with a broad degree of preciseness, which gives participating individuals great freedom of action within the framework of the content. As Jassawalla & Sashittal (2002) state, companies with a highly efficient and effective innovation process have beliefs and values that favor collaboration, creativity, and risk-taking deeply embedded and readily apparent in individual actions, which is related to freedom of action.

To summarize, the fundamentals of content are related to producing and reproducing structures, which allows for a high degree of freedom in action and interaction. Table 3 exemplifies what others have found related to successful product innovation processes and thus content of structures related to innovation; examples of concrete action related to successful innovation are also included. An institution must be reflected in the thoughts, actions, and interactions made by participating individuals. To emphasize the view of content, Cooper, Edgett, and Kleinschmidt (2004) conclude that some elements of the innovation climate are the strongest discriminators between best and worst performers of innovation. Thus, the content of the climate (the structures of thought, action, and interaction) have a profound effect on the product innovation process.

3.5.2 The innovation process in terms of strength

The discussion above has shown how different content in institutional structures can promote or restrain an innovation climate. As some rules, routines, or norms may promote a group of individuals while other institutional structures may restrain the group's innovativeness. Flynn and Chatman (2004) implicitly discusse strength as a strong, cohesive culture. Two fundamental questions in respect to strength are what and how? What is related to content, discussed in previous section, while how is related to the degree of correspondence in individuals' frames of reference and thus homogeneity or heterogeneity within individuals frames of reference. However, strength is always related to content, since homogeneity or heterogeneity in its essence is similarity or dissimilarity to content.

Individuals draw on their frame of reference in order to perceive, interpret, and give meaning to a social environment (Walsh, 1995). Thus, group homogeneity arises from shared experience. Homogeneity is often presumed to hamper a group's innovativeness; however, let us assume a large homogeneity in which individuals have a high degree of similarity in their frames of reference regarding an institutional structure. In addition, let us assume that the institutional structure in this case is a norm with the content "tolerate dissimilarity" (cf. Madhavan & Grover, 1998). This creates an interesting paradox: high homogeneity, in theory, hampers an individual's ability to innovate, but at the same time, this homogeneity involves content perceived to promote innovation. Consequently, homogeneity and heterogeneity effects on a group's ability to innovate must be seen on different levels. The level restraining innovation is related to homogeneity in individuals' knowledge base, or shared experience in the field of expertise; this resembles the work of Eisenhardt and Tabrizys (1995), who found that the institutional content of multifunctional teams are related to success. Thus, a logical explanation in relation to strength is the need of heterogeneity in terms of knowledgebase. The other level corresponds to institutional structures guiding ongoing moments of action and interaction through the structuration process. These two levels are however interrelated since they both are drawn upon when enacting with the social environment constituting the innovation process. Hargadon and Fanelli (2002) argue similar, that participating individuals come to hold (relatively) aligned interpretations, goals, and identities, because they tend to be surrounded by their own actions.

However, both levels have different effects on the product innovation process. Expertise is one component of creativity, which implies that homogeneity within an individual's knowledge base might inhibit a group's creative potential (Amabile, 1998). In contrast, heterogeneity in a knowledge base is a prerequisite but not sufficient condition for innovative ideas to arise. This leads to homogeneity in the second level of institutional structures, guiding the ongoing moments of interaction as dependent on the content. If the content is positively related to innovation with a high degree of homogeneity, this implies that all participating individuals are guided by positive content, which therefore increases group innovativeness. Homogeneity in tolerance for other perspectives (Madhavan & Grover, 1998), favors internal and external communication (Brown & Eisenhardt, 1995), initiative, creativity, and risk-taking (Jassawalla & Sashittal, 2002), contributing to a social setting in which individuals may obtain a heterogenic knowledge base.

Hargadon and Fanelli (2002) discuss how repetitive interaction generates alignment between what people believe is possible and the confirmation of these beliefs in the actions of others. As such, organizations may avoid this homogeneity by variations in experience and thus in knowledge base. Heterogeneity within an individual's frame of reference in terms of knowledge base relates to the creative potential of the group, while homogeneity within an individual's frame of reference in terms of institutional structures harnesses this creative potential through action and interaction. Therefore,

individuals participating in an innovation process will have both homogeneity and heterogeneity depending on the content in focus. Nevertheless, common experience through action and interaction will contribute to the formation of homogeneity independent of content. In relation to the structuration process, common experience through action and interaction will generate homogeneity through similarities in the structures governing the social situation and in knowledge base. This homogeneity may either promote or inhibit innovation depending on the level of content in these structures.

3.6 THE DYNAMIC UNFOLDING OF PRODUCT INNOVATION PROCESSES

Extensive research using statistical methods has identified activities related to the success and failure of the innovation process. In addition, a number of reviews of studies have been performed in the field (e.g. Brown & Eisenhardt, 1995; Ernst, 2002; van der Panne, van Beers, & Kleinknecht, 2003). Brown and Eisenhardt (1995) developed a model of factors related to process success as opposed to financial performance. This implies that a successful process will not necessarily result in financial performance. According to them, one factor affecting performance is experience related to action, characterized by extensive testing and frequent iterations of product designs combined with frequent milestones (i.e. short time span). Other authors (Zirger & Maidique, 1990; Cooper & Kleinschmidt, 1987, 1988) have addressed this by suggesting concrete activities related to success on different levels of abstraction. A fundamental assumption in these activity models is a view of the innovation process as a linear rational plan (Engwall, 2003; Brown & Eisenhardt, 1995) in which an idea is sequentially are developed in stages into a commercial product. Trott (2005) presents eight sequences, while others like Fairlie-Clarke and Muller (2003) present a detailed model of eighteen activities, all further developed into concrete actions.

Cunha and Gomes (2003) discuss how order in structural models is achieved by rationalizing work processes, introducing the concept of operating routines. These routines may be described as patterns in action and interaction which simplify the work to be done in the innovation process. Engwall (2003) states that the innovation process does not evolve in this sequential system of order but rather is unstructured, iterative, and thus not fully predictable in action and interaction through standardization. Planning and standardizing the innovation process requires experience of a situation identified as similar and thus, the individual tries to reproduce the structures by drawing on the experience and structures governing the innovation process as performed in the past.

However, Cunha and Gomes (2003) describe an improvisational model of innovation with temporal convergence in meetings with planning and execution. In this case, the process is based on minimal technical and social structures guiding the team by clear roles, no-exception milestones, and action by experimentation. The team is allowed to work autonomously within the limits prescribed by a simple and well-defined set of

rules. This resembles what Brown & Eisenhardt (1995) refer to as experiential tactics with frequent iterations, extensive testing, and a short time between milestones suitable for uncertain situations, which often surround a product innovation process. Eisenhardt & Tabrizi (1995) articulates this act of balance as "fast product development emerges as more uncertain than predictable, more experiential than planed, and more iterative than linear."

One important reflection is that it is not a question of whether to perform the identified factors related to success in a linear manner but rather how to use them within the product innovation process. After pointing this out, I will address a linear perspective in order to describe how individuals frames of reference, thought, action and interaction evolves within a product innovation process. In Table 4, a simplified model of an innovation process is presented as containing three distinguished phases. Based on a categorization of activity models in literature the early phase may be characterized as an idea phase, the mid phase as a working phase and the late phase as a market phase. During these phases, individual frames of references should change but in different ways depending on the content under investigation. Next, I will discuss how the product innovation process evolves in terms of social and cognitive aspects.

TABLE 4 A simplified model of the innovation process

	Early phase	**Mid phase**	**Late phase**
Feldman & Page (1984)	• Exploration • Screening • Concept testing • Business analysis	• Development	• Market testing
Cooper & Kleinschmidt (1988)	• Initial screening • Preliminary market assessment • Preliminary technical assessment • Detailed market study • Predevelopment business / financial analysis	• Product development • In-house product tests • Customer tests of product	• Trial sell • Trial production • Pre-commercialization business analysis • Production start-up • Market launch
Song & Montoya-Weiss (1998)	• Strategic planning • Idea development and screening • Business & market opportunity analysis	• Technical development • Product testing	• Product commercialization
Van de Ven et al. (1999)	• Extended gestation period • Initiating innovation • Planning	• Development • Rework due to setbacks and mistakes • Change in criteria of success and failure. • Fluid participation • Investor and top manager intervention • Relationship development • Create industry or community infrastructure	• Linking and integrating • Ending when success or failure

Cooper, Edgett, & Kleinschmidt (2002)	• Ideas • Initial screen • Preliminary analysis • Second screen • Business case • Decision on business case	• Development • Post-development review	• Pilot • Decision to launch • Launch and implementation • Post-launch review
Fairlie-Clarke & Muller (2003)	• Identify product opportunity • Generate product proposals • Evaluate and approve product proposals • Identify requirements and generate PDS • Develop product business plans • Generate project proposals • Evaluate and approve project proposals	• Fund and schedule projects • Monitor projects • Design product • Specify supply processes	• Develop new supply resources • Evaluate and approve supply development • Technical validation • Commercial validation • Develop product support • Release products into product range • Execute product launch

3.6.1 A model of unfolding social and cognitive dimensions in product innovation processes

Figure 5 presents a model containing the central concepts presented in this thesis and serves as a tool to understand and capture the social processes involved in product innovation. The model is three dimensional and should be interpreted as two circles (one in relation to the self and one in relation to significant others) both passing through the individual's frame of reference (A) and intertwined in individual action and interaction. This implies that the same action and interaction made by an individual both produce and reproduce structures (E) in relation to significant others as well as produce and reproduce the identity of an individual in relation to self. On one side of the frame of reference (A) is action and interaction (B); to reach the other concepts (C, D, E) within each circle, the information setting must be filtered through the individual's frame of reference (A). The frame of reference (A) thus assimilates and accumulates information about thoughts, actions, and interactions. When individuals engage in a product innovation process, they draw on experiencees of thoughts, actions, and interactions, in their frame of reference.This assimilated and accumulated experience is the foundation for their action and interaction (B) in relation to the self and to significant others in the product innovation process. When individuals engage in this social setting, their frame of reference (A) also works as a filter to guide for expected consequences (C) based on the action, and interaction made in the product innovation process. It may also guide by filtering consequences to be noticed or considered due to selective perception. In relation to the self, the individual's frame of reference (A) will filter and guide thoughts (D) to be made and possible to make, which will be assimilated and accumulated into the frame of reference before guiding new action and interaction. This dimensional relation to self includes the freedom of choice over thought, action, and interaction, even though action and interaction may have limitations in terms of physical features (Brunsson, 2002; Giddens, 1979). In relation to significant others, the frame of reference (A) will filter the action and interaction of others. Due to the response to intended or unintended consequences,

this action and interaction will simultaneously influence the social structures of signification, legitimation, and domination included in (E) (Giddens, 1979).

The second dimension of the model (where the first represents self vs. significant others) is the relation to the physical aspect of being observable for a participating individual or if the concept is hidden inside the individual. For an individual participating in a product innovation process, the action and interaction made by other individuals is recognized through his or her senses. It is possible to se the physical movements of a body, hear them speak etc. However, what we hear and see is filtered through our frame of reference (A); if our assimilated and accumulated experience indicates a certain way of action and interaction or result thereof, then this will lead to intended or unintended consequences. Although it could be seen as logical to place intended and unintended consequences behind the filtering frame of reference, it is also possible to observe through expressions or through body language. Nevertheless, these sounds or expressions are nothing but ways of action or interaction as a response to previous actions and interactions. The initial action or interaction (B) is filtered through the individual's frame of reference (A) in order to give rise to intended or unintended consequences (C) within the individual. These consequences (C) are then processed through thinking (D) where the frame of reference (A) filters for appropriate responses in action and interaction (B) as well as social structures (E) governing the present time and space. Thus, action and interaction in product innovation processes are produced and reproduced in the duality of thought and social structures (Giddens 1979).

This implies that a group that is brought together for the first time to create an innovation will bring the content of the institutional structures from their usual organizational entity to the new setting. This content is situated within the frame of reference of each individual and is specific to previously encountered situations. When a group enters the early phase, they will bring institutional structures based on similar content in terms of company ground rules of conduct. An example of such structures is tolerance for others' perspectives. Based on the discussion in Section 3.5.1, the content is related to the institutional structures governing the situation, which implies that individuals are aware of and thus capable of instantly reproducing these structures. This is not necessarily the case, since structures probably differ between functional departments as well as between organizations and countries. If not, the individuals will have to produce the institutional structures that will guide all action and interaction within the innovation process. In relation to the self, all actions and interactions are filtered when reflecting upon them as well as drawn upon when taking action or interaction. The same action and interaction are guided by the social structures that govern the situation. In relation to others, this means that the action and interaction made by an individual produces or reproduces the institutional structures as well as modifies the individual's frame of reference. When an individual applies their frame of reference and their actions or interactions lead to unintended consequences, this results in a modified frame of reference, which might alter the structures governing future actions and interactions. If the actions result in intended consequences, this leads to a

reproduction of the social structures and the individual's frame of reference. Thus, when individuals reproduce structures through action and interaction, they share experience within the social setting, which adjusts their frames of reference toward homogeneity.

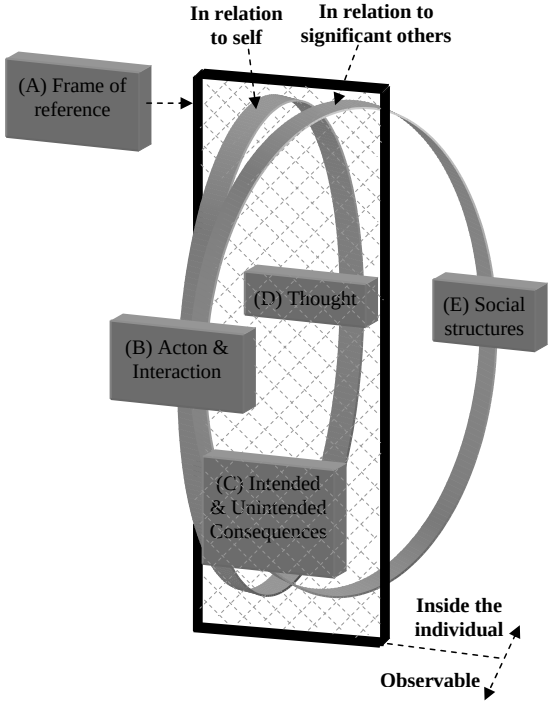

FIGURE 5 A dynamic model of product innovation processes

For example, one activity within the early phase could be developed into an idea. If performed before, participating individuals may draw from their frame of reference and guiding structures when starting to act and interact. It may be to wait until it is their turn to speak (drawing on social structures); the experience stored in their frame of reference will guide towards certain ways of thinking, acting, and interacting. The way that the individual presents this will be aligned with the structures perceived to govern the situation. This dynamic process continues throughout the product innovation process, implying that individuals have a picture in their frame of reference about which activities to perform in each phase of the process. They will also know how to behave in each phase in terms of action and interaction due to the structures in their frames of reference. In this way, homogeneity in frames of reference will arise concerning which activities to perform, since the individuals share experience throughout the innovation process.

4 TOWARDS A RESEARCH PLAN OF THE SOCIAL AND COGNITIVE DIMENSIONS IN PRODUCT INNOVATION PROCESSES

In this chapter, I will address how the fundamental concepts introduced in the conceptual model may be studied in terms of a research plan. This includes a discussion of the course of action and choices surrounding the techniques included in the plan, which will be presented in detail in Chapter 6.

The purpose of this thesis is to provide a conceptual focus and make a significant test of techniques for an empirical test. This chapter aims at developing a research plan with the intent of future empirical test of the conceptual model. The concepts used in the model are frame of reference, thought, action, interaction, intended and unintended consequences, and social structures. In order to confirm or reject the conceptual model, all central concepts must be addressed in an empirical study. However, since the purpose is to develop a research plan for an empirical test, a first step in making the research plan is to focus on the concepts which techniques are in need of a significant test in the context of the product innovation process. In particular, I will examine frame of reference, thought, action, interaction, structure, homogeneity, and heterogeneity. The repertory grid technique, social network analysis, and alter-ego network analysis all considered useful for capturing the concepts introduced in the conceptual model. How each technique is related to the fundamental concepts will be discussed in the following sections.

4.1 FOUNDATIONS IN THE REPERTORY GRID TECHNIQUE

The repertory grid technique is based on Kelly's (1955/1991) fundamental postulate, which states that:

"a person's processes are psychologically channelized by the ways in which he anticipates events."

This fundamental postulate, elucidated by Kelly's corollaries (Appendix 1), constitutes the essence of his *theory of personal constructs*. Some of the corollaries are more central to the subject of this thesis (individual, organization, range, and experience) and consequently will be further discussed. The repertory grid technique can illustrate how different individuals construct their reality. In following the fundamentals, reality comes about *(The organization corollary)* when individuals try to make sense out of experiences from encountered situations (e.g. Fransella & Bannister, 1977) and use this to anticipate future events (Kelly, 1955/1991). The repertory grid technique explores the system of constructs being shaped or reshaped due to individual experience and social encounters. According to Kelly, the individual constructs his/her reality in terms of real bipolar constructs, which are only real in their actual employment by the user and not by themselves in the things that they are supposed to explain. In this way, the constructs only represent the way that an individual frames the experience and may differ among individuals due to their previous experiences, leading to different constructs guiding their anticipation of events.

In the foundations, set forth by Kelly (1955/1991), a construct represents the way in which events are constructed as alike and yet different from other events. Thus, the constructs are always dependent on the specific context or phenomenon under examination (cf. Borell, 1994) and as relevant to something seen as different as it is to something seen alike. To exemplify, assume that an individual constructs his or her reality in terms of easy vs. difficult to handle. The individual may construct several contexts according to this construct, which may be applied to eating breakfast, getting the kids dressed, driving to work, or activities to be made within a product innovation process. The construct may also be misapplied, as when constructing an activity within the product innovation process as easy to handle while others may see it as difficult to handle. A construct may also be inappropriate; for example, constructing another individual in the innovation process as easy to handle may not be a very enlightened way of viewing other participants. However, the construct may not be relevant at all for other contexts, such as time of day or an activity out of the individual's control within the product innovation process. Kelly discusses this as constructs used by the individual that have a limited range of convenience (*the range corollary*). That is to say, outside of the range of convenience, the individual does not find the construct relevant to the object; the construct within the range of convenience has a meaningful and relevant similarity and difference, which forms the essence of the construct. Hence, the context is constituted by the elements lying within the range of convenience; to distinguish a context, a minimum of three elements are required. The minimum context is constituted by a construct, which determines how two things are alike and different from a third on the same dimension (ibid). For example, would the elements user involvement, generate ideas, and planning create a context for the construct easy vs. difficult to handle, if the individual considers it as a meaningful construct for the elements. By other techniques two and even one element is used as context but as such, they must be related to an element not included in order to establish a context to construct about.

Fundamental to this thesis, is Kelly's (1955/1991) view of predicting constructs as channelized by the ways in which the individual anticipates events. Kelly explains: "we look at the undifferentiated stream of circumstance flowing past us, and we try to find something about it that repeats itself. Once we have abstracted that property, we have a basis for slicing of chunks of time and reality and holding them up for inspection one at a time. On the other hand, if we fail to find such a property, we are left swimming in a shoreless stream, where there are no beginnings and no endings to anything. Thus the first step in prediction is to get hold of a solid fistful of something to predict." Thus, the process of identifying the event (in this case, activities in a product innovation process) as something replicated implies that its replicated properties may reappear in another event; therefore, prediction is always implied when constructing (*the experience corollary*). This explains how an individual's frame of reference filters and guides thought and action: when an individual abstracts replicated properties in the events already experienced, it becomes possible for the individual to chart probable future events in terms of these same properties.

4.1.1 *Performing a repertory grid*

When conducting a repertory grid, the inquiry resembles the procedure of a structured interview, but with conversations that provide understanding of the other individual's view of reality. The repertory grid technique formalizes this process by assigning numbers to the relation between contextual elements and their constructs (Fransella & Bannister, 1977). There are three steps to conducting a repertory grid: generating elements, eliciting constructs, and relating generated constructs to elements by assigning numbers that represents their location in the individual's duality of constructs (Figure 6).

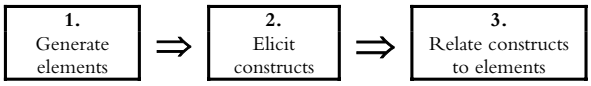

FIGURE 6 A general process of using the repertory grid technique

Elements are related to the context under examination and may be in the form of objects, persons, roles, events, institutions, ideas, or professions etc. (e.g. Fransella & Bannister, 1977). When conducting the first step of (1) generating elements, various methods with more or less involvement from respondents or researchers may be used. According to Borell (1994), one way to generate elements is to have the respondent reflect on aspects of something (e.g. activities in the product innovation process). Another way is if the respondent and researcher jointly generate relevant elements of interest for innovation projects. A third way would be if the researcher solely identifies elements based on theory or personal experience (cf. the course of action made by Öhman, 2004; Johansson, 2004; Häckner et al., 1996). Conducting a study of the conceptual model proposed in the previous section implies a combination of these methods. To capture homogeneity and heterogeneity, all participants must at least relate to either identical elements or constructs, which implies a thorough process of selecting fixed elements or constructs to assure that they are within the range of convenience and appropriate for the context of a product innovation process.

The second step is to (2) elicit constructs, which the respondents use to make sense out of identified elements. Fransella and Bannister (1977) describe several ways for the researcher to elicit constructs from the respondent (see also Kelly, 1955/1991). One commonly used method for eliciting constructs is to use triads of randomly selected elements within the group of elements generated in the first step. Three of the researcher and/or respondent generated elements are randomly selected, and then the respondent is asked in which way "two of them are alike and thereby different from the third" (Kelly, 1955/1991). This method will henceforth be referred to as the triad technique. These constructs may be in the form of adjectives or whole sentences that constitute the pole and contrast of the construct giving meaning to the elements (Borell, 1994). An alternative method is to use a sequential form in which three elements is selected and then changed sequentially. If there are too many elicited constructs, then they may be reduced or modified through in-depth analysis of the construct by finding a common link (Fransella & Bannister, 1977). There are also

other ways to generate constructs, such as drawing on similarities and dissimilarities between elements. One example is to let the respondent describe the similarities and differences between two elements. Another example is to construct one element by describing characteristics of a particular element. Nevertheless, I will use the triad technique to generate constructs, since this is the technique originally suggested by Kelly (1955/1991).

The third step is to (3) relate the constructs to the elements, which indicate an individual's sense of the elements constructed. By rating these constructs on a Likert scale, the respondents grade how they perceive whether the elements are related to either the pole or the contrast. On a nine-point Likert scale, a score of one represents an individual's understanding of an element as closely associated with the contrast of the construct, while a score of nine represents an individual's understanding of an element as closely associated with the pole of the construct. By relating all constructs to an element will hence illustrate the underlying structure in an individual's frame of reference characterizing the meaning ascribed to the element by the respondent (cf. Fransella & Bannister, 1977; Reger, 1990; Borell, 1994).

Table 5 illustrates a complete matrix of a repertory grid. This involves the elements that the individual finds to be important for explaining the product innovation process. To depict the inner meaning of the respondent's understanding of the elements, constructs are generated; the first row presents the construct extremes as easy (pole) and difficult (contrast). Each score represents the respondent's underlying estimation of how an element may be described in relation to the constructs. This implies that the respondent sees the element of user involvement as relatively easy to perform and unimportant; thus, hardly astonishing, this is not something to which the respondent devotes time. On the contrary, the activity (element) of generating ideas is regarded as difficult and important but not something that is given much attention, since the respondent does not devote time to it. On the other hand, the activity (element) of planning is fairly easy and equally unimportant/important but something to which time is devoted.

TABLE 5 A simplified example of a repertory grid matrix

Element / Construct	User involvement	Generate ideas	Planning
Easy – Difficult	2	9	4
Do not devote time to – Devote time to	2	2	8
Unimportant - Important	1	8	5

This hypothetical example shows how one individual constitutes the reality of activities surrounding the context of a product innovation process. In this way, the grid constitutes a representation of an individual's frame of reference about an innovation process. On the individual level, each individual will have divergent and unique representations of elements and constructs about an innovation process. On

the other hand, a group of individuals with shared experience may show a number of individuals with a frame of reference characterized by a common understanding of the innovation process.

4.2 FOUNDATIONS OF SOCIAL NETWORK ANALYSIS

Social network analysis is a method used for investigating the social interaction among participating members of a group regarding some aspect of interest for the researcher (e.g. Krackhardt & Hanson, 1993; Cross & Prusak, 2002; Cross, Borgatti, & Parker 2001; Tsai 2002). In this way, social network analysis reveals patterns of relations which produce organizational structures over time; thus, it shows both formal and informal patterns of relations within the company. In this study, social network analysis is used for its ability to reveal patterns of interaction among participating individuals in a product innovation process. The interest in this thesis is not to illustrate formal and informal structures but to illuminate if and how participating individuals interact during activities (elements) identified in the repertory grid. If the elements are discussed within the group, then it may be seen that these elements are conscious in the individuals' frames of reference. Consequently, factors may evolve into underlying assumptions over time and thus become possible aspects of institutionalized thought.

The social network analysis presented for an individual resembles the matrix performed in the repertory grid. In the upper row, action-oriented activities (the elements used in the repertory grid) are presented; the first column presents names of individuals to be contacted regarding an activity. The names may be identified in advance or left empty to fill in later. If the group is clearly defined, then it seems suitable to have predefined individuals; in the context of a product innovation process, however, it is likely that individuals interact with a large number of people both within and outside of the company. Hence, the respondents will be given the task of identifying individuals that he or she has contacted. The last step is to grade the degree of interaction made during a set time by providing the exact amount of contacts during that period or by grading them on a scale, preferably a Likert scale similar to the one used in the repertory grid. A potential drawback of using an exact amount of contacts is the reliance on memory. With a small number of contacts, it will possibly be easier to recall, but with a large amount, an individual may provide only a rough approximation while the use of an exponential scale will provide a more precise approximation. The use of the chosen scale will be further discussed in Section 5.3.

The results of social network analysis may be displayed both graphically and numerically. The graphical display clearly shows the relationship between participating individuals and their positions both formally and informally in the innovation network. The numerical display shows data about the relations within the innovation group, including the density and centrality of relations; minimum, maximum, and standard deviation; and correlation tables to illustrate group patterns of communication.

Identifying how different individuals in a product innovation process communicate about the activities to be performed (elements) provides an understanding of how individuals share their experience about activities. It is important to clarify that such analysis does not address the content of each contact but rather assigns it to a content related to some activity; it does not reflect the value of the contacts taken. Nevertheless, it may show structures of communication and thus patterns of institutionalization. The matrix below gives an illustration of how an individual recalls interactions regarding activities (elements) within the product innovation process.

TABLE 6 A simplified example of a social network analysis matrix

Respondent: Sven			
Element / Name	User involvement	Generate ideas	Planning
Anders	1	3	6
Mats	1	4	6
Monika	1	2	5

According to Table 6, Sven interacted moderately with Anders about generating ideas and several times last month about planning in the innovation team. The respondent has not discussed user involvement and thus probably has not been actively thinking about or consciously chose not to communicate with those individuals. Thus, the element of user involvement may in combination with the repertory grid technique give an alternate picture of the same underlying phenomenon. If the repertory grid indicates that an element is important in an individual's frame of reference and, according to the respondent, highly discussed in the social network analysis, then both techniques indicate that this is an aspect of the individuals' frame of reference that is both conscious and important in the context of this radical innovation process. Moreover, the activity (element) of planning is highly discussed and thus possible to display institutionalized thought (homogeneity) among participating individuals in the product innovation process.

4.3 FUNDAMENTALS OF ALTER-EGO NETWORK ANALYSIS

Alter-ego network analysis is in its fundamental features a modified version of social network analysis. As previously mentioned, social network analysis reproduces patterns of relations among individuals participating in the product innovation process. In social network analysis, the respondent may be included in the list of contacts representing the individual who is seeking answers within the self, or alter-ego. In this study, this is separated in two parts: social network analysis represents contacts with other participating individuals in order to depict the flow of interaction, while alter-ego network analysis represents the individual's conscious thoughts about an element. This may be achieved by asking individuals to state the degree to which they have consciously thought about the elements. By grading on a Likertscale, the individual may describe whether or not he or she has consciously thought about an element in the past month. Similarly, the scale may represent an exact number of thoughts or the

degree of reflection made about an activity (element). One factor guiding this choice is the use of a similar way of measuring an individual's thoughts about an activity as the number of contacts taken. The choice of scale will be further discussed in Sections 5.3 and 5.4.

Table 7 illustrates one member's comprehension about the conscious thought made regarding different elements during the last month. Sven has consciously thought about user involvement a few times during the past month and has thought about planning several times during the past month. Since all elements have been devoted to conscious thought, they are also part of the structures that constitute the individual's frame of reference about activities in the context of product innovation.

TABLE 7 A simplified example of an alter-ego network analysis matrix

Respondent: Sven			
Element / Name	User involvement	Generate ideas	Planning
Sven	2	4	6

4.3.1 Linking techniques to the product innovation process

Three different techniques are used to capture different aspects of the product innovation process. In order to analyze the gathered material, it is important to illustrate the relationship among these techniques to understand different aspects of individuals participating in a product innovation process. All of these techniques focus on activities to be performed and thus are characterized by action within the context of the product innovation process. The repertory grid technique addresses individual frames of reference as well as whether individuals may be described as having homogeneity or heterogeneity regarding how they frame the activities representing action within the product innovation process. Action is represented in the elements that the individual is asked to construct. Using social network analysis, individual interaction about activities within the product innovation process may be depicted. Similarly, individual thoughts about activities within the process may be illustrated using alter-ego network analysis. In both social and alter-ego network analysis, actions are depicted by the activities that the individual is discussing and about which they are thinking. Social network analysis describes interaction about activities characterizing action, the act of interaction may be seen as action in itself. Using all of these techniques, different aspects (frame of reference, interaction, thought, and action) of institutionalization in product innovation processes may be analyzed.

5 TESTING A SIGNIFICANT PART OF THE RESEARCH PLAN

This chapter accounts for the practical dimensions of the techniques used to gather knowledge about the cognitive and social dimensions of the product innovation process. This includes a discussion about the course of action and choices made within the scope of this thesis.

One of the purposes of this thesis is to conduct a significant test of the techniques intended to be used when executing the research plan. The methods to be used are the repertory grid technique, social network analysis and alter-ego network analysis. These techniques to capture individual interaction (social network analysis) and thoughts (alter-ego network analysis) regarding activities made within the product innovation process, are well-documented methods for the intended areas. In the same way that the repertory grid has been used in several areas such as education (Häckner et al., 1996), financial analysts (Johansson, 2004), and strategic management control (Ifvarsson, 2003). However, to my knowledge, it has never been used in the context of the product innovation process. It seems reasonable that the repertory grid technique is suitable for capturing individual frames of reference about activities in the process. By performing a significant test on one individual, it may be determined whether the techniques capture the intended aspects.

5.1 SELECTION OF A PRODUCT INNOVATION PROCESS

Performing a significant test refines the use of the technique and validates the elements chosen. This is important, since the use of same element (or constructs) makes it possible to analyze homogeneity and heterogeneity through the multigrid program[10]. *As such, this is an extremely central aspect, since all techniques to be used are based on* the *use of the same action-oriented elements*; thus, *the*se *elements* must *represent the product innovation process. In addition, it is an absolute necessity to have valid elements describing the context, resulting in constructs within the range of convenience (cf. the range corollary in* Appendix *1) for all participants in* the *process, since it gives the ability to analyze homogeneity and heterogeneity among individuals*. When selecting elements in advance, individuals are forced to construct elements that may not be relevant, which indicates a need for extensive testing. Therefore, thorough selection and testing are necessary in order to validate the elements to be used before executing a full-scale research plan. In respect to the need of selection and testing of elements a V-diagram is presented about how to find relevant elements for common use in all three techniques (Figure 7). The V-diagram represents a link between the theories, principles, and concepts used to conceptualize with the methodological side of making records transformed into knowledge claims, central to answering the focus question (finding relevant elements for common use). This diagram visualizes the link of the conceptual sections with the need to find and validate common elements for future empirical testing.

[10] Multigrid is a program where several individuals' mental representations may be compared into achieve an average representation of the group, indicating homogeneity or heterogeneity.

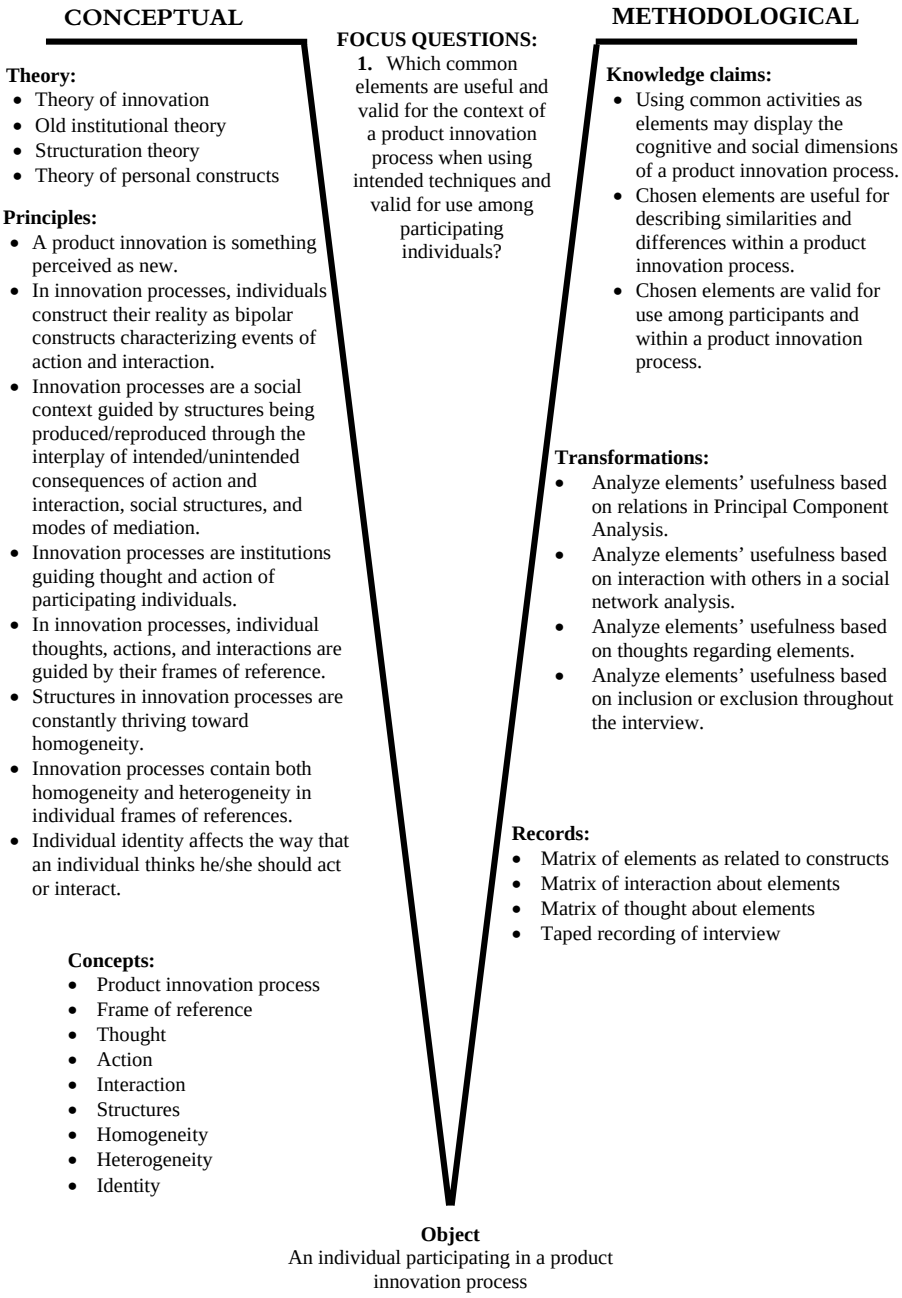

FIGURE 7 *A V-diagram on the use of common elements*
Source: Novak and Gowin, (1984)

First, the individual selected for the test must be part of a product innovation process. This criterion makes it possible to obtain perspectives from a context relevant for full-scale studies. In order to find a relevant product innovation process, a selection based on recommendation from supervisors and individuals with insight in several projects in progress. This pointed in the direction of a product innovation process (C4-DTN[11]) focused on mobile and Internet systems taking place cooperatively between individuals from the university and the industry. Second, the individual participating in the test must be well-informed within the innovation process and preferably with experience from other processes, which could further enhance the validity of the elements used. Furthermore, the individual must have the opportunity to reserve sufficient time due to information prior to the test, making the test and confirming the significant test.

In choosing the C4-DTN case, I was recommended to contact the CEO of a division within Luleå University of Technology, with the aim of finding a product innovation process. During the discussion of the aims and needs of my research, he suggested the C4-DTN project as suitable. In order to create an opinion of my own, I turned to the former leader of the project, since the new leader had recently entered into his position. I was convinced that this project was performed in such a manner and thus fulfilled the criterion of a product innovation process (Se Section 6.1 for a detailed description of the C4-DTN project). This resulted in a discussion with the present leader of the project, which reserved time to participate in my study. Since he has experience as a leader of several projects, he was well-informed of the activities made within a product innovation process and in C4-DTN. He was also favorably disposed toward studies with a perspective of social science on product innovation processes.

Other criterions in favor of the C4-DTN project were convenience, access, and geographic proximity (Yin, 2003). Access was considered most important, since the significant test demanded access to potentially delicate information of planed and realized activities. The other criteria were more related to restricted time and costs. Taking all of these criteria into account, the C4-DTN project seemed to be suitable for the significant test.

5.2 TESTING THE REPERTORY GRID TECHNIQUE

As described in Section 4.1.1, the repertory grid relates constructs to elements. Since the research plan is pointed toward in-depth studies of product innovation processes, these elements or constructs must be able to use multigrid in order to compare several participating individuals. Because of this, fixed elements were chosen that cover the entire product innovation process; this choice is closely related to the choice of using activities related to action as elements, since action is a fundamental bearer in both institutionalization and structuration. Other possible elements might have been persons, features of the product etc. but aligned with the purpose of this thesis focus is on the product innovation process and therefore suitable elements where activities that

[11] C4 stands for Communication Concept for Challenging Context, and DTN stands for Disruption-Tolerant Networking. A complete description of the C4-DTN project is found in Section 6.1.

covered the entire process. The purpose of using fixed elements was not to analyze individual views of the process but rather to evaluate the techniques of the research plan. As such, the initial step was to find relevant elements (A) to represent activities of action covering the entire product innovation process (Figure 8).

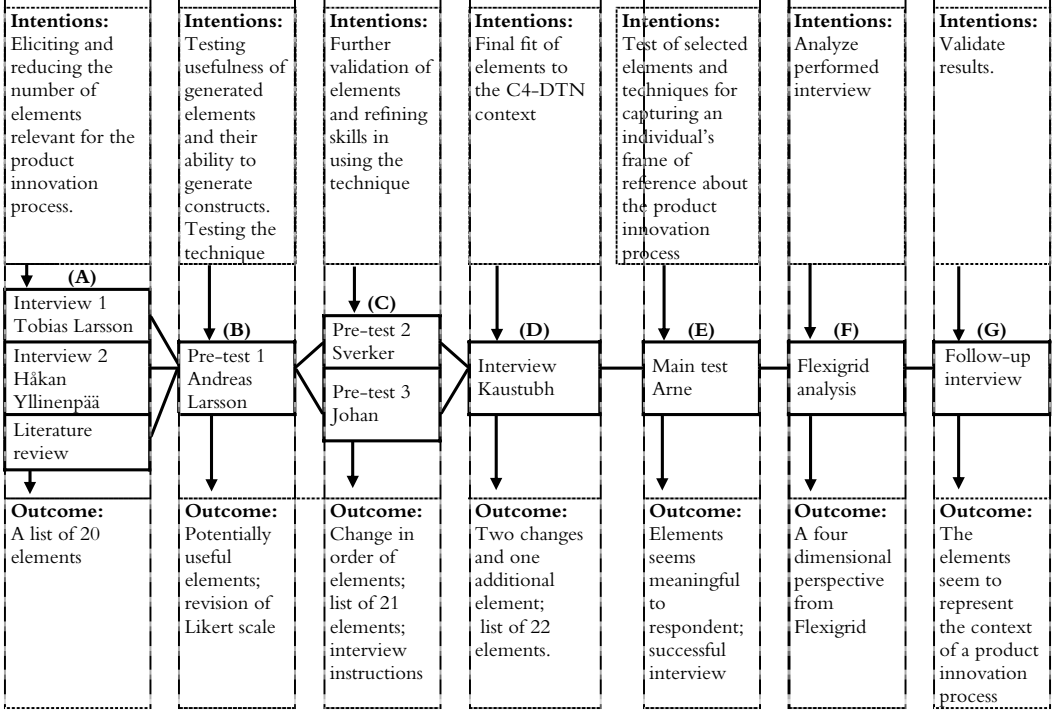

FIGURE 8 Activities performed when testing the repertory grid technique

Several playful grids were made for different features as individuals, cars etc. in order to learn different aspects of finding appropriate elements (A). After these tests, two interviews to obtain diverse perspectives of the innovation process. Both subjects were selected based on their experience in innovation processes. The first interview was conducted with Associate Professor Tobias Larsson, who is involved in the areas of functional products and knowledge-driven engineering design. The second interview was conducted with Professor Håkan Yllinenpää, an expert in the area of entrepreneurship. Both subjects were instructed to draw, sketch, and write about how a typical innovation process evolves in the early, mid, and late phases. It resulted in two descriptions with boxes and arrows giving descriptions on different levels of abstraction. Professor Yllinenpää, with a background in Triple Helix,[12] drew on pieces, which from a meta-level, needed to be part of an innovation process. For Associate Professor Larsson, more concrete activities to be made in an innovation process were described. The aim of these interviews were to identify concrete

[12] Triple Helix may be defined as an innovation process with individuals representing academia, government, and firms.

activities in the process, since institutionalization is made through action, and relate these views of the innovation process to activities in the literature in order to obtain a more valid representation of the entire product innovation process.

Turning to literature, the goal was to identify concrete activities through a review of empirical articles in the area of product development and innovation in search of activity models identified as significant for innovation processes. Based on this review, 39 elements were identified (cf. activities in Brown & Eisenhardt, 1995; Fairlie-Clarke & Muller, 2003; Van de Ven et al., 1999; Cooper & Kleinschmidt, 1988). Using these elements in a repertory grid, however, would lead to several difficulties. For instance, the respondent would have to construct each of these elements. In addition, some elements might have overlapping features, which could imply identical elements that are not meaningful to construct. Another problem may be indistinct differences, which would make it difficult to construct any "real" difference between the elements. Consequently, due to the large amount of elements I tried to find a generic point in common in order to reduce the number of elements used (see Appendix 2) to those that represent activities related to concrete action, since all individuals participating in the process would recognize activities related to their work. Therefore, creative, practical, and business activities were chosen. Based on these criteria, the number of elements was reduced to 21. These elements were then tested through repertory grid interviews in order to further refine and receive feedback on the techniques and elements used, in particular to learn in what type of constructs these action-related elements would result.

The first test (B) of the repertory grid technique was conducted with PhD Larsson, whose thesis addresses social processes of distributed design teams. The respondent was instructed to think about a generic innovation process in which he had participated and to relate this process to the 21 elements listed. The aim of this instruction was to determine if the elements are relevant for a product innovation process and for the respondent. The respondent was asked if he would add or withdraw any elements relevant to the product innovation process. This led to a discussion of the definition of some elements, which resulted in notes made by the respondent in order to make sense of listed elements. However, the respondent could not relate to some element, since he had never performed these actions (educate employees, elaborate distribution, and elaborate support). Nevertheless, the respondent viewed them as relevant and thus did not want to withdraw them from the list. Since the respondent did not want to reduce or add any elements, it appears that these elements are relevant to the product innovation process.

To generate constructs, the triad technique was used. This was made a sequential order firs starting with element one, two and three and then element two, three and four until all elements where used. After the sequential order, the respondent was instructed to review the elements in discretionary order for new possible constructs that could not be described by the ones already generated. The constructs generated by the triad technique were more complex and related to engineer language vs.

customer language; more flexible vs. less flexible; opportunities vs. restrictions; open vs. closed, etc. This resulted in 10 constructs relevant to the respondent for describing the similarities and differences between the elements.

After generating constructs, a nine-point Likert scale where used to relate each element to the generated constructs. This was made by first pointing out the element closest related to the pole, graded as one on the Likert scale, and then the element closest related to the contrast, graded as nine on the Likert scale. After this all remaining elements where graded in relation to the two elements. When grading the respondent stated that he used first impression or feeling in order to grade and used the numbers 1, 3, 5, 7, and 9 as basis of grading elements on constructs. If some element could be considered as neither a seven nor nine the element was placed as an eight on the Likert scale. When all elements have been used in relation to constructs on the scale, it was reviewed in order to se if the whole scale was used. If several elements where given the same number, the respondent was asked if the elements were equally related to the pole/contrast constructs or if they could be differed in respect to the construct.

This first test (B) resulted in learning how to use the repertory grid and improve the forthcoming pre-tests and the main test. In this first test, the need for clear-cut definitions of elements was identified. In order to make comparisons between individual views of central activities and to be able to contribute to the process, five fixed constructs[13] where developed (Table 8). These fixed constructs were jointly generated with a supervisor based on aspects of the product innovation process possible to use for feedback of critical activities. Based on the feedback received, some changes were made concerning the scale. While still using a nine-point Likert scale, five grades were illustrated in order to save time without reducing the respondent's ability to extract variance when needed. In addition, interview instructions were developed and refined. For example by instruction of the possibility of using the entire scale if perceived as necessary to describe the differences between elements on constructs. Another problem concerned the elements perceived as important to the process as a whole, without being well informed or knowledgeable about the particular element. This was solved by instructing respondents to score five marked in order to separate it from a score five describing a real relation of an activity (element) on a pole/contrast construct. Thus, variances generated on the entire scale ended up in the middle of any component. The alternative would have been to leave out these elements when performing the analysis. Nevertheless, such an approach would not have allowed for the possibility to analyze an element in another phase, since some activities may be useful in different phases of the product innovation process.

[13] The five constructs are defined in Appendix 3.

TABLE 8 The five fixed constructs used in the repertory grid

Easy to handle	vs.	Difficult to handle
Requires a small amount of work effort	vs.	Requires a large amount of work effort
Least critical for process success	vs.	Most critical for process success
Least critical for product success	vs.	Most critical for product success
Application of previous knowledge	vs.	Requires new ways of thinking

After addressing the changes from the first test (B), two additional pre-tests (C) were conducted with two students serving as project leaders in their final course in product development; changes were made according to the results of the initial pre-test. These additional pre-tests took place within a short time frame, making it difficult for extensive changes between the interviews. One implication from these tests was the need to rearrange the order of the elements presented in the repertory grid. In all three pre-tests, the individuals perceived that the order of elements indicated a timeline, leading away from similarities and differences between activities (elements). As a result, the order of elements was changed to alphabetic order in Swedish (the interviews were conducted in this language). These were later on translated into English, giving a more random order of listed elements. Since none of the pre-tests indicated a need for adding or eliminating elements, it was concluded that the elements were representative of the product innovation process.

Before these elements could be used in the main test, they were examined in the context of the product innovation process. Therefore, another interview (D) was conducted (approximately 30 minutes in duration) with the former project leader in order to determine the activities in the product innovation process. All of the individuals participating in the pre-tests had a mechanical background in their representations; however, the product innovation process to be examined was taking place in the area of electronic and information technology. Thus, the interview resulted in two changes and one additional element (Choose algorithm, Programming, and Simulating). The 22 elements[14] used in the main test are listed in Table 9. These activities were selected based on the pre-tests and interviews since they where regarded as action-oriented and provided a full description of the entire product innovation process. Linking the elements to Table 4, these activities represent all three phases of the innovation process, with a fairly equal distribution among each phase. It was important to find activities that did not overlap yet accurately describe the overall innovation process.

[14] Definitions of elements are found in Appendix 3.

TABLE 9 The activities identified as appropriate elements

User feedback	Final tests on users
Get support from management/financier	Product release
Generate ideas	User studies
Identify perspectives of others	Test technology/design
Identify suitable technology	Elaborate distribution
Identify opportunities	Elaborate support
Plan/adapt for manufacturing	Educate employees
Plan project	Develop business plan for the innovation
Programming	Develop concept
Simulating	Choose algorithm
Write product specification	Supervise time, cost, and design

5.2.1 Conducting the main test of the repertory grid technique

After all pre-tests, resulting in what was perceived as appropriate elements and constructs to describe differences in a product innovation process, an interview (E) was conducted with Arne, leader of the C4 project. The interview, which lasted for approximately 3 hours, took place in a quiet location that was familiar to the respondent. The entire interview was taped with the permission of Arne. The respondent was briefed about the interview process and then instructed to follow the repertory grid (Appendix 3). The respondent reviewed all elements listed in order to see if they were considered appropriate and representative for the considered product innovation process. The respondent received a document that clearly defined each element in order to reduce differences in interpretations. All listed elements were considered appropriate and representative, since the respondent did not want to include or exclude any element. However, Arne could not completely relate all activities to the C4-DTN project, as the scope of the project was not intended to result in a commercial product but to develop, test, and refine the techniques to be used for future products. Some elements were not a complete match to the C4 process, but Arne did not wish to exclude any of the listed elements since he could not disregard or eliminate these activities within the scope of the product innovation process.

After reviewing the elements, the focus turned toward generating constructs. The respondent generated meaningful constructs in order to describe similarities and differences between elements using the triad technique in a sequential manner. After all elements had been used to elicit constructs, the opportunity to select a group of elements was given in order to capture possibilities not yet considered. All elements were used in at least three combinations during the sequential procedure and discretionary grouping of elements. For some elements, no relevant similarities or differences were found, but other elements could be described by similarities or differences already described by the generated constructs. For each construct generated, a description was sought to define the construct. In addition, the five constructs previously described were printed, in advance, in the matrix.

The final part of the repertory grid interview was to relate each element to each pole and contrast by grading it on the nine-point Likert scale. This scale was chosen due to the large number of elements included; this way, a larger variance could be obtained representing real differences. Similarly, a larger scale makes it easier for well-informed respondents to construct similarities and differences; using a smaller scale might have implied similar representations. Thus, useing a nine-point Likert scale implied that all elements could be placed on the scale indicating "real" and meaningful differences to the respondent. The grading was made in the same way as the pre-test, by first relating the element to the pole and then to the construct, which forced the respondent to use the entire scale. Each remaining construct was graded in relation to the two extreme grades. A potential risk with this procedure was that elements were forced toward a construct even though, if freely placed, they would have been placed elsewhere.

Constructs were generated by asking about similarities and differences, which indirectly resulted in at least one element being related to an extreme pole or contrast. This implies that elements could be grouped on one side of the scale, but and the elements were graded along the entire scale. After all elements were graded, they were reviewed for similarity. For example, if three elements where graded as a four, then the individual was asked if they could be separated in a meaningful manner or if all were equal on the construct dimension. The respondent was also instructed to grade elements, not perceived as meaningful with a score of zero. Later, it was determined if the elements were excluded or out of the range of convenience (graded as a five) and hence resulted in a loading in the middle on generated components. The respondent used this opportunity in some cases, especially in the elements of elaborate distribution, elaborate support, and educate employees. Nevertheless, no elements were graded as zero, which indicates a meaningless element to be excluded.

The conduced interview represents a sincere and trustworthy description of the similarities and differences among the activities made within the product innovation process. The respondent took his time in making the grid, which warrants a representative picture of his frame of reference about the product innovation process. Another important issue to be addressed is the collection of individuals used in each step, from finding relevant elements (A) to performing the main test (E). It could be argued that each individual represents the university, which suggests that the generated elements would not be appropriate in a firm context. However, the elements generated in the literature review are based on empirical articles and thus represent a firm context. The main test was based on the aforementioned interview with Arne, who was recently recruited from a firm context outside of the university. The project was also performed outside of university research. Thus, this approach and these individuals are regarded as representative.

5.2.2 PCA of the data when using the Flexigrid program

The matrix generated in the interview was then used as input data in the Flexigrid program (F). The analysis was made by manually inserting the matrix in the program and then extracting data drawn from the generated matrix (see Appendix 4). The number of components to be extracted was based on the generated data of correlations and principal component analysis (PCA). This in order to find the number of components which could be seen as relevant for describing Arne's view of the activities within the product innovation process. The Flexigrid program works as any program when extracting factors with factor analysis, allowing elements and constructs to be reduced and related to one another. Three criteria were used when choosing the number of extracted components. A first look at the eigenvalues indicated five components. The limit for inclusion of a component is commonly one (Hair et al., 1998), and in this case all five components had eigenvalues above one. However, another criterion for inclusion of components is to look for the point at which the curve first begins to straighten out (ibid). The scree plot generated from Flexigrid indicated a crack in the curve between the fourth and fifth components. Based on this, four components were analyzed. By including four components 76 percent of the total variance could be explained, which is considered satisfactory (ibid). Before conducting this analysis, the correlation table was scanned for correlations equal to one, which indicates identically graded constructs that may be replaced by one common construct. In this case, none of the constructs were considered identical.

5.2.3 Conducting the follow-up interview

A central aspect of validating the results indicated by the elements and constructs loadings on each component is to conduct a follow-up interview (G) in which the respondent reflects on the repertory grid. In this case, a one hour follow-up interview was conducted. The pictures and numerical descriptions generated in the Flexigrid program were provided, revealing interesting relationships between the elements and constructs on different dimensions. In addition, these relations and non-relations were associated with the respondent's role as a project leader. In order to facilitate descriptions, the respondent was given an enlarged picture of generated dimensions and asked to draw, write, and illustrate which grouped elements and constructs that made sense. As the researcher, I offered one possible interpretation by pointing out the most obvious relationship. Next, the respondent was asked to indicate non-relations to generated dimensions where elements and constructs had loadings which placed them in the middle of each dimension. The respondent was asked if they belonged there and if so, to indicate why.

At that time, I realized the value of using four components instead of the analysis of two components. Due to time constraints, I was unable to solve this problem due to my need for technical assistance in making an analysis with four components. However, Tschudi (1998) describes how different descriptions may be used, even though another number of components may be recommended. For example, he describe how some researchers have used analyses of two components despite what is indicated by the scree plot and eigenvalues, while others have used as many as six

dimensions. Another problem related to technical failure was the intention to tape the follow-up interview. Approximately, only the first 15 minutes were taped and later transcribed before the tape recorder malfunctioned. Nevertheless, the follow-up interview was important to validate the main test results as well as to obtain feedback about the techniques intended to be used when executing the research plan in full scale.

Based on the performed significant test, some central aspects may be highlighted for further consideration when executing the research plan. The first concerns the choice of a nine-point Likert scale with five clear steps and the possibility to score each step if necessary. In the significant test, this choice saved time and extracted variance; nevertheless, it may be argued that the forced way of extracting variance may give a biased representation of an individual's frame of reference regarding activities in the product innovation process. This potentially biased representation must be considered in respect to the benefits of using scales to correlate the techniques to capture frames of reference, thoughts, and interactions.

The second central aspect is related to the purpose of making a significant test in order to establish relevant, valid, and meaningful elements that may be used in all three techniques. The elements used in the significant test were all considered relevant for capturing the entire product innovation process. However, for some elements, the respondents were uncertain about ascribing some relation to constructs due to their lack of experience in the field. As such, it may be questioned as to whether these elements are relevant and within the range of convenience. This will be further discussed in Chapter 6 when developing and analyzing the elements used in the light of finding useful, valid, and representative elements. The third aspect is whether the elements used result in constructs correlating with some components and without correlation to other constructs. A correlation of one implies that constructs are synonymous. This will also be addressed in Chapter 6.

5.3 TESTING THE SOCIAL NETWORK ANALYSIS

Social network analysis was used to capture institutionalization in terms of interaction. An interaction between individuals must be about something, in this case, the same activity-oriented action (elements) used when conducting the repertory grid. Extensive testing to establish appropriate and representative activities was mainly conducted within the focus of the repertory grid technique. Because this technique requires more precision, if the activities are suitable for the repertory grid, then they will also be suitable for social and alter-ego network analysis. Capturing cognitive aspects of an action-oriented element reveals underlying structures in an individual's frame of reference, both consciously and unconsciously, while interaction and thought have a more explicit nature. If an activity (element) works in the cognitive dimension, then it seems reasonable that it will be possible talk and think about that perticular activity. However, in order to make sure that this is the case, all elements were used in

the main test, providing valuable information for social network and alter-ego network analysis.

After the extensive testing, a social network matrix was arranged that presented all elements in the first row and an empty column in which the respondent could name all of the individuals whom he or she had contacted in the past month (Appendix 5). This way of doing was selected ahead of using a fix number of individuals in which the respondent could grade the level of interaction. Providing a fixed list of individuals would require the names of all individuals with whom the respondent may have interacted in the past month. In the case of executing a full-scale research plan, the respondents might interact with a wide range of individuals, creating a large list of potential names. Therefore, all individuals were asked to specify the persons that they had contacted. A potential problem with this is the need to secure whether two or more respondents have contacted the same individual. This was solved by adding a short description of occupation and company for each listed individual. This had no effect on the significant test but will be highly relevant for executing the research plan.

When individuals whom the respondent had contacted were listed and given characteristics, they were graded in relation to the amount of contact made about each activity (element) within the product innovation process. This could be made by using an absolute scale giving the exact amount of contacts made during the past month or by using an approximation translated into a Likert-scale. In this case using a nine-point Likert scale (Appendix 5) in order to provide meaningful representation of the interaction and relate this to the scale used in the repertory grid. The nine-point Likert scale ranged from *never* to *daily* contact with an individual the past month. As such, the scale was exponential and contrary to points representing exact increase between each point in the scale. One motive for this choice was that the level of interaction varies widely, which implies exponential points to capture the entire spectrum of contact. Furthermore, the relative difference between each point in the scale gave a reasonable number of points. Another important aspect of the scale was that five grades where assigned numbers; one represented never contacted and three occasional contacts the past month, giving the respondent the opportunity grade in between. The respondent was also instructed about this opportunity. In addition, an approximation of the value of such contact was also made. A valuable contact affected the view of some activity, implying a change in the frame of reference as captured by the repertory grid. This was determined by asking the respondent about the *effect on view* and *effect on work* of each contact regarding each element. A nine-point Likert scale was again used, ranging from *no effect* to *very large effect*.

In the significant test, the respondent was instructed to look back at the past month in the C4-DTN project and asked, "Which individuals have you contacted the past month concerning aspects in the process such as generate ideas, identify opportunities etc.?" The instruction was to consider individuals within as well as outside of the process regarding each activity-oriented element. For Arne, it was relatively easy to recall the individuals, provide characteristics about them, and grade the degree of

contacts made as well as its effect on his view and work. The respondent assigned numbers to activities discussed with each contact, with each empty square representing no contact (a score of 1 on the Likert scale). The same procedure was followed when grading the contacts' effects on view and work. Since all elements were recognized from the repertory grid, this part of the test was carried out quickly yet efficiently.

5.4 TESTING THE ALTER-EGO NETWORK ANALYSIS

The alter-ego network analysis (Appendix 5) was used to capture individual thoughts about activities in a product innovation process. When individuals engage in thought processes about some activity, it seems reasonable that a change in their frame of reference may occur, indicating areas of ongoing structuration and institutionalization. Since alter-ego network analysis is part of social network analysis, they both share the same problems and considerations regarding the use of elements and scale. Therefore, the same action-oriented elements were used in the first row, while the first column only had a square filled with "myself." The respondent where asked to grade the level of reflection made during the past month concerning the activities in the repertory grid. Similar to the scale used in the social network analysis a nine-point Likert scale was used for grading this reflection as well as the *effect on his/her view* and the *effect on his/her work* over the past month. Using a nine-point scale in all three techniques simplified statistical use by combining the degree of reflection and contacts with the repertory grid. The scale was exponential in order to capture the large differences between *no reflection* and *daily reflection*.

An important issue regarding the use of alter-ego network analysis is that the respondent must provide their actual reflection and not what he or she may think others want them to answer. This may be a potential problem in a full-scale execution of the research plan, since it may reveal areas of activities outside the focus of the present phase of a product innovation process. One might grade an area of reflection that other participants perceive as important (for example, the project leader) as more valuable. To address this, the respondent was instructed to "*render your personal understanding/memory.*"

6 C4-DTN – ANALYZING THE SIGNIFICANT TEST

In this chapter, I will try to analyze the cognitive and social dimensions of the product innovation process in order to further validate the elements and constructs used when performing the techniques as well as to refine practical issues regarding these techniques. As such, I will analyze the significant test carried out in order to further elaborate on the effects of choices relevant to the research plan.

By analyzing the significant test, I can validate whether the elements[15] used in each technique are useful in capturing aspects of frame of reference, thought, interaction, and action in the product innovation process. The aim of such analysis is not to highlight the respondents' perspectives but to use these perspectives to indicate if the elements are useful for gaining insight into the product innovation process. Another central aspect is to discuss whether the chosen elements are suitable for capturing an individual's frame of reference, thoughts, and interactions regarding action-oriented aspects (elements) of the product innovation process.

6.1 THE C4-DTN INNOVATION PROJECT

Today, we are living in a society surrounded by mobile- and Internet systems. We use such systems when working, traveling, and relaxing, which implies that we consciously or unconsciously use them all the time. However, in some contexts, this technical equipment cannot connect to a network, for instance, when traveling long distances in remote areas or underground in cellars or mines. The conventional technique is based on an end-to-end[16] paradigm in which a program, when connected, downloads the information needed from a predetermined destination. To accomplish this, both ends of the system must be known in advance so that the data can be transmitted to the intended destination. The C4-DTN project addresses this by proposing an opportunistic communication and disruption-tolerant networking architecture to develop techniques for self-localization and positioning of network devices with mobility and intermittent connectivity.

The C4-DTN project is financed by EU structural funds with co-financing from Luleå University of Technology (LUT). Theses funds are intended to cover the costs of one researcher, three PhD students, one project manager, and one business representative. The research objectives are related to developing and testing the techniques that may be transferred to the business representative for widespread impact. As such, participating individuals in the C4-DTN project define the overall communication architecture for disruption-tolerant networking, develop algorithms and prototypes, and test solutions for dissemination to the industrial partner and potential customers.

[15] The process of selecting relevant and meaningful elements is described in Section 5.2.
[16] End-to-end refers to two predetermined nodes talking with each other.

6.2 THE PROJECT MANAGER'S FRAME OF REFERENCE ABOUT THE C4-DTN PROJECT ACTIVITIES

The repertory grid was used to capture the project manager's frame of reference about the C4-DTN project. In the following sections, different aspects of the repertory grid will be analyzed by first introducing the constructs used in order to give meaning to the different action-oriented activities in the product innovation process.

6.2.1 Introducing the constructs

In this section, the constructs will be introduced; the analysis of constructs in relation to the components will be discussed in Section 6.2.2. When performing the repertory grid,[17] the respondent was instructed to elicit constructs in order to make sense out of action-related activities[18] (elements) in the product innovation process. Table 10 presents the constructs used when performing the significant test in order to describe similarities and differences between elements.[19] The first construct (*create arguments within field of application*[20] and *create free thoughts)* represents a meaningful description for the respondent of a similarity or difference between activities to be performed in the process. Constructs 1 through 9 were generated by Arne in order to make sense of the

TABLE 10 Constructs varimax rotated factor loadings on components

	CONSTRUCTS		COMPONENTS Rotated Factor loadings			
No	**CONTRAST -**	**POLE +**	**C1**	**C2**	**C3**	**C4**
1	Create arguments within field of application	Create free thoughts	0.320	0.185	-0.289	-0.791
2	Financial aspects	Technology driven	0.813	0.116	-0.398	-0.011
3	Filtering of idea	Unlimited opportunities	0.600	-0.266	0.157	-0.538
4	Increasing freedom of action	Limiting freedom of action	0.001	0.951	0.140	-0.086
5	Being controlled / influenced	In control	-0.011	-0.801	0.146	-0.059
6	Working without knowing if it is right	May find problem giving extensive rework	0.057	0.179	-0.239	0.882
7	Opportunity to affect product specification	Can no longer affect	-0.145	0.407	0.474	-0.281
8	Develops business (innovative phase)	Choose track (time to carry out)	-0.220	0.793	-0.061	0.116
9	Creating phase	Constraining budget	-0.498	0.550	0.224	0.349
10	Easy to handle	Difficult to handle	0.024	0.009	0.742	0.070
11	Requires a small amount of work effort	Requires a large amount of work effort	0.763	-0.160	-0.026	-0.291
12	Least critical for process success	Most critical for process success	0.904	-0.253	0.165	-0.000
13	Least critical for product success	Most critical for product success	0.800	0.037	0.511	0.068
14	Application of previous knowledge	Requires new ways of thinking	0.317	-0.502	0.635	-0.259

activities (elements) taking place in the C4-DTN project, while constructs 10 through 14 are the general constructs introduced to describe critical activities of action for the

[17] Justification for the significant test and the process of validating elements is described in Chapter 5.
[18] The elements used were activities related to actions in the innovation process. The terms "elements" and "activities" are synonymous in this sense.
[19] Some aspects in the table will be dealt with in this section, while others will be discussed in later sections.
[20] All constructs are marked in *italics*.

C4-DTN project among all participating individuals. The first nine constructs are meaningful for the respondent but may not be meaningful for others (transcriptions of the meaning ascribed to each construct appear in Appendix 6). An important aspect in making the significant test was to test generated elements as well as indicate the usefulness of fixed constructs.

Upon closer review of the relationships between all constructs, it may be concluded that three pairs of constructs show a high degree of correlation (Table 11). Because they may describe the same similarity or differences and thus no real difference between the elements, correlating constructs could be regarded as synonymous; consequently, they should be replaced by another construct representing the two correlating constructs if no logical explanation may be found. The first pair of constructs with a high degree of correlation includes constructs generated by the respondent, indicating a high degree of relation between i*ncreasing freedom of action* and i*n control*. This seams like a reasonable relation since activities *in control* are possible to manage and thus *increase freedom of action*. In addition, constructs 4 and 5 loads on the second component (C2), indicating that there should be some correlation between them. Therefore, this pair of constructs should be regarded as giving an enriched description of the component and not as synonymous.

TABLE 11 Highly correlated constructs

Pair	Construct	Construct	Correlation
4 & 5	Increasing freedom of action VS. Limiting freedom of action	Being controlled/influenced VS. In control	- 0,76
11 & 12	Requires a small amount of work effort VS. Requires a large amount of work effort	Least critical for process success VS. Most critical for process success	0,81
12 & 13	Least critical for process success VS. Most critical for process success	Least critical for product success VS. Most critical for product success	0,78

The second and third pair of constructs (construct 11 & 12 and 12 & 13) also indicate a high degree of relation. Aside from being synonymous, the constructs are fixed since intended for all individuals when executing the research plan. This implies that constructs describe action in the same way but are forced by fixed constructs without any possibility for the respondent to change them into describing a real difference. Based on this, constructs 11, 12 and 13 must be seriously considered. The second pair, showing the highest degree of correlation, features the following constructs: *requires a small amount of work effort* and *least critical for process success*. It seems reasonable that the least critical activities require the least amount of work effort; however, this is not necessarily the case, since different individuals may view some activities as critical for the process success without requiring a large amount of work effort. For example, the ation may be performed before and therefore experience might reduce the work effort thus giving the correlation between the second pair of constructs a logical explanation. The third pair of constructs indicates a relationship between *least critical for process success* and *least critical for product success*. This seems logical, as critical activities are necessary for the success of the product. Nevertheless, there might be activities that are critical for the process but not for the success of the product and therefore should not be

treated as synonymous. As in the case of the first pair, all constructs in the second and third pairs (construct 11, 12 and 13) load on the first component (C1), which indicates that there should be some similarity between them. Therefore, they should not be seen as synonymous but as providing an enriched description of aspects of the first component.

6.2.2 Four dimensions of the C4-DTN project activities

When reviewing the output from the Flexigrid program, four components where chosen in respect to the course of action presented in Section 5.2.2. As shown in Table 10, four components are generated and all components are represented by at least one strong factor loading above 0.7 and therefore account for approximately half of the explained variance. According to Hair et al. (1998), factor loadings above ±.50 are considered practically significant. In this case, factor loadings above ±.60 were included in the analysis. The factor loadings marked in green illustrate a strong loading between a construct and a component (above ±.60), while the light blue factors indicate a weaker but still practically significant relation (above ±.50). When limiting to loadings above ±.60, all four components have a fairly rigid structure, with pure components related to constructs not loading on several components. Only one construct does not load on any component: *Opportunity to affect product specification* vs. *Can no longer affect*. However, if rounded off, then it will be within the practical limit, while other constructs[21] within the practical limit load on more than one component.

The number of components indicates that the respondent has a fairly complex and nuanced view of the activities in the C4-DTN project. In terms of variance, the four components account for 76.3 percent of the total variance (see Appendix 4), which indicates that the individual's frame of reference may be explained by the generated components to a large degree.[22] The relatively clear loadings on each component also imply a clear description of the parts of each component. The four components indicate a rigid yet complex and nuanced description of the respondent's frame of reference. In the following sections, each component will be further discussed.

The first component (C1), technical orientation, due to its semantic relationship to the constructs, indicates a connection to technical aspects of the process. Within this component, five constructs (see Table 10) have a strong significant loading; another is included when rounded off to practical significance in order to describe the component. This dimension is related to *technology-driven* aspects, which require a *large amount of work effort* and are *most critical for both the product and process success*. At the same time, it is somewhat related to a *creating phase* within the process. Based on the content of these aspects, they all express some sort of freedom and importance in technology.

According to Table 12, activities considered practical significant are marked in red (or yellow)[23] to indicate activities with a factor loading above (or below) the standard

[21] Constructs 3, 13, and 14
[22] C1 accounts for 25.6%; C2 for 22.4%; C3 for 13.5%; and C4 for 14.8% of the total variance.
[23] The respondent has interacted or reflected about the elements highlighted in orange.

deviation of one and thus related to correlating constructs on the same component. The relation between components, constructs, and elements may be exemplified by the technical orientation (C1) component, which is positively correlated to GENERATING IDEAS[24] (element C in Table 12) and positively correlated with the eleventh construct, indicating that this element may be described by the pole construct as *requiring a large amount of work effort*. In contrast, the element SUPERVISE TIME, COST, AND DESIGN (V) is correlated with the contrast of the same construct, which indicates that the element *requires a small amount of work effort*.

Activities within the C4-DTN process related to constructs connected to the technical orientation component (C1) are: GENERATE IDEAS, IDENTIFY SUITABLE TECHNOLOGY, SIMULATING, TEST TECHNOLOGY/DESIGN, and DEVELOP CONCEPT. Thus, these activities are represented as *unlimited opportunities* and *technology-driven* aspects that *require a large amount of work effort* and are *most critical for the success of both process and the product*. Contrary related to the contrast constructs are administrative activities such as GET SUPPORT FROM MANAGEMENT/FINANCIER, PLAN PROJECT and SUPERVISE TIME, COST AND DESIGN (marked as yellow in Table 12) which Arne describe as related to f*inancial aspects* that are *least critical for process and product success*, r*equire a small amount of work effort*, and can be used as a *filter for ideas*.

TABLE 12 Elements relation to components

		COMPONENT Rotated factor scores			
	ELEMENTS	**C1**	**C2**	**C3**	**C4**
A	User feedback	-0.513	-0.249	-2.085	0.354
B	Get support from management/financier	-1.907	-2.714	0.395	1.141
C	Generate ideas	1.429	-0.317	-0.200	-2.839
D	Identify perspectives of others	0.243	0.806	-0.275	0.749
E	Identify suitable technology	1.452	0.345	0.105	0.782
F	Identify opportunities	0.491	-1.218	-0.609	-2.438
G	Plan/adapt for manufacturing	-0.877	0.880	0.546	0.478
H	Plan project	-1.316	-0.840	-0.395	-0.050
I	Programming	-0.094	-0.067	-0.706	-0.241
J	Simulating	1.272	0.332	0.103	0.625
K	Write product specification	-0.210	0.040	-0.568	0.032
L	Final tests on users	-0.104	0.270	-1.006	0.422
M	Product release	-0.677	1.938	2.380	-0.451
N	User studies	0.038	0.208	-0.923	0.668
O	Test technology/design	1.849	0.347	-0.740	1.638
P	Elaborate distribution	-0.588	0.012	1.157	-0.294
Q	Elaborate support	-0.750	-0.042	0.296	-0.391
R	Educate employees	-0.547	0.000	0.199	-0.448
S	Develop business plan for the innovation	0.596	-0.928	2.077	0.325
T	Develop concept	1.018	-0.882	1.031	0.435
U	Choose algorithm	0.753	-0.151	0.105	0.172
V	Supervise time, cost, and design	-1.557	2.229	-0.886	-0.670

[24] All elements appear in CAPITALS.

The second component (C2), process control, is significantly related to the constructs[25] of *limiting freedom of action*, *being controlled/influenced,* and *choose track (time to carry out)* and has practical significance to the constructs *constraining budget* and *application of previous knowledge*. Thus, this component seems to be related to control of actions in the product innovation process. The elements[26] related to constructs of this component (C2) are SUPERVISE TIME, COST, AND DESIGN and PRODUCT RELEASE. These two activities seem to be related to ongoing, limiting, and influencing choices within the process. It seems logical that a project manager might describe the element SUPERVISE TIME, COST, AND DESIGN as limiting freedom of action. These actions restrain the actions of others within the project frames being controlled and thus cause a need to *choose a track* within these frames. At the same time, the project manager is *controlled/influenced,* which indicates that he is not a part of setting the frames that he is controlling. Logically, the element PRODUCT RELEASE implies a finished innovation that is limited by a fixed date in which the innovation must be ready, implying choices of and influence on action.

The alter perspective of process control (C2) is related to elements with a negative factor score (marked in yellow) as shown in Table 12. The elements IDENTIFY OPPORTUNITIES and GET SUPPORT FROM MANAGEMENT/FINANCIER are described by their correlation with the constructs *creating phase, develops business (innovative phase), in control,* and *increasing freedom of action*. It seems logical to describe the element IDENTIFY OPPORTUNITIES as related to a *creating phase* that *develops business* and in which an individual is *in control* of the action, which *increases freedom of action*. To GET SUPPORT FROM MANAGEMENT/FINANCIER is surprisingly related to the creative phase of the innovation process. One way of viewing this is the need for creativity when obtaining support; the decisions made by management/financier give the project manager *increased freedom of action* in order to carry out the innovation process. Another way of viewing this relationship is by viewing the innovation as consisting of a creative phase and ending in a decision from management/financier about whether or not to carry out the innovation process.

The third component (C3), business orientation, is mainly related to the component *difficult to handle;* it may also be described as *requiring new ways of thinking*, *most critical for product success*, and *can no longer affect*. When only reviewing the constructs, it is easy to ascribe a creative aspect to this component; however, it is related to the activities of PRODUCT RELEASE, DEVELOP BUSINESS PLAN FOR THE INNOVATION, ELABORATE DISTRIBUTION, and DEVELOP CONCEPT. These elements seems related to business and due to the technical background of the project manager are viewed as *difficult to handle,* which implies *new ways of thinking* for the manager; this *new ways of thinking* construct could also be related to the need to foresee the impact of the innovation in order to develop a business plan and distribution. In respect to the role of project manager, it is logical to ascribe these

[25] See Table 10
[26] See Table 12

activities as critical but seems contradictory when the activities cannot be affected. In respect to the timeline of the present innovation process, these activities (DEVELOP BUSINESS PLAN and DEVEOLOP CONCEPT) are relatively early in the process, while the other two activities occur in the last phase. It seems contradictory that the activities in the ending phase are perceived as *can no longer affect* the process, even though it is still in progress.

When turning to the alter perspective of business orientation (C3), the activities of USER FEEDBACK and FINAL TESTS ON USERS are described as *easy to handle, opportunity to affect product specification,* and *least critical for product success*. Among these activities, there are some contradictions. From a technical perspective, these activities could be easy to handle, since they concern the testing of the present innovation in a real setting. It is not a complicated task to arrange from a project manager perspective. In the same way, these tests and feedback result in a need to refine. Nevertheless, these activities are considered least critical for product success, which suggests that they are useless and do not add value to the innovation process. On the other hand, these activities could be least critical in relation to the importance of getting an innovation at all. It seems like that further discussion with the respondent is needed for clarification.

The fourth component (C4), adaptation, is related to the constructs of *filtering the idea, finding problems giving extensive rework,* and *creating arguments within field of application*. All of these constructs involve adapting to reality by filtering ideas, modifying innovation, or as a basis for arguments if the innovation turned out well. Not surprisingly, these constructs are related to the activities of TEST TECHNOLOGY/DESIGN and *GET SUPPORT FROM MANAGEMENT/ FINANCIER*. This appears logically since testing may work as a reality filter for ideas and may provide extensive rework as well as powerful arguments, since the tests indicate strengths and weaknesses of the innovation in a proactive way. These arguments may also be used when obtaining SUPPORT FROM MANAGEMENT/FINANCIER if extensive rework is necessary. From a innovation process perspective, tests are made in a mid-phase while support from management are given great weight in an early phase and occasionally throughout the entire process, due to project evaluations and unforeseen implications. From this perspective, SUPPORT FROM MANAGEMENT is an activity in constant need of argument, while TESTING TECHNOLOGY/DESIGN creates arguments.

The alter perspective of adaptation (C4) is described by the constructs c*reate free thoughts, unlimited opportunities* and *working without knowing if it is right*. These constructs concern adaptation but in a more reactive way. Thus, they may be used to IDENTIFY OPPORTUNITIES and GENERATE IDEAS. These activities are reactive adaptations characterized by unlimited opportunities through free thoughts. It is impossible to determine whether the ideas are right or not unless critical reviews or pretests are made concerning the ideas and opportunities identified. These activities take place in an early phase of the innovation process, which is logical to its describing

constructs, since this project has broadly defined boundaries with great maneuverability until details of the innovation are elaborated; thus, these relations seem logical from both a project manager and innovation process perspective.

6.3 SOCIAL NETWORK ANALYSIS ABOUT THE C4-DTN PROJECT

Turning to social network analysis, communication about each action-oriented activity and its effect on the respondent's view and work were determined. Only a few activities were discussed by the project manager during the past month.[27] Mainly, he had communicated with individuals representing organizations that were not involved in the innovation process as business representatives. Discussions were related to actions of GENERATING IDEAS and IDENTIFYING OPPORTUNITIES.[28] Notably, these contacts had only a minor or no effect on his view and work. The individual with the largest effect on the project manager's view was a project member responsible for the research. In addition to discussing the aspects[29] already mentioned, they also communicate about PROJECT PLANNING as well as TIME, COST, AND DESIGN. These discussions had a larger effect on the respondent's view and especially his work. A logical explanation is that the respondent need to be well-informed of present ideas and opportunities as well as present state in relation to deliverables in order to discuss and develop new ideas and opportunities with business representatives. Planning and supervision are also closely related to the identity ascribed to a project manager.

When linking the results from the social network analysis to the repertory grid, it may be concluded that activities related to three (C1, C2, C4) of the four components were discussed during the past month. The only component not discussed was activities related to business orientation (C3). Since business-oriented aspects are seen as post-development (they [*can*] *no longer affect* the process but are still [*most] critical for product's success* and are *difficult to handle)*, it is likely that this aspect should be discussed, at least within the team. In this sense, the process lacks a relationship to business orientation aspects; on the other hand, the project manager has contacted business representatives to identify opportunities. This may be a first step of introducing a connection to business orientation (C3) since the opportunities of business representatives could be the ones being internally discussed and strived for.

[27] The matrix about contacts is found in Appendix 5.
[28] The five activities discussed and/or thought about appear in orange in Table 12.
[29] Aspects refer to various ways of discussing an activity (element). For example, the activity of generating ideas may be directly discussed when generating an idea or it may be discussed from the aspect of reviewing an already generated idea.

6.4 ALTER-EGO NETWORK ANALYSIS ABOUT THE C4-DTN PROJECT

Alter-ego network analysis reveals about which activities of the C4-DTN process that the project manager has been actively thinking. The results indicate that only four aspects have been given conscious thought:[30] IDENTIFY PERSPECTIVES OF OTHERS, IDENTIFY OPPORTUNITIES, PLAN PROJECT, and SUPERVISE TIME, COST, AND DESIGN. The respondent thought about all of these activities a number of times over the past month except for IDENTIFY PERSPECTIVES OF OTHERS, which was thought about to a lesser extent. Similar to the effects of discussions, the three activities given a larger degree of thought are the ones indicating a larger effect on work, while the other had a greater effect on his view than on his work. A logical interpretation is that actions relatet to IDENTIFY PERSPECTIVES OF OTHERS are relevant and thus will effect his view, but mostly will effect the actions of others participating in the process. This since others perspectives are about the innovation and thus not effect the actions ascribed to identity of the project manager, but rather transferred to identity of the researcher. Once again, it is not astonishing that activities such as planning and supervising are central to identity of the project manager.

6.5 CONCLUDING REFLECTIONS ABOUT THE METHODS USED

Based on this significant test, several conclusions can be made regarding aspects of and the usefulness of these techniques. The repertory grid technique was able to provide detailed descriptions of the guidelines that an individual ascribes to activities within a product innovation process. In order to further enhance this description, follow-up interviews are needed in order to clarify understanding of the relationship between constructs and elements. Moreover, more precision in the description of constructs is needed to avoid ambiguity. For example, *financial aspects* vs. *technology driven*[31] can be further divided into two constructs, i.e. more or less financially-oriented and more or less technology-driven, if meaningful for the respondent. If so, these construct should be divided into separate constructs when conducting the repertory grid interview.

A very important reflection concerning the use of several techniques is their ability to capture different and especially complementing aspects of an innovation process. Based on the repertory grid several elements were loaded on the four components (Table 13). Alter-ego network analysis identified an activity given much thought and with effects on work and view but not central on any component according to the repertory grid. In the same way, the repertory grid indicates several activities on the first component (C1) as requiring a *large amount of work effort* and as *most critical for process and product success*; nevertheless, these activities were not discussed by the project manager. If using these techniques on several individuals in the innovation process, it is probable that alternative and/or varying descriptions and relations would occur. For

[30] Appendix 5 presents the matrix about thought.
[31] See Table 10

example, the noncentral mid-phase activities[32] might the research representative ascribe great importance, since this is their primary area of action.

Another conclusion is that most aspects discussed appear to be in the early phase. However, in contrast the research representative would probably discuss and think about aspects ascribed to the mid-phase. What might be troublesome is the lack of discussion about business-oriented aspects in the late phase. Ideas and technical development made in the early and mid-phases will not be transformed into use if these aspects are not developed or discussed. Another possible explanation is that this process does not aim toward selling a product but only to plant its implications within the company; therefore, the activities in the late phase are dealt with within the company and not within the scope of the innovation process.

TABLE 13 Activities used

Central elements[33]		
Early phase	**Mid phase**	**Late phase**
User Feedback	Simulating	Elaborate distribution
Get support from management/financier	Test technology/design	Develop business plan for the innovation
Generate ideas	Develop concept	Final tests on users
Identify suitable technology	Supervise time, cost, and design	Product release
Identify opportunities		
Plan project		
Elements not central on any component		
Identify perspectives of others	Choose algorithm	Educate employees
	User studies	Plan/adapt for manufacturing
	Write product specification	Elaborate support
	Programming	

The aim of the significant test was to evaluate whether fixed elements representing actions within the product innovation process could be used and, if so, to validate these elements since the entire study is dependent on relevant and valid elements used in all three techniques. Based on the results in Table 13, there are elements that appear to be central to each phase in the process. There are also a number of elements that are discussed and/or thought about (marked orange), suggesting that these elements may be ascribed meaning but are not discussed in the present stage of the innovation process. A central consideration is whether elements used in this test may be expanded in a broader sense to several individuals in a product innovation process. It is highly plausible that elements not considered central in the mid-phase might be considered as more important to individuals working on activities in this phase. The elements not appearing as central in the ending phase are elements that may be specific instead of generic for an innovation process. In this case, such element might be more relevant for an innovation to be commercialized by a company.

[32] See Table 13

[33] A central element refers to elements with loadings on one or more of the four components.

7 FORMULATING A RESEARCH PLAN OF PRODUCT INNOVATION PROCESSES

This section will first address aspects drawn from the significant test and its implications, resulting in focus questions for a future study. These questions will be addressed from a theoretical and a methodological perspective in order to develop a research plan.

7.1 FORMULATING A FOCUS OF THE RESEARCH PLAN

As previously described in Section 3.6, innovation processes are sometimes described from the perspective of best practice activities (Fairlie-Clarke & Muller, 2003; Cooper, Edgett & Kleinschmidt, 2002; Feldman & Page, 1984). However, these suggestions of best practice innovation activities are not applicable to all contexts in terms of action due to their level of abstraction. Elements used in the significant test were derived from theory, suggesting activities that could represent action, and interviews, giving different perspectives in order to make the elements representative of action within this context. In the significant test, elements were used by various techniques in order to capture different aspects of a product innovation process. One result of this test was that individuals participating in the innovation process might construct activities in one way, interact about other activities, and think about yet another activity. In other words, innovation processes are complex and cannot be fully understood through a sequential best practice perspective.

Since innovation, by definition, is something perceived as new, and the innovation process depends on the innovation being developed, then one might assume that every innovation process should be unique in some way. Otherwise, the process would reproduce a present product. *To a large degree, there will be similarities to activities performed in previously innovation processes within the company*. Some activities will be considered unimportant and thus withdrawn from the plan of activities within the innovation process, while other activities may be considered important and thus added; however, there will not be an exact match in terms of actions performed. There will always be some freedom of action within the innovation process. As Giddens (1984) points out, the action taken will guide future action; thus, *there should be some level of correspondence between processes and individual views of activities and actions to be made in the process*. Nevertheless, even if activities differ slightly between performed innovation processes and individual action within the frame of these activities, they are still built on *a reproduction of institutional structures that provide stability and meaning to performed thoughts, actions, and interactions*. Based on this, individuals will construct activities differently, but these activities (elements) are generic (with some unique traits). This makes it meaningful to use common elements for individuals within an innovation process that are adjusted to context between different innovation processes. Consequently, these are the details of a product innovation process that are of great importance in understanding the dynamics of innovation.

As the significant test indicates, several techniques must be used in order to capture the dynamic nature of an innovation processes. In the section above, I argue for differences and similarities among innovation processes but the significant test makes it plausible that different individuals will have distinct views concerning the innovation process. For example, some technically-oriented elements were not central for the project manager but would probably be very central for those individuals obliged to perform these tasks. As such, it seems likely that *each individual ascribes an identity toward action and interaction within* the *innovation process*. By combining techniques, differences may be highlighted to provide details of the product innovation process.

Another important feature of product innovation processes, as indicated by the significant test, is the difference in activities that are more central to different phases of the process. Following a sequential view, it seems logical that action should represent the present phase. Based on this view, some activities should only take place in an initial phase and perhaps thought about and discussed in later phases. However, different techniques might reveal a chaotic innovation process in which some things are iteratively interacted about and may be acted on within the process. Nevertheless, *central elements in a particular phase might be more interacted about and/or thought about before, during, and after it has been made in action*.

An important note for future studies, based on the significant test, is that the combination of techniques requires a large amount of time for the researcher and the participating individual(s). As indicated above, it seems necessary to use several techniques in order to capture these aspects of a product innovation process. This might make it more difficult to find companies that are willing to take part in this research. This could be addressed by reducing the scope of the study from the entire innovation process to one segment of the process, such as the early phase or fuzzy front end. According to Khurana and Rosenthal (1997), the front end process begins when individuals first recognize an opportunity and ends with the deliverables of a product concept, a clear product definition, and a project plan. The fuzzy front end is also a research area presently receiveing much attention from researchers; a search on "fuzzy front end" in business source elite, Blackwell Synergy, Science Direct, and Emerald yielded 17 relevant articles[34] published between 1997 and 2006. Consequently, focusing on the early phase of the product innovation process would be beneficial for the intended techniques, companies' willingness to participate, and gaining knowledge of the early phase of innovation.

This discussion highlights some fundamental issues and perspectives of innovation processes based on the significant test. The overall goal is to contribute to the field of innovation processes by addressing the continuous micro-processes in the product innovation process as an initial idea evolves into a concept. Returning to the illustration presented in the introduction, Edison and his assistant iteratively thought about, interacted, and acted in different directions, which resulted in an innovation. These thoughts, interactions, and actions continuously evolved into an innovation.

[34] The search rendered 22 hits, 17 of which were considered relevant in respect to the fuzzy front end.

This example, however, does not explain the structures of a clear product definition and a project plan as indicated by Khurana and Rosenthal (1997). However, Edison recognized an opportunity and had a clear vision (but not a clear product definition) where the initial idea iteratively transformed into an innovation. This results in the following focus question:

1. *How does an innovation process unfold as a product idea transforms into a concept?*

Important aspects of this focus question are to clarify what the early phase is and how it may be transforming; these aspects are addressed in Section 7.2. In order to understand how the early phase of product innovation processes unfolds, one must understand the implicit details summing up in to mechanisms that influence this phase. A first step is to visualize cause-effect relations of the unfolding product innovation process. Possibilities of the techniques used in the significant test and identification of mechanisms are related to the interrelation of action, interaction, thought, and individual constructs of the process at the individual level. Thus, it is not a question of objective mechanical relations but rather a subjective view of how participating individuals perceive their mechanisms (cause-effect relations). This results in a second focus question:

2. What mechanisms influence the early phase of product innovation processes?

Both focus questions are at the center of the V-diagram presented in Figure 9. This diagram is a simplified version of the one presented by Novak and Gowin (1984). However, it is sufficient for the purpose of linking the conceptual and methodological sides in order to guide the outlined focus questions. The V-diagram also works as a guiding structure for the forthcoming sections of this chapter; thus, the research plan presented based on these focus questions will guide a theoretical presentation, resulting in the purpose for the future dissertation followed by a methodological discussion.

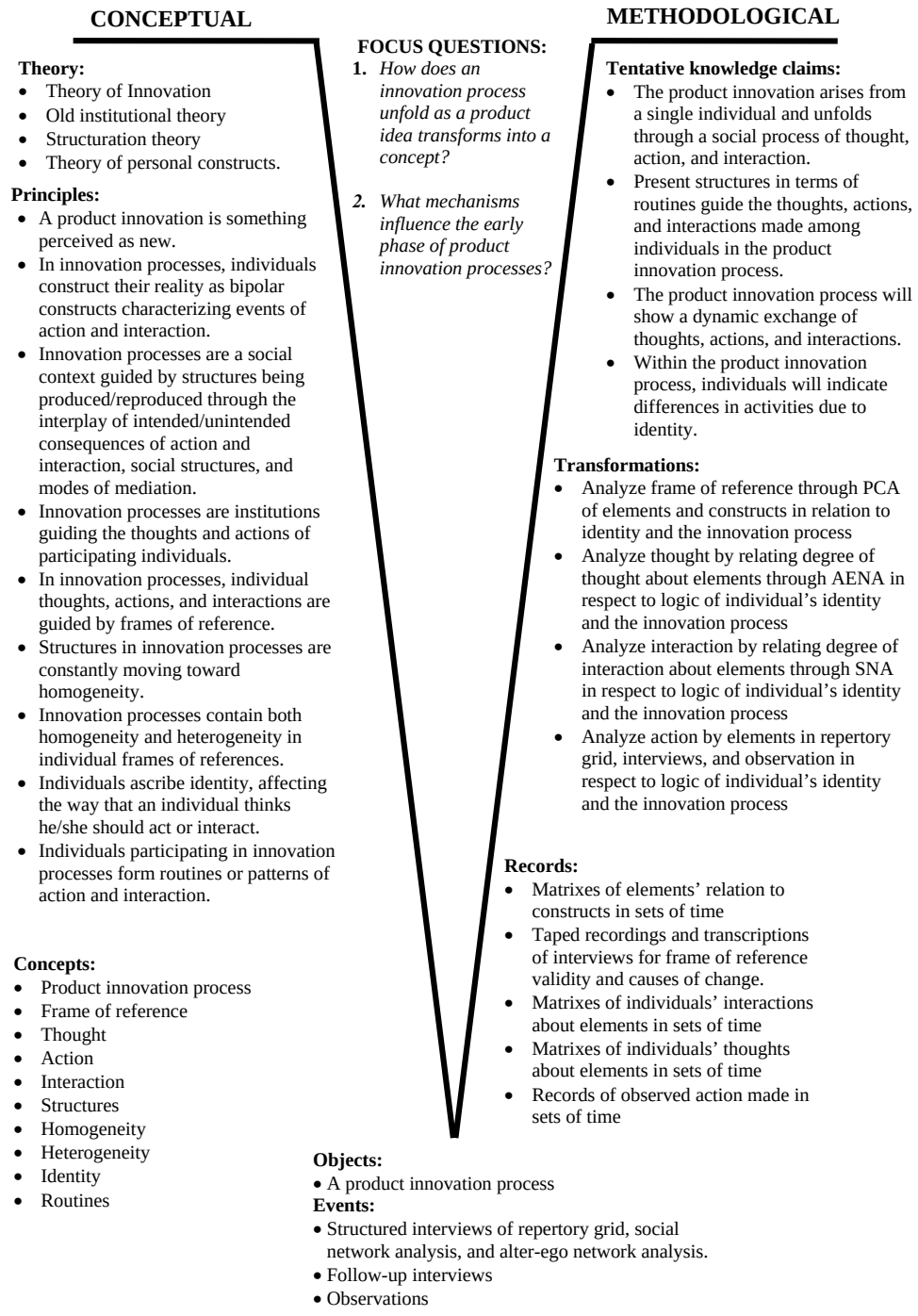

FIGURE 9 Evolving the research plan through a V-diagram

7.2 CONCEPTUAL CONSIDERATIONS IN THE RESEARCH PLAN

The phenomenon under examination is the early phase of the product innovation process. In respect to this, it is relevant to define the early phase. Returning to the view of Khurana and Rosenthal (1997), the fuzzy front end process starts with the recognition of an idea and ends when the project is presented and thus committed resources or terminated. In the words of Reid and de Brentani (2004), the fuzzy front end is related to all "activity spent on an idea prior to the first official group meeting to discuss it," or what they call "the start date of team alignment." They further discuss how the fuzzy front end process involves idea generation and concept development along with information collection and pre-screening. Reid and de Brentani also mention that some initial funds are allocated for exploring the new idea. Other authors (Alam, 2006; Kim & Wilemon, 2002; Zhang & Doll, 2001; Koen et al., 2001) discuss similar definitions of the fuzzy front end of innovation processes. In this thesis, the terms "early phase" and "fuzzy front end" refer to the same underlying activities of thought, interaction, and action. Looking back at the simplified model of an innovation process presented in Table 4, all activities in the early phase would apply to those performed in the fuzzy front end. Therefore, the early phase and fuzzy front end are treated as synonymous but will hence only be referred to as the early phase.

When clarifying the beginning and end of activities in early phases of a product innovation process, it is important to further develop the collective and subjective character of this early phase. In relation to the first focus question (*How does an innovation process unfold as a product idea transforms into a concept?),* some literature provides a black or white view, only discussing included or excluded activities (cf. authors presented in Table 4). However, there are gray areas in terms of this phase (see Figure 10). The activity of developing product ideas may begin in the mind of an individual during daily ongoing institutionalized moments of action and interaction.

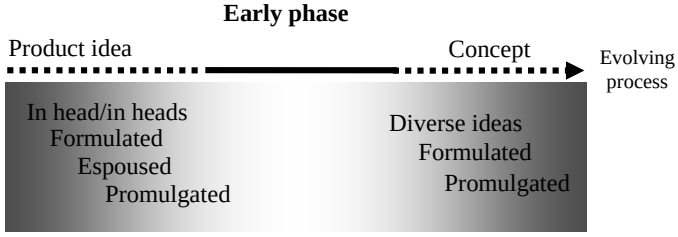

FIGURE 10 The beginning and end of the early phase

Then, the individual evolves this idea by formulating it in relation to the self and to significant others. In order to be an innovation, it must be perceived as new in relation to present structures. After some interaction and action, the idea will be espoused by significant others; after a formal encounter, the idea may be promulgated as workable. Somewhere in between these states, the early phase begins. The beginning of the early phase is thus subjective in the sense that no clear cut moment may be specified. The collective character is related to the degree of involvement with significant others in

order to start and evolve an early phase. In relation to this thesis, it would be preferable to enter the early stage as early as possible.

The practical side of this concerns problems of access to the arena in which the product idea evolves. It is not possible to enter the early phase in the mind of the individual coming up with the initial grain of idea. It may even be harder to enter the stage of formulating the idea, since it may be difficult for the individual to describe the idea, or he or she may have a vague notion of the related context and features. If granted formal access and provided with trust, then it would be possible to enter in the arena which ideas are exchanged with significant others with some degree of alignment (espoused) and formed into something possible to express and discuss. When promulgated, the idea has been accepted as something to which to devote resources, which makes it easier to find and be granted access to the organization. Similarly, a concept may be described as consisting of diverse ideas to be delivered as a formulated concept agreed upon in relation to significant others or as a promulgated concept to carry on with or to terminate. In this thesis, the early phase ranges from promulgated product idea to concept. In this way, the early phase can be formally recognized in descriptions and decisions, which simplifies problems related to identification and access.

Another issue related to the focus on early phase, is the length in time between the initial and concluding activity performed within this phase. In other words, is the early phase large enough in time period to be captured within the individuals in a meaningful manner using the intended techniques. By arguing that action and interaction will lead to an altered frame of reference and structures (see the conceptual model in Figure 5), the early phase must last at least long enough to perform the actions and interactions. However, it is not a question of time per se but rather the level of action and interaction within the information setting (space, not time). The focus is thus on the actions and interactions made within the early phase, which, if measured in time, could vary considerably. Change in an individual's frame of reference could occur in seconds or over several months. Similarly, if no actions or interactions are made, then time passes without any change in the individual's frame of reference or guiding structures. In other words, time is irrelevant in respect to space and thus to the actions and interactions made in the early phase.

Let us return once more to the first focus question: *how does an innovation process unfold as a product idea transforms into a concept?* To elaborate on how, let us review the collective and subjective character of product innovation as characterized by the principles presented in the V-diagram in Figure 9. When an idea arises in an individual during the ongoing moments of action and interaction, it will change his or her present frame of reference. Individual frames of reference accumulate and assimilate past experiences from which to draw in social encounters of thoughts, actions, and interactions. These accumulated and assimilated frames of reference are *organized as bipolar constructs* characterizing the encountered experience. In this way, context, situations, and individuals may be guided as good or bad, simple or complex,

etc. As such, an *individual's future thought*s*, action*s*, and interaction*s are guided by past constructed encounters that have been accumulated and assimilated into their *frame of reference*. This implies that the early phases of product innovation processes arise out of an individual either using a past experience as model on a "different" encountered situation or by using a "different" model on an encountered situation. In both cases, the result will be a modification of the present frame of reference guiding thought, action, and interaction due to unintended consequences in either situation or frame of reference. In other words it implies something new or innovative in terms of products.

Individuals taking part in the early phase of the product innovation process are all guided by their frames of reference, which are based on their unique collection of experience. However, on a collective level, they are all experiencing the same actions and interactions during their participation in the innovation process, which causes them to relate to similar structures in their frames of reference. In this sense, individuals *constantly thrive toward homogeneity* in these structures; however, there will never be an exact match in terms of past experience, which implies *both homogeneity and heterogeneity* in individual frames of reference. This homogeneity and heterogeneity may overlap during the early phase depending on time and focus.

In the beginning of the early phase, a large degree of heterogeneity about the idea exists; through social encounters, and thus common experience, homogeneity will develop over time. Also contributing to a high degree of homogeneity is a sense of shared risk with significant others. If a high degree of homogeneity exists, then one does not stand alone if questioned within the organization. However, there may be a large degree of homogeneity about the concept but not how to generate the concept, depending on the focus of interest. It is thus possible to indicate a high degree of homogeneity about the activities but does not necessarily imply a high degree of homogeneity about the fundamental features included in the concept. Homogeneity and heterogeneity are also related to differences in identity ascribed by participating individuals, which affects the part of an individual's frame of reference that is activated in an encountered situation. If an individual has a deep-structured *identity* as project manager, then he or she will most likely *ascribe certain constructs into the situation* as more important than an individual ascribing another identity.

In the early phase, individuals produce something new in terms of thought, action, and interaction that is both enabled and restricted by the individual's frame of reference. Nevertheless, since individuals draw on past experiences when *producing* thoughts, actions, and interactions, they are also *reproducing structures*. Therefore, patterns may occur, which may restrict new ways of thought, action, and interaction. These *institutionalized patterns* can include *rules, routines, norms, and values* giving guidance of appropriate ways of thoughts, actions, and interactions among participants within the social arena surrounding a product innovation process. If individuals have participated in early phases of previous product innovation processes, then they have produced and reproduced patterns, which assures some degree of homogeneity in

activities to be made. However, restrictions due to institutional patterns depend on the content of these institutional rules, routines, norms, and values not on homogeneity or heterogeneity per se.

This discussion of the early phase of product innovation processes presents some central concepts: product innovation processes, frames of reference, thoughts, actions, interactions, structures, homogeneity, heterogeneity, and identity. Several of these concepts are complex in their construction and especially in their relation to each other. Product innovation process has a natural representation to context in which this research will create knowledge. Concepts like frame of reference, thought, action, interaction, and structure relate to the theoretical areas of structuration and institutionalization. However, the relationships between these concepts are unclear and uncertain from a theoretical perspective due to different uses of similar concepts on different dimensions depending on the theoretical focus.

From an institutional perspective, Scott (2001) describes how an institution rests on a regulative, normative, and cultural-cognitive pillar. Within these pillars, Scott argues that different dimensions all transmit the institution as a carrier and thus provide stability and meaning to social life in product innovation processes. These rules, norms, and cognitive meanings arise in interaction and are constantly preserved and modified in action (ibid). Giddens (1979) includes action as well as interaction as fundamental to an individual's ongoing production and reproduction of social structures. Clearly, both interaction and action stand out as central concepts. If turning to the carriers of institutions (Table 14), Scott suggests four carriers with different features related to each pillar. However, these categorizations are not fixed; theorists vary in which features and carriers they emphasize. One reason for this might be the comprehensive research needed if all carriers within each pillar were collected within the institution (the early phase of a product innovation process). Therefore, I will focus on routines as a carrier of institutions.

Routines are patterns of action and interaction.

This definition does not exclusively relate to routines as specific sequences of action and interaction like a repetitive movement on an assembly line. A routine may contain some degree of variation, which in itself implies small variations while still reproducing the routine. Feldman (2000) elaborates on this, stating that the continuous variation included in the very essence of routines gives it "qualities of both stability and change." Nevertheless, reoccurrence is central in the concept of routines, which may be defined as "patterns of action and interaction" (Becker, 2004). Included in these patterns is a repertoire of possible ways of action and interaction that incorporate the pattern to be included in the routine. This resembles Feldman's (2000) view of routines, which states that "change is more than choosing from among a repertoire of responses, and that the repertoire itself, and the rules that govern choice within a repertoire can also change." In this paper, changes in patterns of action and interaction are represented by changes in an individual's frame of reference; thus, both

the repertoire of possible action and interaction as well as the view of which action is chosen may change over time and space while still performing a routine.

Defining a routine, Scott (2001) emphasizes habitual behavior reflecting held and conveyed tacit knowledge, i. e. patterns of action and interaction. However, this definition leads to challenges. A routine as a pattern of action and interaction may be described (which is difficult if seen as tacit knowledge) but not the initial origin or cause, which may be taken for granted and thus difficult to express in words. Individuals may describe what they do but not why they do it. A possible answer could be, "because we always have…" or in exceptional case a story telling the origin of a particular routine. Furthermore, individuals in early phases may describe their patterns of action and interaction in one way (espoused theories) but act and interact in another way (theories in use; cf. Argyris & Schon, 1978). By defining routines as patterns of action and interaction, I do not focus on a normative or legitimizing use of routines but rather on descriptions of *what individuals usually do* in an early phase. Argyris, Putnam, and McLin Smith (1985) state that patterns of action and interaction are made explicit through reflection and then governed by individuals' theories-in-use (in other words, *what they usually do*). If individuals emphasize "espoused theories" of their action and interaction, it is detected by the use of several techniques for capturing these concepts. If returning to the features described in the dimension of routines (Table 14), protocols and standard operating procedures will represent patterns of action and interaction usually done in the early phase. This "usually done" represents the need for previously performed early phases and thus experience in the individual's frame of reference.

TABLE 14 The pillars and carriers of institutions
Source: Scott, (2001)

Carriers	**Pillars**		
	Regulative	**Normative**	**Cultural-cognitive**
Symbolic systems	Rules, laws	Values, expectations, standards	Categories, typifications, schema
Relational systems	Governance systems, power systems	Regimes, authority systems	Structural isomorphism, identities
Routines	***Protocols, standard operating procedures***	***Jobs, roles, obedience to duty***	***Scripts***
Artifacts	Objects complying with mandated specifications	Objects meeting conventions, standards	Objects possessing symbolic value

In the second pillar, Scott (2001) relates roles and obedience to duty as normative features. Instead of roles, I will use the concept of identity, even though it is mentioned as a relational carrier of the cultural-cognitive pillar. As described in Section 3.3, individuals ascribe identities in social settings, which may be deeply structured within the self or situated identification only lasting, as the situational cues exist within a particular context (Rousseau, 1998). Roles can affect action and interaction in the social setting but are necessarily not incorporated into the self (situated identity). Scott does not elaborate on the difference between identity and role. However, differences arise through implicit use of this categorization of relational

systems as relying on "patterned expectations connected to networks of social positions: role systems" related to cognitive identity as contrary to routines relying on "patterned actions that reflect the tacit knowledge of actors" related to normative roles. He relates roles to action and identities to expectations of social position (role systems).

Concerning role and identity, there are inconsistencies in the argumentation performed by Scott (2001). One way of looking at this difference is to view roles as placing "himself or herself into a defined position relative to others," while identity has a categorical distinction incorporated into the self (Brewer, 2001). If incorporated into the self, it lies closer to tacit knowledge, since an individual probably cannot rationalize actions routed in identity while possible for role action. Using the analogy of an actor, he or she plays a role, but it does not feel real until a part of the self is incorporated into the role. Similarly, a project manager defines himself or herself relative to other participating individuals as having some degree of authority and legitimacy, which places him or her in a power position relative to the significant others in action and interaction. This role, however, may not be acted or interacted in a trustworthy way until incorporated into the self. Because it is difficult to separate them, the concept of identity will be related to an ascribed routine as a guideline for action and interaction, which may be temporal as in situated identification or deeply structured and thus tacitly incorporated into the individual's self. Included in this view of identity is an expectation of a certain way of action, which may be either self-induced by viewing others or by reproducing structures in action or interaction with significant others. It is also possible to feel uncomfortable within an ascribed identity, representing a discrepancy between identity and self. Since my view of identity is based on a temporal state within a situation, it resembles the view of having multiple identities.

In the cultural-cognitive pillar, scripts are called a feature of routines. Although Scott (2001) does not elaborate on fundamental differences between schemas and scripts, scripts are assumed to be more closely related to action. In this thesis, I view the concept of frame of reference as synonymous to the term schema[35]as used by Scott. When individuals engage in thinking or participate in a social situation through action and interaction, they draw on their frames of reference to make sense of the situation. Thus, individual frames of reference guide actions, interactions, and interpretation. Because frame of reference and scripts are so closely intertwined (consequently difficult to separate besides in theory), they will be treated as synonymous; thus, frame of reference is a routine-based concept of the cultural-cognitive pillar. The concept of frame of reference was elaborated in Section 3.2. Another central concept used in this thesis is thought, which may be argued as related to a tacit dimension, action related as in purposeful, and to a cognitive dimension. When an individual engage in thinking processed he or she draws on their frame of reference to take action or interact. However, routines as patterns of action and interaction may also reflect mechanical representations of purposeful action and interaction not involved in a purposeful

[35] The term "frame of reference" is seen as synonymous to schema and cognitive structure.

thinking process. Therefore, thought is also included as a central concept in this category.

When turning towards these concepts relation to structuration, they are also fundamentals in the ongoing moments of maintaining the institution through production and reproduction of structures. Action and interaction are fundamental parts of structuration that draw on social structures of legitimation, signification, and domination. Receiving intended consequences reproduces the same structures and otherwise it will produce new structures governing that particular social setting (cf. Macintosh, 1994). According to Giddens (1979), this package of structures is mediated through frames of reference, resources, and norms and is viewed through agency in communication, power, and sanction. In an institutionalized social setting, each time that an individual acts or interacts, they draw on these structures, which may become a part of the individual's identity and thus incorporated into their frame of reference. A simplified way to see the connection between structures in the institutional setting is *to relate them to content* within each feature described as routines in each pillar.

Based on the previous discussion, the central concepts for the research plan are product innovation process, frame of reference, thought, action, interaction, structure, identity, homogeneity, and heterogeneity. These will be operationalized in relation to the routine dimension presented in Table 14. The next section will address aspects related to the techniques intended to capture these concepts.

7.3 How to capture evolving product innovation

To address the two focus questions, a number of techniques have to be used. The first focus question describes the transition of something into a concept of a perceived innovation. This something is a premonition or vague idea, which through time of thought, interaction, and action evolves into a concept of perceived innovation. In order to capture this evolving product innovation process, the techniques must capture the *transition from one state to another* within the process as well as the *content of this transitional state*. Since the focus lies in the process as conceptualized in thought, interaction, and action, the intended techniques must capture these aspects. The significant test also indicated a need to use several techniques due to the complex relations between individual thoughts, interactions, and actions in the product innovation process. An individual may think about some aspects of the process, interact about other aspects, and act on another aspect. Participating individuals may also have different thoughts, interactions, and actions due to their frames of reference, identity, and institutional routines governing the innovation process. As such, participants tend to use certain ways of thought, interaction, and action in the early phase of the innovation process, which must be captured by intended techniques.

To capture the central concepts presented in the V-diagram in Figure 9, various techniques will be used at different times throughout the early phase (Figure 11). The

study will begin with interviews in order to establish routines of action and interaction governing the early phase. These concrete routines will then be used in the repertory grid technique (RGT), social network analysis (SNA), and alter-ego network analysis (AENA) at the beginning and at the end of the early phase. In order to determine their way of doing (rules, routines, norms, and values), observation of meetings and daily work will be conducted. In the subsections below, I will address each technique and its ability to capture the central concepts of the early phase of the product innovation processes.

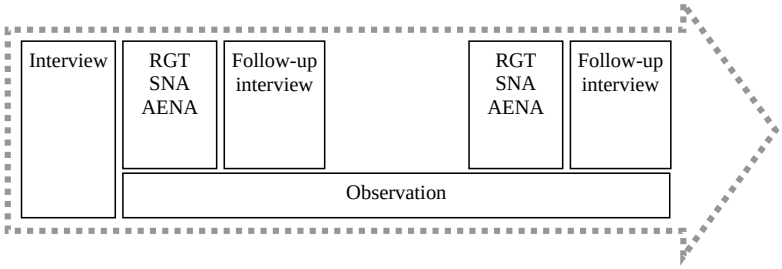

FIGURE 11 Intended moments of information collection within the early phase

7.3.1 Interview

Interviews are a fundamental technique for capturing several of the central concepts. First, the aim is to generate representative elements for patterns of action and interaction in the early phases of the product innovation process. As such, the focus is on standard operating procedures, as in descriptions of formal routines in the early phase. Other means of obtaining this information include reviewing documents, diaries, observations, or a literature review. By reviewing documents, several activities of action and possibly interaction may be identified but not in detail, implying the possibility of not includeing some activity in the repertory grid technique. Similarly, a literature review give usually made action and interaction, in theory, but may not reveal the action and interaction made in a particular social setting governing the early phase under examination. Diaries or observations provide access to details and an exact description of actions and interactions; however, this is a time-consuming effort, since one early phase has to be performed in order to generate elements which may be used in the next performed early phase. Therefore, interviews are most suitable for generating elements. Interviews may be conducted in many different ways, e. g. personal, group, structured, and unstructured (Denzin & Lincoln, 1994). In this case, semi-structured interviews will be conducted to combine detailed descriptions while allowing for follow-up questions. Asking the participant "what they usually do," which represents past experience from previous processes, will indicate routines in the early phase of product innovation.

In relation to how an innovation process unfolds and the mechanisms governing the early phase, interviews may provide detailed descriptions, stories, and reflections. By

analyzing these interviews, mechanisms may be identified by focusing on the description of the process along with critical incidences and the causes to incidences. Descriptions of action and interaction in the entire early phase may be collected for use in the repertory grids, but asking about critical incidences will also give validation of results; later techniques may indicate thoughts, interactions, or actions about activities other than those perceived as critical.

Interviews will also be conducted with the purpose of validating and learning about the frame of reference presented by the repertory grid technique. Through follow-up interviews, individuals can respond to the presented patterns (cf. the course of action made by Öhman, 2004 and Häckner et al., 1996) through e.g. nodding, expressions or a story to the presented relation. This will allow for discussion of inconsistencies that might be tacit or even unconscious.

7.3.2 Repertory grid

Frame of reference is a difficult concept to grasp, since it represents continuously altering mental templates. Techniques that describe frames of reference[36] must deal with a concept often considered as tacit and even unconscious to the individual. Frequently used techniques, all based on structured or semi-structured interviews, include cognitive maps (Huff, 1990), self-Q interviews (Bougon et al., 1990), and the repertory grid technique (Kelly, 1955/1991). Using cognitive maps in this case implies a map specifying the territory of an early phase, with action in focus, through a graphical representation of the mental relations, similarities and/or differences in the action and interaction activities performed. When using self-Q interviews, the individual is seen as an expert; these self-generated questions expose their tacit and explicit knowledge as well as their construction of the early phase of product innovation processes. The repertory grid technique may reveal individual frames of reference based on a bipolar categorization of constructs describing meaningful similarities and differences between elements (cf. Kelly 1955/1991). This technique, based on structured interviews, has been used in a variety of contexts (Stewart & Stewart, 1981) and also tested in the significant test presented in this thesis.

The use of the repertory grid technique is mainly related to the concepts of homogeneity and heterogeneity in individual frames of reference. Because these frames of reference must be described in the context of a product innovation process, concrete activities of action will be used as elements in order to describe similarities and differences among participants. These matrixes, in which participating individuals describe similarities and differences among activities to be performed within the early phase, are then processed using Flexigrid and Multigrid (Tschudi, 1998). These repertory grids will highlight areas of homogeneity and heterogeneity among participants' frames of reference.

[36] The frame of reference cannot be depicted but is partially exposed by mapping or indicating relations, which makes it possible to discuss.

On a practical level, this implies a need to identify actions made in the early phase of the product innovation process. Some guidance is found in literature describing included activities but most important is adaptation towards activities of action characterizing the action ordinary made in early phases of a participating company. Rules and routines or "what ought to be done" and "what are done" must be established before investigating similarities and differences among these activities. Rules are found through specifications in formal documents that influence the process and through discussions with a project manager; routines may be described by participants or established through observations. However, observations entail following a process in advance, which makes them unsuitable due to time limitations. Examples of activities include discussing ideas, initial screening, and developing concepts. Representative activities will be determined after discussion with individuals who are participating in the early phase. These activities will be used to describe similarities and differences; each individual then generates meaningful constructs that are processed in Flexigrid and Multigrid (Tschudi, 1998). To display a transition, at least two occasions of investigation are necessary due to the fundamental assumption that frames of reference evolve toward homogeneity.

The content of generated dimensions in Flexigrid and Multigrid, must be related to identity and time of impact within the early phase. Depending on ascribed identity and their responsibilities in the process, individuals will give different meaning and importance to activities. This will be shown by differences in the number of dimensions generated by Flexigrid as well as similarities in constructs used to describe activities in the early phase. Some activities may be more central in different times, depending on evolving frames of reference, and present focus. Thus, one must connect activities performed in the early phase with those considered as central at that time. Follow-up interviews allow the individual to react and comment on the generated dimensions, related elements, and constructs. In this way, increased understanding of each grid may be displayed and discussed in order to validate generated dimensions. These follow-up interviews will be conducted shortly after each repertory grid interview has been processed with pictures of generated dimensions and transcriptions of definitions for each generated element and construct.

7.3.3 Social network analysis

Interaction is central to understanding how the early phase of the product innovation process unfolds. One technique to collect information about patterns of interaction is social network analysis. Other techniques include observing and structuring ongoing interaction in terms of who and what. Similar to a cognitive map, participating individuals may draw their relations and content concerning action within the early phase. However, social network analysis gives the opportunity to use statistical calculations, combining alter-ego analysis and the repertory grid technique, provided that similar scales are used. In respect to the second focus question, the other two techniques are preferable, since they address the content of interaction in a dynamic way. Using social network analysis, the content will be addressed static by naming the

same action related to the activities in the repertory grid. Nevertheless, social network analysis will be used for its statistical use.

This technique is based on a structured interview focusing on patterns of interaction about activities characterizing routines in the early phase. In this way, patterns of interaction will highlight activities subject to socialization. This socialization is related to pressure as well as the need for cohesion and thus homogeneity. Activities that are highly interacted about will thus show an increase in homogeneity among participants between the two occasions for social network analysis.

Using this technique, participating individuals will be asked to think about the activities presented and to list all individuals with whom they have interacted. These individuals may either be participating in the early phase or may be outside of the process. Next, the respondent will grade the extent to which interaction has been made. In the significant test, a nine-point Likert scale was used successfully, but this scale was formulated to interaction during the past month which might require revision depending on the time span of the early phase. Asking for interactions made during the past month implies that the process lasts for at least two months. When a matrix has been performed by all participating individuals, it be may addressed by a computer program in which networks of relations are visually displayed. These visual pictures of the relations in the process can also be combined by centrality measures guiding central individuals and the degree of interaction performed.

For a meaningful analysis, the degree of interaction will be used in several ways. First, it will point toward activities of social exchange, which indicates an active process of structuration. Combining this analysis with the repertory grid technique will increase the likelihood of finding altering grids concerning these activities between the two occasions of structured interviews. Second, the activities interacted about indicate the areas that the individual perceived as central at that time. This will be seen through the frequency of interaction made about an activity. If interaction occurred, then the individual needed to clarify in some way due to uncertainties. Activities with a high degree of interaction show a higher degree of homogeneity among participants and indicate important relationships among participants within and outside of the formal group. The informal manager will become apparent through his or her large degree of incoming interaction on the social exchange performed in the early phase. These are important individuals since their identity has a great impact in indicating important activities for participating individuals.

7.3.4 Alter-ego network analysis

As thought, action and interaction are three cornerstones of institutionalization and the process of structuration, it is important to capture them all. Thought are mainly captured by use of alter -ego network analysis. Interviews will examine individual thought but not in the same structured way. Alter-ego network analysis captures an individual's thoughts about the same activities used in the repertory grids and social network analysis. Individuals may think about an activity in the early phase, because it

has been performed before, which providing guiding social structures, or because it has never been performed before, which result in a need to interact.

The alter-ego network analysis will be performed at the same time as the repertory grid and social network analysis. Similar to social network analysis, it is based on a matrix in which all activities are listed on one axis, and "myself" is listed on the other. The individuals are asked to consider the degree of own thoughts and reflections concerning each activity. This is then graded on a nine-point Likert scale ranging from "not at all" to "daily" during the past month; as previously noted, this implies that an early phase lasts at least two months. Both social network analysis and alter-ego network analysis would benefit from a reduction in time span, due to problems in recalling what he or she was thinking about one month ago. On the other hand, this would also reduce the possibility to see changes in the repertory grids. Thus, the choice of time span must be closely considered and applied after the product innovation process, since the early phase may vary in length and size.

The alter-ego network analysis must be related to which activities are given thought and which are not. This is especially interesting when combined with the other techniques used. If an activity is not given any thought and/or interaction but is considered central in the repertory grids for the early phase of the product innovation process, this indicates problems within social structures such as norms, allowing exchange or a need to correct routines.

7.3.5 Observation

One way to obtain a deeper understanding of how an early phase unfolds from an idea into a concept is by participation in the making. Both active[37] and passive[38] observation gives the opportunity to reflect about ways of acting and interacting in the process. An advantage for passive observation is the ability to observe and reflect during and after each encounter. When observing actively, it is difficult to both participate and reflect on what is really happening. This requires excellent field notes, memory, and/or recordings as well as instant reproduction of each social encounter to note each detail. Another disadvantage is the unknown effect of the researcher's action and interaction, which might influence how the early phase unfolds. It may be questioned if action and interaction as well as identified mechanisms result from the researcher's active participation or unfold naturally during the process. Preferably, I will take a more passive position in the innovation process. However, I will discuss or answer questions if addressed, since trust is a fundamental to this study. If I do not participate in the social arena , then trust will not develop, which may skew results by answering in a way that they think they should (cf. espoused theory) and not in respect to what they really do (cf. theories-in-use; Argyris & Schön, 1978).

When conducting observations, it is important to have a clear perception of what to observe. Otherwise, this may create the problem of what is essential within the early

[37] Active observation refers to observing while participating through action or interaction in the process.
[38] Passive observation refers to observing without taking part in action or interaction.

phase (cf. Bell, 1995). If relating this to the two focus questions, it implies a focus on concrete action and interaction made and the content of this action and interaction. Focusing on action per se will account for what is really done in the early phase, i. e. how the idea is transformed into a concept through action and interaction. By focusing on the content of "what is really done," it is possible to find cause and effect relations between thought, action, interaction, and frames of reference. To make this even more concrete, the focus is on routines as the institutional carrier, which will naturally guide observations toward patterns of action and interaction assigned to the regulative, normative, and cultural-cognitive pillars. In the regulative pillar, Scott (2001) emphasizes protocols and standard operating procedures. As a result, observations will focus on actions in relation to what participating individuals in the interview describe as actions that are usually performed in the early phase. In respect to the normative pillar, observation will focus on identity. Focusing discrepancies in identity based on explicit and observed will add to causes and effects of action and interaction. In the cognitive dimensions, we will focus on moments of "oh." This is to say that these moments imply new connections in an individual's frames of reference.

In order to perform these observations, some degree of structure will facilitate both what to look for and how to register during the ongoing process. Bell (1995) discusses several ways of performing structured observations and registration through arrangement, tables, and diagrams. Since the observations should focus on routines in terms of content, a table would make it possible to note participants, subjects, and different categories of content. As such, a structured journal and notes will be made in order to account for the unfolding early phase of product innovation processes.

7.3.6 Interconnectedness of used techniques

All of these techniques shed light on closely related yet distinct aspects of social processes of innovation. An idea may evolve in an individual's frame of reference and then be presented to significant others through interaction or action; through unified action and interaction, this idea eventually evolves into a concept. Each technique focuses on one or more concepts presented in the V-diagram (Figure 9). Nevertheless, additional meanings are given when combining these techniques and concepts in analysis. For example, identity (obtained through the interviews) is connected to ascribing certain activities of action as important (repertory grid technique). To develop the idea, one may start by thinking or reflecting (alter-ego network analysis) on what needs to be done (interviews), guided by frame of reference (repertory grid technique). To spread the view of what needs to be done, the individual interacts with significant others (social network analysis) or starts to act (observation). Through this social interplay, the idea unfolds into a concept.

7.4 METHODOLOGICAL CONSIDERATIONS IN THE RESEARCH PLAN

This thesis focuses on innovation processes, specifically the early phase of the product innovation process. This is seen as a small and delimited part of organizations' daily and ongoing social processes of action and interaction. Furthermore, these processes

involve a constant, ongoing structure of action and interaction among individuals taking part in the social context of innovation within the organization. Thus, I will focus on individuals taking part in this social process of innovation.

Returning again to the focus questions, innovation is viewed as a phenomenon that evolves over time. It is thus essential to clarify how to account for differences in time. Often, a discrepancy between the starting point and the end of a process is assumed. However, with a perspective based on structuration, this does not have to be the case. If no unintended consequences occur, then all structures will be reproduced, which will indicate no differences in frames of reference. Nevertheless, there will be action and interaction throughout the entire process.

In order to capture the unfolding process in the early phase, the process will be observed and information will be collected at two points in time. When performing observations, the focus will be on project meetings and not real-time observation of the action and interaction made by each individual. One alternative would be to collect information at the beginning and at the end, which gives the opportunity to observe differences. However, such course of action does not give insight into how and why the differences occur without a chronological view of time. One could say that it is embedded in the very nature of an unfolding process with a view based on chronology. The second focus question focuses on content in the early phase (mechanisms influencing the early phase). In order to visualize cause and effect relations (mechanisms), it is important to display these mechanisms chronologically.

7.4.1 A perspective of social processes of product innovation processes

When performing this future study, it is possible to choose one perspective or to highlight several perspectives. This can be achieved by focusing on the individuals taking part in the process, by differentiating between organizational levels, or by comparing companies. Related to the perspective governing this study, it has focus on the individual. This is to say, structures do not exists by themselves (cf. Giddens, 1979) but within the individual as a carrier of the structures governing the early phase of product innovation processes. In the same way, the cause-effect relations (mechanisms) influencing the social situation of early phases originate in the participating individuals. However, discussions will be made concerning both individual and group analysis in order to address homogeneity, heterogeneity, and patterns of shared action and interaction. Nevertheless, I will maintain the focus on the individual.

Another area in need of clarification is the distinction between structure and process. This thesis focuses on process by addressing how an idea transforms into a concept. The dynamic product innovation process involves constant thought, action, and interaction among individuals. Within this process, the aforementioned techniques will reveal structures through patterns in the individual's descriptions, frames of reference, and ways of actions and interactions. Thus, structure refers to the parts constructing the early phase of the process, which is differentiated from structures in Giddens's (1979) structuration theory. The repertory grid technique will reveal

structures that make it possible to discuss the content of an individual's frame of reference. Similarly, the social- and alter-ego network analysis will focus on structures by showing patterns of interaction and thought of content. Combining these techniques will indicate patterns in structures as in unfolding patterns when an idea transforms into a concept.

7.4.2 Problems when studying social processes of product innovation processes

A study focused on individuals taking part in an early phase of product innovation demands access, trustworthiness, authenticity, time, and closeness. Access is a fundamental prerequisite for studying any evolving process. In this case, access may be difficult to achieve, since extensive use of techniques requires time with each individual participating in the process. This problem is twofold, since both the organization and participating individuals must approve of their involvement in this study. The significant test indicated that this as a potentially large problem, as all individuals are preferred to participate. However, the significant test was performed in the context of a project within the university, which is characterized by a large degree of self-determination. When using intended techniques within a company context, this self-determination decreases but is still dependent on the willingness of all individuals to participate. Consequently, each individual needs to assign time and space since them being closely involved and exposed throughout the study. Forced participation due to compliance rather than willingness will affect the results trustworthiness. A potential problem related to trustworthiness is related to interpretation when combining the analysis from each used technique, which will be based on perception and thus founded in the frame of reference of all individuals analyzing the collected information. Nevertheless, a carefully prepared and well carried out study will warrant trustworthiness in the process, which gives high authenticity.

These techniques depend on individuals' memory. For example, the significant test was based on individuals' memory of their interactions and reflection on activities performed over the past month. This is also related to the degree of activity conducted in the early phase of the product innovation process. If many activities have been conducted, it may be more difficult for an individual to remember specific details of each relation and reflection.

The need for a neutral researcher is especially important when using the repertory grid, since even small recognition by expressing approval through nodding, sounds etc. will guide the individual toward the "right way" of thinking. As such, the repertory grid may give a skewed description of participating individuals' frames of reference by affecting the process in which constructs are generated. However, some degree of involvement is needed since it gives the possibility for clarity of constructs in terms of ascribed meaning and need for separation of constructs.

7.4.3 Selecting a product innovation processes

When performing this study, it is important to find an organization that fulfills several criteria. First, the organization must fit the criteria of a product innovation process. The focus of this study on the early phase of the process implies them having some

sort of formalized way of addressing this phase in order to find and recive access. If the organization does not have any formalized way of collecting ideas into the formal structures of decision-making, then it will be impossible to find an beginning early phase. This creates a problem, since it is preferable to begin this study as close to the formulation of the idea as possible. If the idea is expressed and discussed among individuals before intercepted into the formal structures of decision-making, which makes it easyer to find, but then the process does not include the entire early phase. There are several possibilities when selecting a product innovation process. Contacts can be made in advance with a company where participation is granted, or only part of the early phase will be retrospectively captured. Choosing the latter implies an inability to observe the actions and interactions made during that time and a reliance on individuals' memory, which may result in conflicting descriptions of how the idea evolved. Another alternative is to choose an organization without knowing if an early phase of a product innovation process will start within a near future; this risk is reduced if innovations are seen as a constant part of survival within the organization.

The discussion of real time vs. retrospective information collection is based on an assumption of experience in performing early phases of product innovation processes. If the organization has performed previous innovation processes, then it has already produced structures governing this situation. At least one innovation process must be carried out by participating individuals in order to reproduce the structures of the previous process. As a result, it is likely that the organization will be rather large, thus reproducing this type of work and reproduced channels for decision-making. In contrast, a smaller organization will be guided by and closely connected to the founder's ways of action and interaction; it is possible that no assigned process exists but rather performed by the founder as only participant.

Intensity, time span, scope, and number of participants must also be considered. Intensity is related to the minimum degree of action and interaction among participating individuals. If the process is based on work among solitary individuals, where the innovation represents a summarized collection of each individual's action, then it is not a meaningful context for this study. Project meetings, discussions and/or collaborative action are required. The process must be span enough time to reflect, perform action, and interact in order to cause changes in individuals' frames of reference; however, the time span cannot be too extensive due to limitations for this study.

The scope of the innovation process may range from small, simple products to large, complex products. The scope is also connected to the number of participating individuals. Since it is preferable that all individuals involved in the early phase take part in this study, the scope cannot be to large due to time constraints. On the other hand, if the scope is too small, then there would not be a need for interaction. Similarly, if the scope of the innovation process is too large and complex, then it is possible that the product development is divided into different units of responsibility. For example may the development of an aircraft be divided into separate parts like the

body, wings, engines, electronics etc. all performing early phases of innovation within a larger product innovation process. Consequently, adding complexity by interconnectedness in the different early phases.

7.5 TENTATIVE IMPLICATIONS FROM KNOWLEDGE OF EARLY PHASES

Based on the significant test, the initial purpose of addressing product innovation processes is to obtain knowledge about the early phase of the process. A literature review about the early phase[39] was conducted, which indicated a gap in knowledge about how the early phase of innovation unfolds. Gaining this knowledge will identify mechanisms influencing the process, which suggests a first step for how managers may control the process. Such information can lead to more effective innovation processes, which could save time, cost, and improve quality.

This study will describe how an idea unfolds into a concept, revealing who is involved as well as what occurs in this phase and why. I will follow the journey of thought, action, and interaction from a single individual to the social processes of action and interaction, producing or reproducing institutional routines. Cause and effect mechanisms will also be determined, which influence how an idea unfolds into a concept within the product innovation process.

Second, tentative knowledge from this study will provide insight into routines and emphasize certain content in action and interaction that may promote innovativeness. This will be achieved by focusing on perceived effects of participating individuals' thoughts, actions, and interactions, where routines in terms of reproduced patterns of action and interaction have a content that the participants perceive as adding energy to the product innovation process.

The third tentative knowledge possible to obtain by performing this research in full-scale would be the relationship between the identity ascribed by each individual and their focus in thought, action, and interaction, i. e. the likelihood that ascribed identity makes it more plausible to consider certain activities as more important.

Although many would argue that the product innovation process is a dynamic, iterative, and chaotic journey from idea to concept, this is not necessarily the case. The innovation process could be well-planned with reproduced routines, which implies that individuals engage in a process where action and interaction resemble sequential thinking due to the institutional content, even though the process may appears as chaotic by individuals not participating.

7.5.1 Concluding remarks

The purpose presented in this thesis, is focused on (1) developing a model (2) formulating a research plan for the significant test, (3) make the significant test, and (4) develop a research plan for a full scaled empirical test. The first purpose where

[39] The term used in the search was "fuzzy front end."

addressed in chapter 3 and especially in the last section (3.6.1) in which the social and cognitive process of product innovation are discussed and illustrated. The second purpose are addressed in chapter 4, where guidelines was addressed to make the significant test. This significant test is then presented and analyzed in chapter 5 and 6, which is in line with the third purpose. In this last chapter 7, a research plan is formulated for a full-scale empirical study of the early phase of product innovation processes. This research plan incorporates all concepts in the conceptual model as well as lessons from the significant test.

Knowledge about the early phase of the product innovation process (in particular, the social mechanisms influencing thought, action, and interaction) may provide a tool for management to understand the causes and effects in this process. Thus, this research may allow management to take control of a negative spiral and constitute new patterns of thought, action, and interaction that enforce their innovative capacity.

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APPENDIX 1: Kelly's fundamental postulate and corollaries

Kelly's (1955/1991) fundamental postulate states that "a person's processes are psychologically channelized by the ways in which he anticipates events." Based on this fundamental postulate, Kelly makes several propositions (corollaries) that elaborate the postulate in greater detail:

- The *construction corollary* states that a person anticipates events by constructing events.
- The *individual corollary* states that persons differ from each other in their constructions of events.
- The *organization corollary* states that each person characteristically evolves, for his convenience in anticipating events, a construction system embracing ordinal relationships between constructs.
- The *dichotomy corollary* states that a person's construction system is composed of a finite number of dichotomous constructs.
- The *choice corollary* states that a person chooses for himself that alternative in a dichotomized construct through which he anticipates the greater possibility for extension and definition of his system.
- The *range corollary* states that a construct is convenient only for the anticipation of a finite range of events.
- The *experience corollary* states that a person's construction system varies as he or she successively construes the replication of events.
- The *modulation corollary* states that the variation in a person's construction system is limited by the permeability of the constructs within whose ranges of convenience the variants lie.
- The *fragmentation corollary* states that a person may successively employ a variety of construction subsystems that are inferentially incompatible with each other.
- The *commonality corollary* states that the extent to which one person employs a construction of experience is similar to that employed by another (his or her psychological processes are similar to those of the other person).
- The *social corollary* states that the extent to which one person construes the construction processes of another may play a role in a social process involving the other person.

APPENDIX 2: Reduced elements used

This shows the initial 39 elements, which where scaled down to the 22 used when conducting the repertory grid technique, social network analysis and alter-ego network analysis.

Initially considered elements	*scaled down to*	**Used elements**
Generate ideas		User feedback
Identify market		Get support from management/financier
Identify technical opportunity		Generate ideas
Evaluate ideas		Identify perspectives of others
Identify user needs		Identify suitable technology
Identify suppliers needs		Identify opportunities
Perspectives within the team		Plan/adapt for manufacturing
Write product specification for user		Plan project
Write product specification for the company		Programming
Plan project		Simulating
Evaluate suitable technologies		Write product specification
Develop concept		Final tests on users
Promote to management		Product release
Develop project business plans		User studies
Supervise cost specifications		Test technology/design
Supervise time specifications		Elaborate distribution
Supervise design specifications		Elaborate support
Choose technology		Educate employees
Develop technology		Develop business plan for the innovation
Perform tests on technology		Develop concept
Perform tests on design		Choose algorithm
Plan for manufacturing		Supervise time, cost, and design
Make drawings		
Order material		
Adapt factory		
Develop factory		
Develop tools		
Educate salespersons		
Educate distributors		
Evaluate		
Conduct technical test of model		
Conduct user test of model		
Test market		
Price testing		
Develop manual		
Feedback from users		
Marketing the product		
Support		
Product release		

APPENDIX 3: Guidelines for the structured interview

Introduction text:

1. During this interview, I want you to think about the DTN-project as a whole.
2. Review all of the activities listed in the matrix. Do they seem representative of an innovative process like the DTN-project?
3. Is there any other element that you think should be included?
4. Is there any element that you think should be excluded?
5. What do elements 1 and 2 have in common that differentiates them from the third element?
6. Please explain what you mean by the construct.
7. What do elements 2 and 3 have in common that differentiates them from the fourth element?
8. I would like you to include the following constructs in the matrix:

   Easy to handle – Difficult to handle
   Requires a small amount of effort – Requires a large amount of effort
   Least critical for process success – Most critical for process success
   Least critical for product success – Most critical for process success
   Application of previous knowledge – Requires new ways of thinking

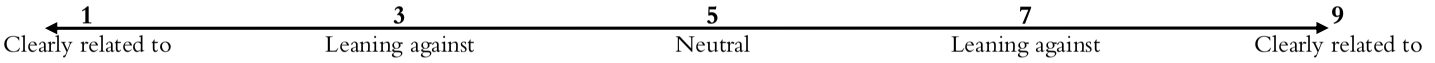
9. Now relate each element to the constructs by grading each construct on a nine-point scale.
10. First grade the element most closely related to number one on the scale (in other words, the pole construct).
11. Next, grade the element most closely related to number nine on the scale (in other words, the contrast construct)
12. Now grade the remaining elements in relation to elements graded as number one and nine.
13. The scale is based on five steps to which each element is related. If you think that the element cannot be graded as clearly related to one of them, then you can use the number between the grades.
14. It is possible to place several number ones, nines, and fives and so on, if you cannot separate them.
15. Zero indicates an element that is not meaningful or that cannot be related to the constructs. Split constructs?

Name:

.....

		ELEMENT																										
		User feedback	Get support from management/financier	Generate ideas	Identify perspectives of others	Identify suitable technology	Identify opportunities	Plan/adapt for manufacturing	Plan project	Programming	Simulating	Write product specification	Finishing tests on users	Product release	User studies	Test technology/design	Elaborate distribution	Elaborate support	Educate employees	Develop business plan for the innovation	Develop concept	Choose algorithm	Supervise time, cost and design				
Constructs	**Low scores 1**																											**High scores 9**
	1.																											1.
	2.																											2.
	3.																											3.
	4.																											4.
	5.																											5.
	6.																											6.
	7.																											7.
	8.																											8.
	9.																											9.
	10.																											10.
	11.																											11.
	12.																											12.
	13.																											13.
	14.																											14.

0 = Cannot relate /Is not meaningful for this element



Definitions of elements:

User feedback..... Is defined as all thought or action related to feedback from user and internal dissemination of this information.

Get support from management/financier ..... Is defined as all thought or action related to get authority in the form of approval and/or resources in the form of time, money or personnel to the project.

Generate ideas..... Is defined as all thought or action related to the initial idea creation for the project independent whether it is done separate or through collective creation and refining of the initial idea.

Identify perspectives of others..... Is defined as all thought or action related to the identification of perspectives of others concerning the innovation internally in the group and external individuals not considered as user, for example suppliers, salespersons, material technicians etc.

Identify suitable technology..... Is defined as all thought or action related to the search and evaluation of suitable technologies through for example benchmarking, related technologies, need evaluation and valuation or ranking of identified technologies.

Identify possibilities ..... Is defined as all thought or action related to internal or external activities intended to identify technical or market opportunities in relation to the company's field of knowledge.

Plan/adapt for manufacturing..... Is defined as all thought or action related to planning and adaptation of machines and internal processes for production of the innovation.

Plan project ..... Is defined as all thought or action related to ascribing resources as time, money and accessible personnel. Other activities might be to ascribe rolles, settle goals, make budgets, plan time for milestones and revision of present plans.

Programming..... Is defined as all thought or action related to identifying, planning, realizing and developing the programming.

Simulating ..... Is defined as all thought or action related to planning, realizing and analysing simulations made with the intent to improve the innovation.

Write product specification..... Is defined as all thought or action related to establish, decide and write down the product specification for the innovation concerning needs, design, usability, market demands and company demands.

User studies..... Is defined as all thought or action related to activities where participants in the project studies potential users of the innovation in order to further develop the initial idea or concept.

Finishing tests on users..... Is defined as all thought or action related to external verification of chosen technology and design.

Release the product ..... Is defined as all thought or action related to plan and work out the release in detail as in media contacts, marketing etc.

Test technology/design ..... Is defined as all thought or action related to internal testing of technology and design in real life situations.

Elaborate distribution ..... Is defined as all thought or action related to the identification, development, choice and execution of suitable channels for distribution.

Elaborate support..... Is defined as all thought or action related to development and refining support functions for the innovation.

Educate employees ..... Is defined as all thought or action related to give employees sufficient knowledge for development, manufacturing and selling of the innovation.

Develop business plan for the innovation ..... Is defined as all thought or action related to the development of business plans for the proposed innovation.

Develop concept ..... Is defined as all thought or action related to generate, develop, evaluate and choose concept for further development.

Choose algorithm ..... Is defined as all thought or action related to find, develop and choose a suitable algorithm.

Supervise time, cost and design ..... Is defined as all thought or action related to secure the project in relation to time plans, limits in expenditure and product specifications.

Definitions of constructs:

Easy to handle ..... Is defined as the degree of complexity to handle and/or carry through ..... **Difficult to handle**

Requires a small amount of work effort ..... Is defined as the degree of work effort to handle and/or carry through ..... **Requires a large amount of work effort**

Least critical for process success ..... Is defined as the degree of importance for a successful process realization ..... **Most critical for process success**

Least critical for product success ..... Is defined as the degree of importance for a successful product realization ..... **Most critical for process success**

Application of previous knowledge ..... Is defined as the degree of innovativeness in the process ..... **Requires new ways of thinking**

APPENDIX 4: Data generated based on the repertory grid technique

(Rotated results)

```
Data transformation: 1 ):  Correlate  (standardize CONSTRUCTS): MOST COMMON
a) Maximal nr. of components =  4
b) Minimum relative variance of a component (1 recommended by Kaiser) 0
   if b) gives K components then nr. of components will be: M = MIN( 4 ,K)

Maximal nr. of components for VARIMAX  =  4
```

Minimum, mean, maximum and standard deviation of each variable

CONTRAST	/ POLE (9)	VBL.	MIN.	MEAN	MAX.	STD.DEV.	% OF TOTAL VAR.
Create arg within f o ap	/ Create free thoughts	1	1	4.91	9	1.65	5.40
Financial aspects	/ Technology driven	2	1	4.91	9	1.93	7.39
Filtering of idea	/ Unlimited opportunities	3	1	4.59	9	2.04	8.24
Increasing freedom of ac	/ Limiting freedom of act	4	1	4.91	9	1.65	5.40
Being controlled/influenc	/ In control	5	1	4.95	9	1.74	6.04
Work witho know if right	/ May f probl giv ext rew	6	1	5.91	9	1.73	5.94
Opportu affect prod spec	/ Can no longer affect	7	1	4.55	9	1.59	5.01
Develops business	/ Chose track	8	1	5.05	9	1.82	6.59
Creating phase	/ Constraining budget	9	1	4.73	9	1.60	5.09
Easy to handle	/ Difficult to handle	10	1	4.68	9	1.72	5.85
Require small am work ef	/ Require large am work ef	11	1	3.95	9	2.18	9.47
Least crit f proc succes	/ Most crit f proc succes	12	1	4.77	9	2.50	12.45
Least crit f prod succes	/ Most crit f prod succes	13	1	5.73	9	2.11	8.88
Appl previous knowledge	/ Require new w o thinking	14	1	4.50	9	2.04	8.26
		Total mean		4.87		Mean var.	3.60

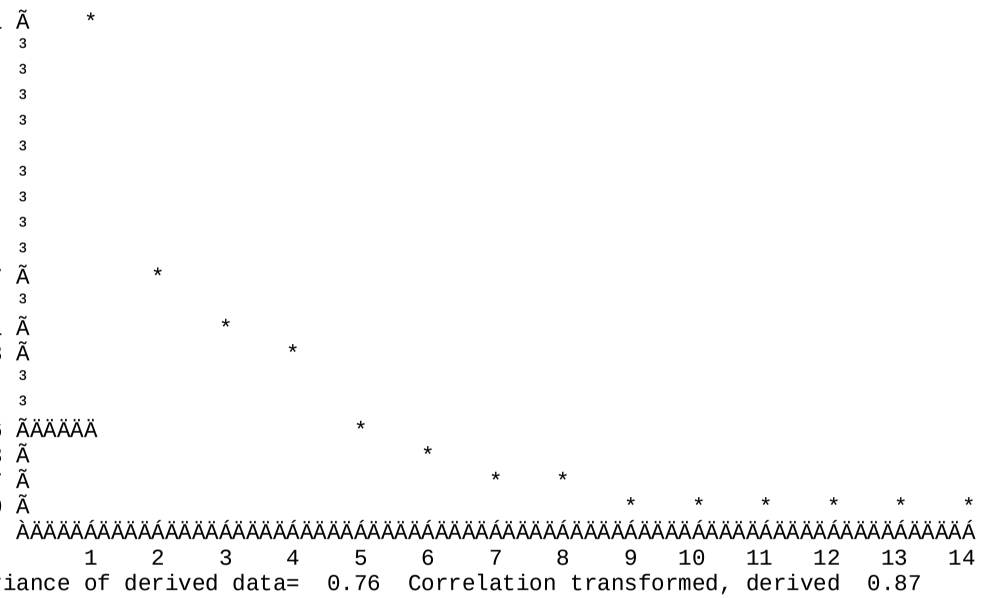
Correlation table, showing the relationships between all the variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.00													
2	0.45	1.00												
3	0.48	0.35	1.00											
4	0.13	0.05	-0.16	1.00										
5	-0.06	-0.08	0.22	-0.76	1.00									
6	-0.54	0.16	-0.46	0.04	-0.21	1.00								
7	0.09	-0.24	-0.04	0.49	-0.14	-0.13	1.00							
8	0.06	-0.05	-0.36	0.65	-0.53	0.22	0.12	1.00						
9	-0.42	-0.42	-0.59	0.56	-0.20	0.27	0.33	0.61	1.00					
10	-0.11	-0.23	0.07	0.05	0.03	-0.18	-0.02	0.05	0.07	1.00				
11	0.35	0.53	0.57	-0.08	0.20	-0.33	-0.10	-0.34	-0.42	-0.11	1.00			
12	0.17	0.58	0.62	-0.21	0.27	-0.04	-0.07	-0.43	-0.46	0.03	0.81	1.00		
13	0.12	0.44	0.48	0.06	0.03	-0.02	0.10	-0.15	-0.29	0.45	0.50	0.78	1.00	
14	-0.04	0.02	0.59	-0.35	0.47	-0.43	0.18	-0.50	-0.42	0.34	0.33	0.49	0.48	1.00
M(Abs)	0.23	0.28	0.38	0.28	0.25	0.23	0.16	0.31	0.39	0.13	0.36	0.38	0.30	0.36

Intensity (root mean square) 0.36 Mean absolute value 0.29

Component	Root	%VAR	Cum%
1	4.811	34.364	34.364
2	2.417	17.264	51.628
3	1.861	13.296	64.923
4	1.598	11.413	76.336
5	1.046	7.474	83.810
6	0.673	4.806	88.616
7	0.527	3.765	92.381
8	0.406	2.900	95.281
9	0.270	1.925	97.207
10	0.210	1.503	98.709
11	0.112	0.798	99.507
12	0.055	0.394	99.901
13	0.011	0.077	99.978
14	0.003	0.022	100.000

Scree plot for dtn1eng



Variance of transformed data= 1.00 Variance of derived data= 0.76 Correlation transformed, derived 0.87

Principal components

CONTRAST -	/POLE +	VBL.	1	2	3	4	DIST.	VAR-R	%ACC.
Create arg within f o ap	/Create free thoughts	1	0.381	0.510	-0.118	-0.652	0.919	1.000	84.517
Financial aspects	/Technology driven	2	0.490	0.517	-0.545	0.169	0.913	1.000	83.376
Filtering of idea	/Unlimited opportunities	3	0.806	0.206	0.126	-0.191	0.863	1.000	74.490
Increasing freedom of ac	/Limiting freedom of act	4	-0.473	0.807	0.238	-0.000	0.965	1.000	93.145
Being controlled/influenc	/In control	5	0.473	-0.659	0.083	-0.028	0.816	1.000	66.592
Work witho know if right	/May f probl giv ext rew	6	-0.406	-0.029	-0.452	0.707	0.933	1.000	87.028
Opportu affect prod spec	/Can no longer affect	7	-0.167	0.322	0.586	-0.128	0.700	1.000	49.041
Develops business	/Chose track	8	-0.649	0.521	0.034	0.018	0.833	1.000	69.392
Creating phase	/Constraining budget	9	-0.767	0.117	0.281	0.203	0.850	1.000	72.247
Easy to handle	/Difficult to handle	10	0.087	-0.013	0.669	0.317	0.746	1.000	55.584
Require small am work ef	/Require large am work ef	11	0.755	0.322	-0.138	0.025	0.833	1.000	69.369
Least crit f proc succes	/Most crit f proc succes	12	0.832	0.242	-0.077	0.391	0.954	1.000	90.925
Least crit f prod succes	/Most crit f prod succes	13	0.616	0.406	0.278	0.534	0.952	1.000	90.698
Appl previous knowledge	/Require new w o thinking	14	0.690	-0.209	0.542	0.095	0.907	1.000	82.302
SS			4.811	2.417	1.861	1.598	10.687		
%VARIANCE			34.364	17.264	13.296	11.413	76.336		

Factor scores

	VBL.	1	2	3	4	DIST-N	*	DIST.	VAR-R	%ACC.
A User Feedback	1	-0.650	-0.502	-1.942	-0.593	2.190	*	0.855	1.032	70.784
B G suppor f man/fin	2	-0.279	-3.494	0.265	0.318	3.530	*	1.468	2.327	92.608
C Generate ideas	3	2.229	1.140	0.204	-1.982	3.200	*	1.544	2.484	96.050
D Ident persp of oth	4	-0.570	0.618	-0.438	0.668	1.160	*	0.504	0.823	30.860
E Ident suitab techn	5	0.619	0.829	-0.411	1.269	1.688	*	0.676	0.762	59.908
F Ident opportun	6	1.830	-0.167	-0.148	-2.154	2.835	*	1.299	1.784	94.644
G Plan/adapt f manuf	7	-1.233	0.162	0.663	0.286	1.439	*	0.771	1.215	48.981
H Plan project	8	-0.549	-1.339	-0.127	-0.697	1.611	*	0.686	0.697	67.534
I Programming	9	-0.041	-0.029	-0.580	-0.481	0.755	*	0.268	0.175	41.134
J Simulating	10	0.550	0.764	-0.332	1.065	1.460	*	0.591	0.603	57.783
K Write prod spec	11	-0.265	-0.067	-0.487	-0.241	0.608	*	0.251	0.589	10.708
L Final tests o user	12	-0.512	0.093	-1.001	-0.005	1.129	*	0.474	0.384	58.516
M Product release	13	-1.087	1.321	2.667	0.203	3.175	*	1.287	1.787	92.781
N User studies	14	-0.451	0.053	-1.027	0.288	1.159	*	0.469	0.519	42.349
O Test techn/design	15	0.491	0.844	-1.515	1.875	2.601	*	0.955	1.047	87.126
P Elaborate distrib	16	-0.181	-0.242	1.293	-0.089	1.331	*	0.495	0.355	68.998
Q Elaborate support	17	-0.353	-0.325	0.548	-0.523	0.897	*	0.364	0.158	83.592
R Educate employees	18	-0.218	-0.173	0.429	-0.527	0.735	*	0.279	0.139	55.726
S Devel busin plan	19	1.113	-0.595	1.632	1.175	2.374	*	0.999	1.153	86.571
T Develop concept	20	1.221	-0.347	0.534	1.081	1.751	*	0.839	0.867	81.271
U Choose algorithm	21	0.594	0.211	-0.134	0.465	0.794	*	0.395	0.368	42.408
V Supervise T C & D	22	-2.259	1.246	-0.093	-1.402	2.937	*	1.499	2.732	82.229
Mean(SS)		1.000	1.000	1.000	1.000	4.000				

Transformation matrix

	1	2	3	4
1	0.741	-0.550	0.134	-0.360
2	0.504	0.830	-0.022	-0.239
3	-0.230	0.089	0.933	-0.263
4	0.379	0.028	0.334	0.863

VARIMAX rotated components

CONTRAST -	/ POLE +	VBL.	1	2	3	4	DIST.
Create arg within f o ap	/ Create free thoughts	1	0.320	0.185	-0.289	-0.791	0.919
Financial aspects	/ Technology driven	2	0.813	0.116	-0.398	-0.011	0.913
Filtering of idea	/ Unlimited opportunities	3	0.600	-0.266	0.157	-0.538	0.863
Increasing freedom of ac	/ Limiting freedom of act	4	0.001	0.951	0.140	-0.086	0.965
Being controlled/influenc	/ In control	5	-0.011	-0.801	0.146	-0.059	0.816
Work witho know if right	/ May f probl giv ext rew	6	0.057	0.179	-0.239	0.882	0.933
Opportu affect prod spec	/ Can no longer affect	7	-0.145	0.407	0.474	-0.281	0.700
Develops business	/ Chose track	8	-0.220	0.793	-0.061	0.116	0.833
Creating phase	/ Constraining budget	9	-0.498	0.550	0.224	0.349	0.850
Easy to handle	/ Difficult to handle	10	0.024	0.009	0.742	0.070	0.746
Require small am work ef	/ Require large am work ef	11	0.763	-0.160	-0.026	-0.291	0.833
Least crit f proc succes	/ Most crit f proc succes	12	0.904	-0.253	0.165	-0.000	0.954
Least crit f prod succes	/ Most crit f prod succes	13	0.800	0.037	0.511	0.068	0.952
Appl previous knowledge	/ Require new w o thinking	14	0.317	-0.502	0.635	-0.259	0.907
SS			3.586	3.137	1.885	2.079	10.687
%VARIANCE			25.615	22.404	13.465	14.852	76.336

Rotated factor scores

	VBL.	1	2	3	4	DIST.
A User Feedback	1	-0.513	-0.249	-2.085	0.354	2.190
B G suppor f man/fin	2	-1.907	-2.714	0.395	1.141	3.530
C Generate ideas	3	1.429	-0.317	-0.200	-2.839	3.200
D Ident persp of oth	4	0.243	0.806	-0.275	0.749	1.160
E Ident suitab techn	5	1.452	0.345	0.105	0.782	1.688
F Ident opportun	6	0.491	-1.218	-0.609	-2.438	2.835
G Plan/adapt f manuf	7	-0.877	0.880	0.546	0.478	1.439
H Plan project	8	-1.316	-0.840	-0.395	-0.050	1.611
I Programming	9	-0.094	-0.067	-0.706	-0.241	0.755
J Simulating	10	1.272	0.332	0.103	0.625	1.460
K Write prod spec	11	-0.210	0.040	-0.568	0.032	0.608
L Final tests o user	12	-0.104	0.270	-1.006	0.422	1.129
M Product release	13	-0.677	1.938	2.380	-0.451	3.175
N User studies	14	0.038	0.208	-0.923	0.668	1.159
O Test techn/design	15	1.849	0.347	-0.740	1.638	2.601
P Elaborate distrib	16	-0.588	0.012	1.157	-0.294	1.331
Q Elaborate support	17	-0.750	-0.042	0.296	-0.391	0.897
R Educate employees	18	-0.547	0.000	0.199	-0.448	0.735
S Devel busin plan	19	0.596	-0.928	2.077	0.325	2.374
T Develop concept	20	1.018	-0.882	1.031	0.435	1.751
U Choose algorithm	21	0.753	-0.151	0.105	0.172	0.794
V Supervise T C & D	22	-1.557	2.229	-0.886	-0.670	2.937
Mean(SS)		1.000	1.000	1.000	1.000	4.000

APPENDIX 5: Guidelines for the structured interview

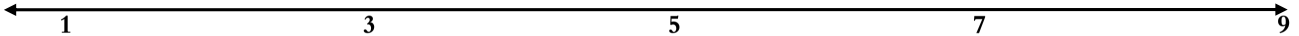
THE DEGREE OF COMMUNICATION AND REFLECTION

This section aims to inquire about the degree of communication and reflection concerning certain aspects of the innovation process. It contains 3 parts with part 1 aiming to map the degree you discussed the different aspects concerning the DTN-project. You will also value how much these conversations affected your view of the aspect and how it affected your work. Part 2 aims to map how much you reflected upon different aspects concerning the DTN-project and how you value the effect of the reflections upon your view on the aspect and your work. In part 3 you will find content definitions of each aspect used in parts 1 and 2.

PART 1 – The degree of communication

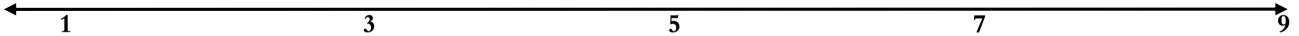
Look back at the past month in the DTN-project. **(1)** *Which individuals* have you contacted the past month concerning aspects in the process; such as to generate ideas, identify opportunities, etc.? It may be individuals within the project group, family or friends, other employees within the university/company, employees in other companies, etc. **(2)** *How often* have you contacted these individuals concerning aspects in the process the past month? **(3)** When you reflect on the conversations, *how do you value* this contact/these contacts concerning each aspect discussed? *Please notice that I would like you to render your personal understanding/memory and not what you might think someone else believes or thinks.*

The amount of contacts during the past month concerning the aspect:



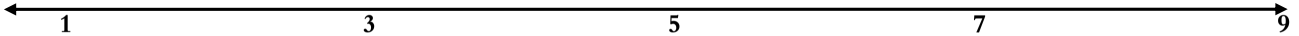
1	3	5	7	9
I have ***never*** contacted this individual during the past month.	I have contacted this individual ***occasionally*** the past month.	I have contacted this individual ***several times*** the past month.	I have contacted this individual ***several times per week*** the last month.	I have contacted this individual ***daily*** the past month.

My valuation of the contacts ***effects on my view*** the past month concerning the aspect:



1	3	5	7	9
The discussion/discussions ***did not affect*** my view on the aspect.	The discussion/discussions had a ***small affect*** upon my view on the aspect.	The discussion/discussions had ***some affect*** upon my view on the aspect.	The discussion/discussions had ***large affect*** upon my view on the aspect.	The discussion/discussions had ***very large affect*** upon my view on the aspect.

My valuation of the contacts ***effect on my work*** the past month concerning the aspect:



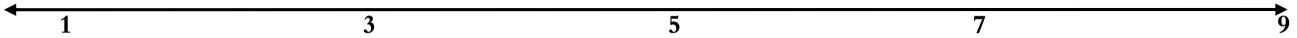
1	3	5	7	9
The discussion/discussions ***did not affect*** my work upon the aspect.	The discussion/discussions had a ***small affect*** upon my work on the aspect.	The discussion/discussions had ***some affect*** upon my work on the aspect.	The discussion/discussions had ***large affect*** upon my work on the aspect.	The discussion/discussions had ***very large affect*** upon my work on the aspect.

Name: **Arne C4-DTN**		**Activities I have discussed with the considered individual:**																									
Individuals I have contacted concerning… **(Name & occupation X on the company Y)**		User feedback	Get support from management/financier	Generate ideas	Identify perspectives of others	Identify suitable technology	Identify opportunities	Plan/adept for manufacturing	Plan project	Programming	Simulating	Write product specification	Final tests on users	Product release	User studies	Test technology/design	Elaborate distribution	Elaborate support	Educate employees	Develop business plan for the innovation	Develop concept	Choose algorithm	Supervise time, cost and design		
BnearIT	I have the past month contacted…	1	1	2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
	I regard that my view…			1			2																		
	I regard that my work…			1			1																		
Bottenvikens stuveri	I have the past month contacted…			2			3																		
	I regard that my view…			3			3																		
	I regard that my work…			3			3																		
SSAB	I have the past month contacted…			2			3																		
	I regard that my view…			2			2																		
	I regard that my work…			2			2																		
Volvo	I have the past month contacted…			2			2																		
	I regard that my view…			1			1																		
	I regard that my work…			1			1																		
TietoEnator	I have the past month contacted…			2			2																		
	I regard that my view…			1			1																		
	I regard that my work…			1			1																		
LUT	I have the past month contacted…			5			5		2														4		
	I regard that my view…			1			4		3														3		
	I regard that my work…			6			6		5														7		

PART 2 – The degree of reflection

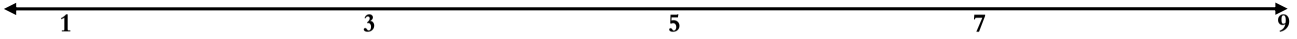
Look back on the past month in the DTN-project. **(1)** *How often* during the past month have you thought or reflected upon aspects within the process, such as to generate ideas, identify opportunities, etc.? **(2)** When reflecting upon your thoughts, *how do you value* your reflection regarding the aspects you have been thinking about? *Please notice that I would like you to render your personal understanding/memory and not what you might think someone else believes or thinks.*

The amount of reflection during the past month concerning the aspect:



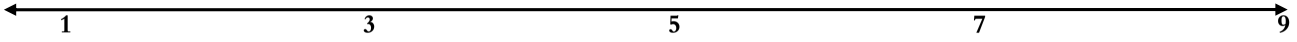
1	3	5	7	9
I have ***never*** reflected upon this the past month.	I have ***occasionally*** reflected upon this the past month.	I have reflected ***several times*** upon this the past month.	I have reflected ***several times per week*** upon this the last month.	I have reflected ***daily*** upon this the past month.

My valuation of the reflections **e*ffect on my view*** the past month concerning the aspect:



1	3	5	7	9
The reflection ***did not affect*** my view on the aspect.	The reflection had a ***small affect*** upon my view on the aspect.	The reflection had ***some affect*** upon my view on the aspect.	The reflection had ***large affect*** upon my view on the aspect.	The reflection had ***very large affect*** upon my view on the aspect.

My valuation of the reflections ***effect on my work*** the past month concerning the aspect:



1	3	5	7	9
The reflection ***did not affect*** my work on the aspect.	The reflection had a ***small affect*** upon my work on the aspect.	The reflection had ***some affect*** upon my work on the aspect.	The reflection had ***large affect*** upon my work on the aspect.	The reflection had ***very large affect*** upon my work on the aspect.

Continuation PART 2 – The degree of reflection

		Activities I have reflected upon:																							
I have reflected concerning…		User feedback	Get support from management/financier	Generate ideas	Identify perspectives of others	Identify suitable technology	Identify opportunities	Plan/adept for manufacturing	Plan project	Programming	Simulating	Write product specification	Final tests on users	Product release	User studies	Test technology/design	Elaborate distribution	Elaborate support	Educate employees	Develop business plan for the innovation	Develop concept	Choose algorithm	Supervise time, cost and design		
"my self"	I have the past month reflected…	1	1	1	3	1	4	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	5		
	I regard that my view…				4		5		4														4		
	I regard that my work…				2		4		5														5		

Definitions of elements:

User feedback..... Is defined as all thought or action related to feedback from the user and internal dissemination of this information.

Get support from management/financier ..... Is defined as all thought or action related to obtain authority in the form of an approval, or resources in the form of time, money or personnel to the project, or both an approval and resources.

Generate ideas..... Is defined as all thought or action related to the initial idea creation for the project regardless whether it is done separately or through collective creation and refining of the initial idea.

Identify perspectives of others..... Is defined as all thought or action related to the identification of the perspectives of others concerning the internal innovation in the group and external individuals not considered as users, for example suppliers, salespersons, material technicians, etc.

Identify suitable technology..... Is defined as all thought or action related to the search and evaluation of suitable technologies through, for example benchmarking, related technologies, need evaluation and valuation or ranking of identified technologies.

Identify possibilities ..... Is defined as all thought or action related to internal or external activities intended to identify technical or market opportunities in relation to the company's field of knowledge.

Plan/adapt for manufacturing..... Is defined as all thought or action related to planning and adaptation of machines and internal processes for production of the innovation.

Plan project ..... Is defined as all thought or action related to ascribing resources as time, money and accessible personnel. Other activities might be to ascribe rolls, settle goals, make budgets, plan time for milestones, and revision of present plans.

Programming..... Is defined as all thought or action related to identifying, planning, realizing and developing the programming.

Simulating ..... Is defined as all thought or action related to planning, realizing and analysing simulations made with the intent to improve the innovation.

Write product specification..... Is defined as all thought or action related to establish, decide and write down the product specification for the innovation concerning needs, design, usability, market demands and company demands.

User studies..... Is defined as all thought or action related to activities where participants in the project study potential users of the innovation to further develop the initial idea or concept.

Finishing tests on users..... Is defined as all thought or action related to external verification of chosen technology and design.

Release the product ..... Is defined as all thought or action related to plan and work out the release in detail, as in media contacts, marketing, etc.

Test technology/design ..... Is defined as all thought or action related to internal testing of technology and design in real life situations.

Elaborate distribution ..... Is defined as all thought or action related to the identification, development, choice and execution of suitable channels for distribution.

Elaborate support..... Is defined as all thought or action related to development and refining support functions for the innovation.

Educate employees ..... Is defined as all thought or action related to give employees sufficient knowledge for development, manufacturing and selling of the innovation.

Develop business plan for the innovation ..... Is defined as all thought or action related to the development of business plans for the proposed innovation.

Develop concept ..... Is defined as all thought or action related to generate, develop, evaluate and choose a concept for further development.

Choose algorithm ..... Is defined as all thought or action related to find, develop and choose a suitable algorithm.

Supervise time, cost and design ..... Is defined as all thought or action related to secure the project in relation to time plans, limits in expenditure and product specifications.

Thank you for your participation!

APPENDIX 6: Ascribed meaning to generated constructs

CONSTRUCTS	
CONTRAST -	**POLE +**
Create arguments within field of application *Definition: It creates good arguments why you want to do something.*	**Create free thoughts** *Definition: Se what users do and solve their problems.*
Financial aspects *Definition: The interest is to generate cash. It has to be for economical gain.*	**Technology driven** *Definition: Interest for new technology as a driving force.*
Filtering of idea *Definition: Work as a filter for the most insane things.*	**Unlimited opportunities** *Definition: Identify opportunities with the risk of lack of understanding by others. A continuous flow of unlimited opportunities.*
Increasing freedom of action *Definition: Possible to include everything without any thought on manufacturing, economy etc.*	**Limiting freedom of action** *Definition: A strong limitation of action by for example cost which was not thought about in advance.*
Being controlled / influenced *Definition: A controlling or less controllable factor for the project. Without influence.*	**In control** *Definition: Have a large opportunity to affect and being in control of the situation.*
Working without knowing if it is right *Definition: Take action in the planed direction. Just do it, without locking at problems.*	**May find problem giving extensive rework** *Definition: Verification gives feedback about errors, which may cause not foreseen problems.*
Opportunity to affect product specification *Definition: Refer the specification back, it is possible to affect.*	**Can no longer affect** *Definition: Can no longer affect demands.*
Develops business (innovative phase) *Definition: Develop your business within your area*	**Choose track (time to carry out)** *Definition: If one has decided that it is good enough, this will do, let us make it…*
Creating phase *Definition: Creation, It is possible to do anything.*	**Constraining budget** *Definition: One has to make a choice irrespective of good ideas. Prioritize, choose and restrict.*
Common constructs are defined in Appendix 3.	
Easy to handle	Difficult to handle
Requires a small amount of work effort	Requires a large amount of work effort
Least critical for process success	Most critical for process success
Least critical for product success	Most critical for product success